सत्यमेव जयते

Ministry of Housing and Urban Affairs
Government of India

FAECAL SLUDGE AND SEPTAGE MANAGEMENT

TECHNOLOGY AND FINANCING MODULE

PART B: LEARNING NOTES

National Institute of Urban Affairs

All India Institute of Local Self-Government

NFSSM Alliance

Ecosan Services Foundation

CEPT University

TITLE
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CONTENT
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Content for the module is developed by the following partners:
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Collaborative Effort Under Training Module Review Committee (TMRC)

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FOREWORD

Government of India launched Swachh Bharat Mission-Urban on 2nd October, 2014 to make country fully clean in five years and three other flagship Missions viz. Atal Mission for Rejuvenation and Urban Transformation (AMRUT), Smart City Mission (SCM) and Pradhan Mantri Awas Yojana-Urban (PMAY-U) were also launched on 25th June, 2015. These Missions aimed to promote sustainable and inclusive cities that provide core infrastructure and give a decent quality of life to its citizens, a green and clean environment and application of 'Smart' Solutions to make optimum utilization of resources.

Indian cities are faced with the twin challenges of managing their water demand and reducing waste water footprint. A paradigm shift is needed in favor of decentralized solutions for treatment of waste water and its reuse, promoting water harvesting and protecting our ecology. Several Indian cities are taking concrete initiatives to address this challenge. Success of achieving Open Defecation Free cities under Swachh Bharat Mission, has provided impetus for addressing safe treatment and disposal of septage waste.

National Faecal Sludge and Septage Management Policy-2017 of Govt of India, provided the policy framework for a paradigm shift in favor of decentralized and non sewered sanitation systems for urban India. Seventeen States have adopted the National FSSM Policy and put in place their own State specific FSSM Policy. More than 440 towns across 10 states are installing decentralized septage treatment plants.

I am happy to share this set of 3 Training Modules (Orientation Module, Technology & Financing Module and Septage Treatment Systems Design Module) prepared by the National Institute of Urban Affairs (NIUA) and the National Faecal Sludge and Septage Mangagement Alliance that will be useful for Urban Local Bodies officials and all para-statal technical agencies in planning and designing decentralized solutions. I hope the National and State level nodal training institutes of MoHUA and all other Urban Resource Centres, Universities, Colleges and autonomous bodies will find them useful for imparting conceptual and practical skills trainings to address the challenges of waste water and septage management.

These modules are made available on the **NIUA website: scbp.niua.org** in downlodable PDF fomat for wide range and dissemination.

(Durga Shanker Mishra)

New Delhi
02 October, 2019

Acknowledgement

Increasing urbanization of India is putting significant pressure on the available water resources and the safe disposal of waste water. Most cities are facing increasing water stress and are breaching the limits to accessing drinking water from ground water, rivers and water bodies.

A paradigm shift is needed in the urban water and waste water sector, to move away from supply side to demand management and reducing the waste water footprint of cities. Septage management is one critical component of the urban sanitation challenge. With a grant from Gates Foundation, NIUA has rolled out a Sanitation Capacity Building Platform. Over the past 4 years, NIUA has promoted decentralized and non sewered sanitation through capacity building, technical assistance, research and policy support to states and urban local bodies.

As member of the National Faecal Sludge and Septage Management Alliance(NFSSMA), NIUA has focused on capacity building of urban local body officials and engineers of para state technical agencies across 10 states of India. NIUA supported 8 nodal national training institutes of AMRUT for delivery of trainings and partnered with 9 universities to integrate concepts and technologies in their curriculum. NIUA supported the states of UP, Rajasthan and is currently working with Uttarakhand for appropriate urban sanitation solutions.

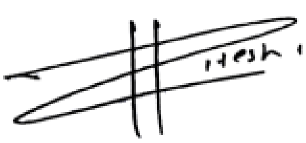
Through a collaborative engagement of the Training Modules Review Committee(TMRC) of NFSSM Alliance, anchored by NIUA, all training content developed so far on septage management, has been strategically revised updated into a 3 set learning Modules on Faecal Sludge and Septage Management :

- **One Day Orientation Module** provides an overview of septage management challenges, technology options and planning. Appropriate for all stakeholders.
- **Two Day Technology & Financing Options for FSSM Module** and exposure visit to a Septage Treatment Plant, is an excellent induction and orientation for Elected representatives, Urban Local Bodies officials and Engineers.
- **Three Day Faecal Sludge Treatment Systems Design Module** provides an in-depth training on twin aspects of Technology choice and Designing of Treatment Plants and Co Treatment of Septage with STPs. Appropriate for technical staff of ULBs, Para state agencies, consultants and private sector.

All the three Training Modules are in 2 parts : Presentations and Learning Notes. To serve as guidance for trainees as well as trainers. All the modules are also available on the NIUA website : **scbp.niua.org**

The modules are produced as a collaborative engagement of NIUA and NFSSM Alliance Partner Organisations. NIUA acknowledges the support provided by Ecosan Services Foundation (ESF), Pune, CEPT University and All India Institute of Local Self Government (AIILSG), Mumbai for developing the content for various modules. We acknowledge the support provided by Bill & Melinda Gates Foundation.

In the coming years, these modules will be developed into more innovative module formats including e learning and gamification, and new face to face training modules. Thereby addressing the next generation of septage management challenge of urban India.



Hitesh Vaidya
Director, NIUA

About National Faecal sludge and Septage Management Alliance (NFSSMA)

The 'NFSSM Alliance' was formed with a vision to "Create an enabling environment which amplifies scaling of safe, sustainable and inclusive FSSM through knowledge, partnerships and innovative solutions by 2024"

Convened by Bill and Melinda Gates Foundation in 2016, the Alliance is a voluntary body that aims to:

- Build consensus and drive the discourse on FSSM at a policy level, and
- Promote peer learning among members to achieve synergies for scaled implementation and reduce duplication of efforts

The Alliance currently comprises 28 organizations across the country working towards solutions for Indian states and cities. The Alliance works in close collaboration with the Ministry of Housing and Urban Affairs (MoHUA) and several state and city governments through its members to support the progress and derive actions towards mainstreaming of FSSM at state and a national level. The NFSSM Alliance works on all aspects of city sanitation plans to regulatory and institutional frameworks across the sanitation value chain. The NFSSM Alliance working in collaboration with the Ministry of Housing and Urban Affairs has been instrumental in the passage of India's First Policy on FSSM launched in 2017. This resulted in 19 out of 36 states adopting guidelines and policies for FSSM in India.

The strength of the Alliance lies in its diverse membership, which includes research institutes, academic institutions, think-tanks, quasi-government bodies, implementing organizations, data experts, consultants, and intermediaries. This enabled a multi-disciplinary view of urban sanitation, with members building on each other's expertise. The alliance has had enormous success in championing FSSM as a viable solution to the Government of India by broadly focussing on:

1. Influencing and informing Policy
2. Demonstrating Success through innovation and pilots
3. Building Capacities of key stakeholders across the value chain

The collaborative continues to work towards promoting the FSSM agenda through policy recommendations and sharing best practices which are inclusive, comprehensive, and have buy-in from several stakeholders in the sector

NFSSM Alliance

- ASCI
- Athena Infonomics
- BBC Media Action
- BMGF
- Borda
- CEPT University
- CEPT University
- CSTEP
- CDD
- CPR
- CFAR
- CSE
- Dasra
- EY
- GIZ
- IIHS
- ISC
- IWMI
- KPMG
- NIUA
- PSI
- RTI International
- TIDE Technocrats
- UMC
- UNICEF
- USAID
- WASHi
- Water Aid
- World Bank Group

About Training Module Review Committee (TMRC)

To ensure quality control in content and delivery of trainings and capacity building efforts, a **Training Module Review Committee (TMRC)** was formed with the collaborative effort of all Alliance partners. TMRC which is **anchored by National Institute of Urban Affairs (NIUA)**, has the following broad objectives:

- Identification of priority stakeholders and accordingly training modules for Capacity Building
- Development of a Normative Framework – For Capacity Building at State Level
- Standardization of priority training modules – appropriate standardization of content with flexibility. for customization based on State context
- Quality Control of Trainings – criteria for ensuring minimum quality of training content and delivery
- Strategy for measuring impact of trainings and capacity building efforts

About the Training Module

Title	Technology and Financing Options for FSSM: Exposure Visit Module
Purpose	Given the fact that FSSM is different not just in terms of treatment of faecal sludge but integrating the stakeholders and addressing the entire sanitation service chain, it is necessary to strengthen the existing knowledge base and capacity for its planning and implementation. The objective of this training is to develop a comprehensive understanding of the various components of FSSM to implement effective and sustainable sanitation solutions in cities through hands-on experience of witnessing a case study.
Target Audience	The module is designed for city and state officials, AMRUT nodal agencies and professionals associated with the government. Since the training is planned in participatory mode, a small group is generally ideal so that maximum interaction is achieved. The ideal number of participants per training is 30.
Learning Objectives	By the end of the workshop through experience sharing participants are expected to achieve: • Understanding the sanitation value chain with challenges and need for addressing septage management solutions for their cities. • Understanding of regulatory frame work, planning and financial options for Faecal Sludge Management initiatives in their cities and towns. • Understanding technology options for treatment of septage through site visit and interaction with engineers and city officials. • Understanding the importance of implementing small incremental Faecal Sludge and waste water Treatment measures in their cities and towns.
Format of the Module	The Module has the following two parts: Part A – Presentation slides: Contains the PowerPoint presentations and practical exercises that trainees can refer to during the training sessions and exercise work Part B – Learning Note: Identifies the learning objectives and key learning outcomes that can guide trainers and trainees. Key learning outcomes are defined as specific points for each session, which need to be limited The content can be contextualised and adopted for conducting exposure visit to any state/ city depending on the profile of the participants, their areas of interest.
Duration	The training is proposed to be conducted in three days – Day-1: class room training, Day-2:field visit and interaction with stakeholders Day-3: Interaction with state/ ULB officials from the case study city and Preparation of action plan by participating officials The duration and content can be altered depending on the profile of the participants, their areas of interest and time available for the training

Agenda

Day 1

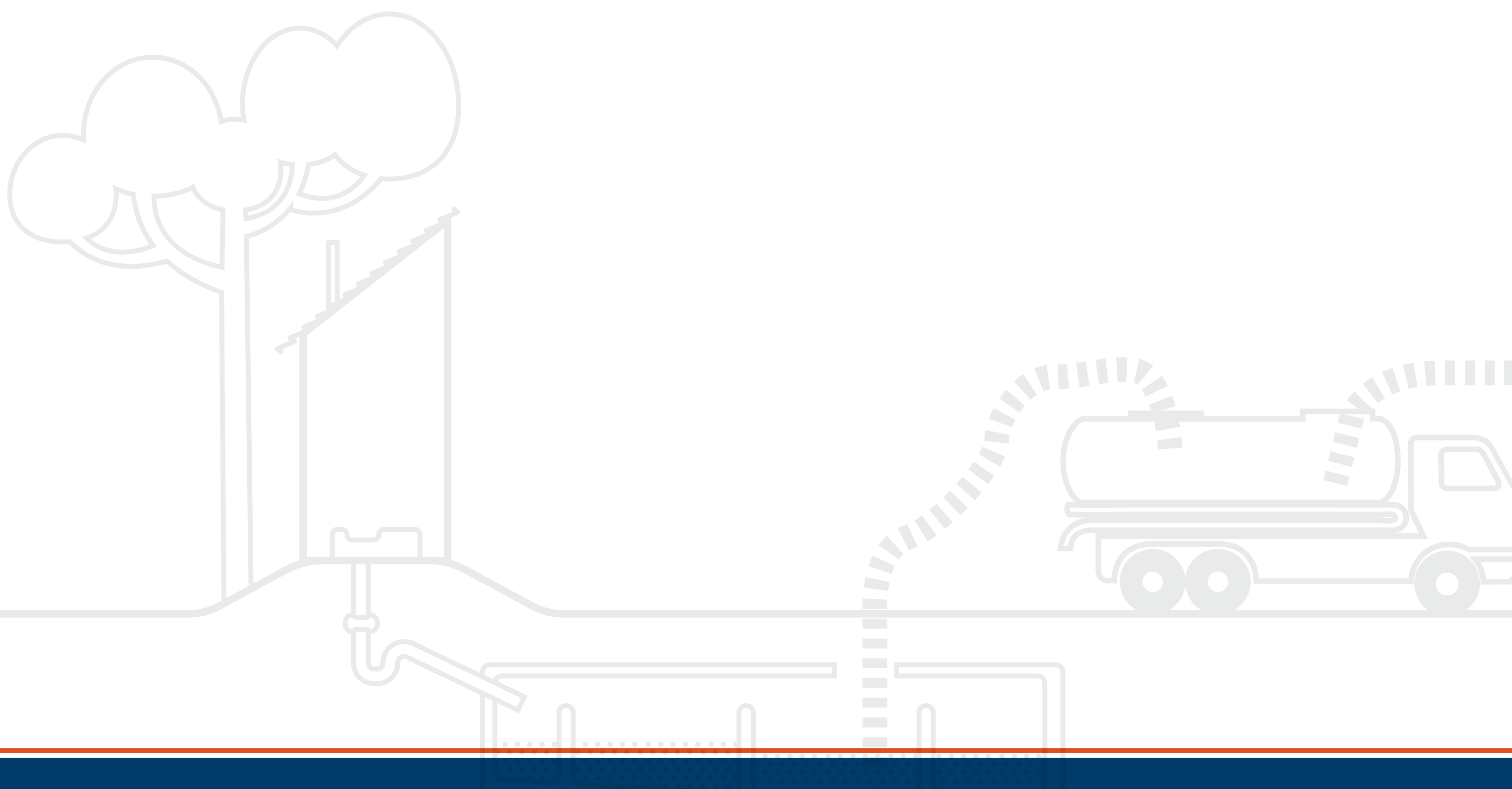
	Duration	Session	Content
	9.30 – 10.00	Introduction of participants and training expectations	
Session 1	10.00 - 10.45	Urbanization and Sanitation	Overview of sanitation systems and context of FSSM, policies and programmes.
Session 2 - A	10.45 - 11.30	Existing situation and challenges	Group exercise - Understanding Sanitation Systems and challenges in initiating FSSM systems
	11.30 – 11.45	Lunch break	
Session 2 - B	11.45 - 12.30	Existing situation and challenges	Shit Flow Diagram illustrations and discussion - Understanding flow of various types of waste water in different city context/ scenario
	12.30 - 13.30	Lunch break	
Session 3	13.30 - 15.00	Planning for emptying services	Overview on need, parameters, conveyance options and demand-schedule based desludging for planning of emptying services.
	15.00 - 15.15	Tea break	
Session 4	15.15 - 16.15	Technology options	Technology options for containment and conveyance, treatment and case studies, and selection criteria
	16.15 – 17.00	Briefing about site visits	Treatment technology details and learnings from implementation

Day 2

	Duration	Session	Content
Session 5	Full Day	Site Visit Discussion - Q and A with officials and staff	Visit to treatment plant to understand the process of treatment, interaction with engineer/ staff at plant/interaction with operator who undertakes desludging Discussion of on-ground implementation challenges and ways to overcome it

Day 3

	Duration	Session	Content
Session 6	9.30– 10.30	Financing and Contracting Options	Financing options, recovery of O&M - user fee, licensing, scheduled vs demand based, private sector participation
Session 7	9.30 - 10.00 10.00 – 10.30 10.30 - 11.00	Interaction with officials from state/city/TSU Follow up on site visit	Learnings from the state Q&A
	12.00 - 12.15	Tea break	
Session 8	12.15 – 13.30	Action Planning	Preparation of detailed action plan
Session 9	13.30 – 14.00	Closure and feed back	Follow up actions and support needed if any



Contents

Session

00

Introduction Session

1. Session objectives

This session intends to

- To create a pleasant environment for learning and sharing.
- To get to know each other.
- To establish training expectations.
- To present the objectives of the training.
- To list down the training ground rules.

2. Session Plan

Activity	Time	Material /Methods
Introduction of Participants	20 min	Flip charts, markers, colour cards
Icebreaking Activity	10 min	Statements related to FSM, Signs of Agree/Disagree.
Understanding participants Expectations	10 min	Colour cards, sticky posts, pens.
Introduction to the agenda	10 min	PowerPoint ,flipchart
Pre-evaluation form	10 min	Pre evaluation forms

Session time: 60 min

3. Learning Notes

3.1 Activity 01-Introduction of Participants:

This session recommends a particular way of introducing participants to one another. Any other appropriate method may be used, provided the participants enjoy themselves, gain some useful information about one another and remember one another in future.

Welcome the participants; briefly introduce yourself and other organisers of the training. The workshop should start with a round of introductions as an 'ice breaker': as a minimum, everyone in the group should take turns to state their name, where they work and their role. If wanted, people can add something a bit more personal about their background. The following are some examples:

Introducing your neighbour: Allow about 20 minutes depending on workshop size. Ask all participants to select a partner for this ice-breaker, ideally someone they have never met before. Give the participants ten minutes to have a conversation with each other (five minutes for each interview) so that they can introduce their partner to the rest of the group. Give each participant about one minute to introduce his or her partner .Make a note of people's names as group members introduce themselves on flip-chart paper and keep it visible as an aide-mémoire.

Circle method: Make the participants stand in two circles facing each other. Tell them to move and stop with the music that will be played for this game. They may infer, or you can point out, that their partners will keep on changing. Each circle moves clockwise when the music is played. When the music stops, each participant pairs with the one opposite her, ask the other's name, address and something about the women's groups she has known or belongs to. Start the music again. When the music stops, participants form new pairs and ask each other the same questions. It takes ten minutes to complete one round. Organize a maximum of three rounds. Ask the participants to sit down after two or three rounds.Make sure that all participants are introduced. It is good if the trainer/s joins the group activity. If the trainer does not play the game, then at the end s/he must introduce herself/himself too. Joining the participants in the game or singing with them establishes quick rapport between trainer and trainees.

It is important to encourage participants to be informative but concise. Activities generally take longer within larger groups. Allowance needs to be made for this as there may be less time for individual contributions.

3.2 Activity 02- Icebreaker:

Generally, ice-breakers are used to facilitate and enhance the training environment. This session will help in understanding the participant's views on faecal sludge management. Prepare in advance two signs with the words “agree, “disagree” and place them on two opposite walls in the room. Ask participants to stand up. Stand at the centre of the room and read aloud the statements (Refer ANNEX01 for sample statements). Ask participants to move across the place depending on their opinion to the statement introduced. E.g., the more they agree or disagree with confident states, the closer to the wall with that sign they should move. If all the participants agree on a statement, try to spice up the exercise by walking over to the opposite side of the room and asking, “Why would anyone be standing on this side of the room? Moderator should try to engage all the participants to take a stand. However, if some of them do not feel comfortable expressing their opinion or do not have opinion on a certain subject, allow them to stand in the middle of the room as an “undecided” group.

Another way of doing the activity to do a snow bowl exercise. Mpderator can throw questions on what the particiapnts know about septic tanks. Questions can be directed by following set of questions like what is the size of septic tank,how it fills up, calculate over number of years and what happens to disposal when desludged. This will help participants to discuss in groups and set the momentum for the training.

3.3 Activity 03-Understanding Participant’s Expectations

This activity is to get a better understand the participants’ expectations of the training and to clear the objectives of the training. Hand out two sticky posts /colour cards to each participant. Ask them to think what they expect from the training, e.g., asking themselves “What do I want to bring home from this training?” Instruct them to write their expectations on a sticky post/color card. Ask them to stick the sticky post or color card on the flipchart (or other designated space in the room). Read some of the most common expectations out loud.

Present with the help of a PowerPoint to explain participants what were the pre-set objectives of the training and how they will converge with their expectations. If some expectations cannot be met, make sure to discuss that with the participants, explaining to them why specific topics will not be covered.

3.4 Activity 04-Introduction to the Agenda

Present the participants with the agenda of the training and discuss with them any outstanding issues. Inform participants about the training methodology, which is interactive, participatory and based on adult and experiential learning. Encourage them to participate through the training. Powerpoint can be used as a tool for the session.

It will be an ideal session to explain the set objectives for the training. As it is an orientation module, explain the objectives and outcome expected from the training.

Before moving on to the second session, clarify ‘housekeeping’ issues including:

- Toilet facilities
- Fire procedure, emergency exits and whether any routine fire testing is expected
- off/silence mobile phones/bleepers,

- Smoking policy
- Start and close times
- Any other practicalities

Establish ground rules including topics such as:
- Confidentiality
- Respect
- Open to differing views
- Constructive challenging
- Being present
- Timekeeping
- Responsibility for learning
- Participation, not domination
- One person to talk at a time

Make explicit the kind of behaviour expected, so that is easier to deal with unhelpful behaviour later (if it occurs). Write up ground rules on the flipchart to use as a reference for discussion and clarification.

Session

01

Urbanization and Sanitation

1. Session Objective

- Understand urban sanitation and the associated challenges
- Learn from strategies adopted by some states to achieve ODF cities
- Distinguish between black and grey water as well as sludge and septage
- Understand the sanitation value chain

2. Session Plan

Activity	Time	Material /Methods
Session	60 mins	Presentation and discussion

3. Key Facts/ Messages

- Development of sanitation infrastructure in a fast urbanizing country like India is quite a challenge.
- Government of India (GoI) has released appropriate policies and acts for operationalising FSSM.
- Understanding and choosing an appropriate sanitation system is very important for disrupting the faecal oral transmission of diseases.

Challenges in FSSM are relatively easier to tackle as compared to the one in sewered sanitation.

4. Learning Notes

4.1 Activity 01-Sanitation Systems

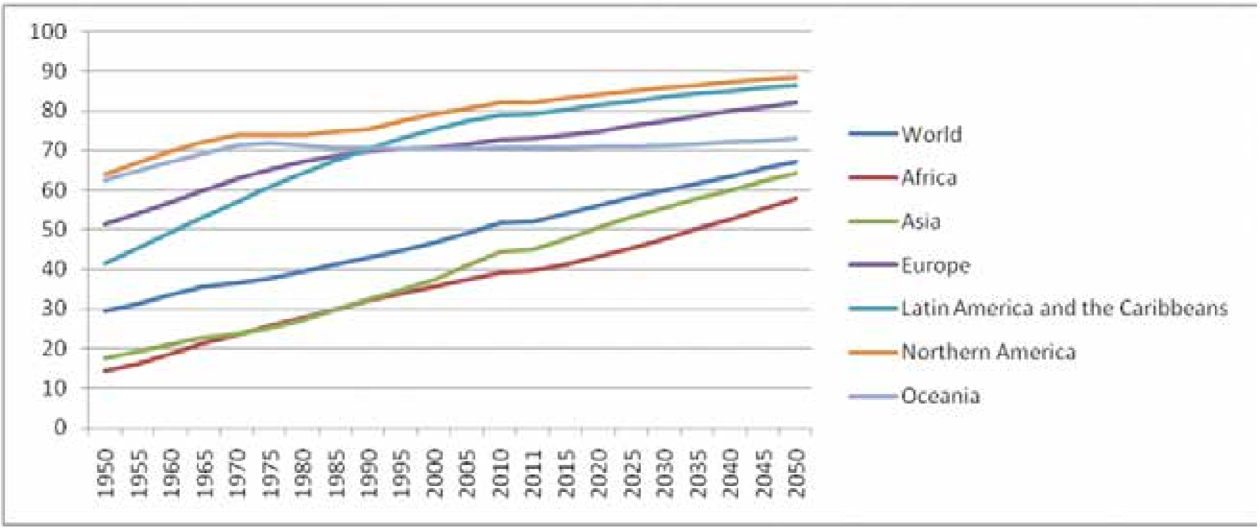
The session will cover on the background of global perspective of Urbanisation and sanitation with a focus on defining the concept of faecal sludge management.

Urbanisation

Urbanisation is one of the most important demographic trends of our time. In 2008, the number of people living in urban centres worldwide has for the first time surpassed the number of people living in rural areas. Today, 55% of the world's population lives in urban areas, a proportion that is expected to increase to 68% by 2050. Projections show that urbanization, the gradual shift in residence of the human population from rural to urban areas, combined with the overall growth of the world's population could add another 2.5 billion people to urban areas by 2050, with close to 90% of this increase taking place in Asia and Africa, according to a new United Nations data set launched today.

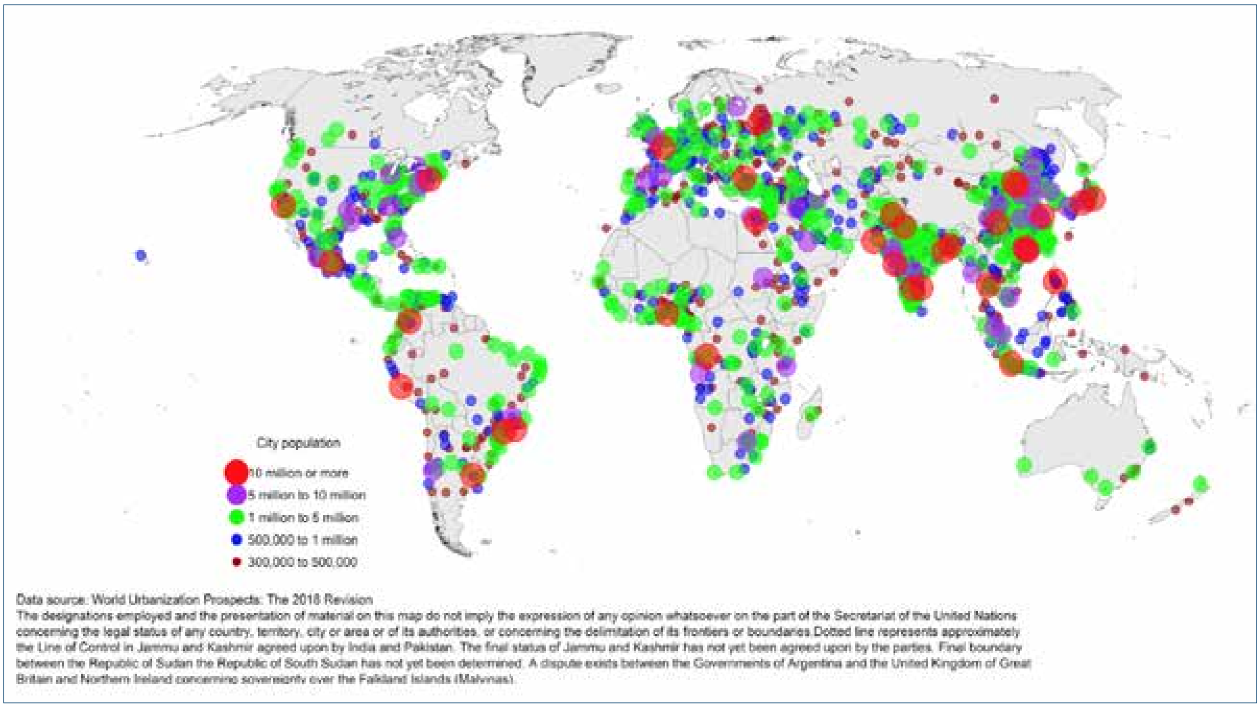
The 2018 Revision of World Urbanization Prospects produced by the Population Division of the UN Department of Economic and Social Affairs (UN DESA) notes that future increases in the size of the world's urban population are expected to be highly concentrated in just a few countries. Together, India, China and Nigeria will account for 35% of the projected growth of the world's urban population between 2018 and 2050. By 2050, it is projected that India will have added 416 million urban dwellers, China 255 million and Nigeria 189 million.

Figure 1:Urbanisation trends and estimates in major regions of the world (in % from 1950 to 2050)



Source: UN-DESA (2010) and UN-DESA (2011)

The urban population of the world has grown rapidly from 751 million in 1950 to 4.2 billion in 2018. Asia, despite its relatively lower level of urbanization, is home to 54% of the world's urban population, followed by Europe and Africa with 13% each. Today, the most urbanized regions include Northern America (with 82% of its population living in urban areas in 2018), Latin America and the Caribbean (81%), Europe (74%) and Oceania (68%). The level of urbanization in Asia is now approximating 50%. In contrast, Africa remains mostly rural, with 43% of its population living in urban areas.



Four main factors are responsible for urban growth: a) the natural demographic growth of urban populations, b) the absorption of rural settlements located at the edges of expanding cities, c) the transformation of rural towns into urban centres and d) migratory movements from rural areas to cities.

Urbanisation represents a challenge for water and sanitation management in developed as well as in developing countries. While cities in developed countries often struggle with high operation and maintenance costs and the decay of existing infrastructure, rapid urban growth in the developing world is seriously outstripping the capacity of most cities to provide adequate services for their citizens (COHEN 2006). In rapidly growing urban slums where there is no planning and few facilities, the number of people living without access to basic water and sanitation services is still increasing. This is of particular concern considering that the WASH sector represents the foundation on which broader goals of poverty reduction, environmental sustainability, social development, and gender equality must be built (BIRCH et al. 2012)

For the past decade, the pace of urbanisation has picked up steadily. Currently, more than half of the world's population of 3.9 billion people, or nearly 54 percent, live in towns, cities, and megacities. This number is expected to grow to two-thirds by 2050. As urbanisation is a must for economic growth, the rate of people's migration to cities is now happening at a breakneck speed, in the process putting enormous pressure on the ability of cities to provide adequate infrastructure to support the burgeoning population.

According to estimates released by UN-Habitat, more than one-third of the developing world's urban population of over 863 million people lives in slums. As city infrastructure starts to crumble under pressure, availability of adequate sanitation facilities becomes the first casualty. Due to an acute shortage of adequate toilets, nearly 100 million people globally are being left with no other option but to practice open defecation. The remaining 600 million people rely on toilets that do not fulfil the minimum requirements of hygiene, safety or privacy — including dirty and crowded communal toilets. It is estimated that almost one-fifth of all urbanites — that is nearly 700 million people live without a decent toilet. To put that into perspective, the queue for people waiting for toilets globally would stretch around the world 29 times! These severely compromised sanitary conditions are not only damaging the environment but also posing a real-time health risk to the people in the form of infectious diseases, such as cholera and more.

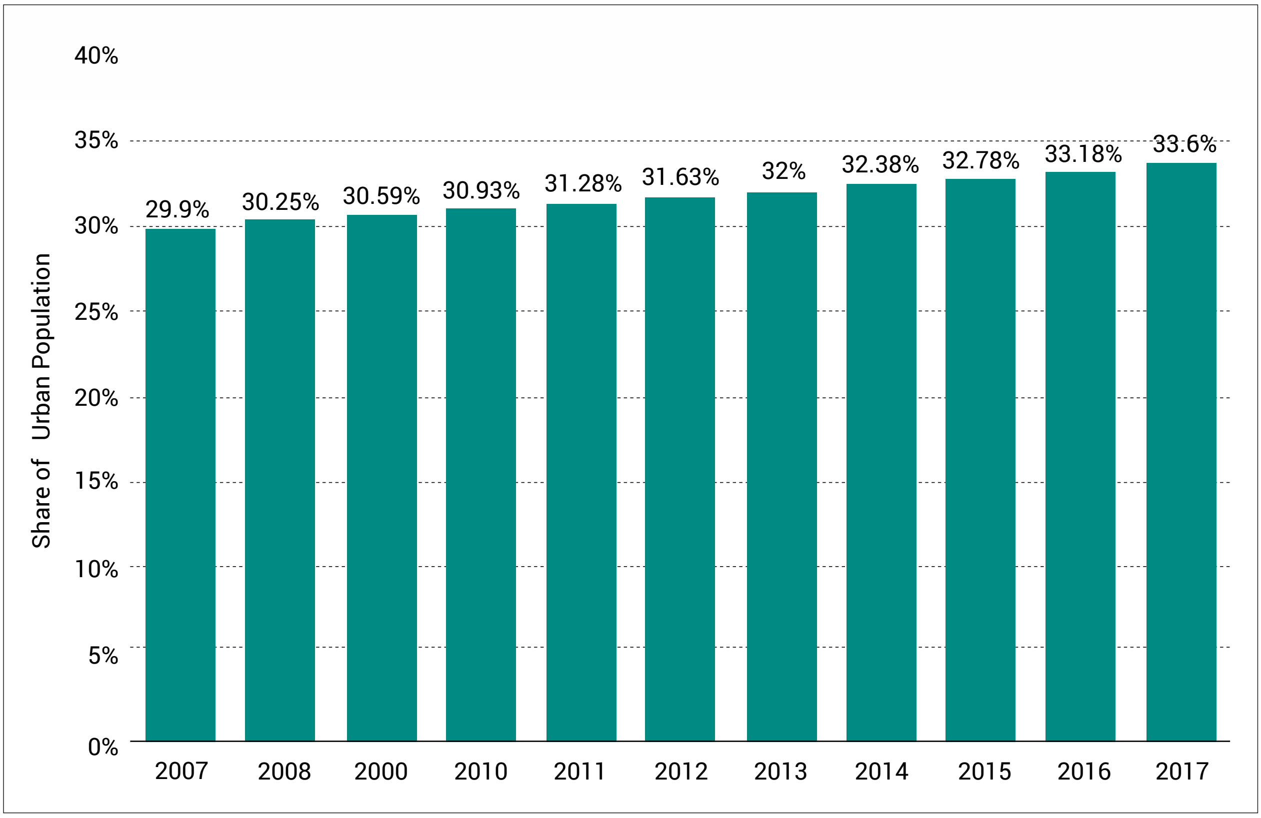
Urban Sanitation In India

Level of Urbanisation

Among all the States and Union territories, the National Capital Territory of Delhi and the Union territory of Chandigarh are most urbanized with 97.5 percent and 97.25 percent urban population respectively, followed by Daman and Diu (75.2 percent) and Puducherry (68.3 percent).Among States, Goa is now the most urbanised State with 62.2 percent urban population, a significant increase since 2001 when urban population of Goa was 49.8%. Another significant instance of rapid urbanisation is that of Kerala, its urban population is now 47.7 per cent, while a decade ago it was just 25.9 percent. Among the North-Eastern States, Mizoram is most urbanised with 51.5 per cent urban population, though in terms of absolute contribution to total urban population in the country, Mizoram's contribution is just 0.1 percent. Similarly Sikkim, which was just 11.0 urbanised a decade ago became almost 25 percent urbanised in 2011. Among major states, Tamil Nadu continues to be the most urbanized state with 48.4 percent of the population living in urban areas followed now by Kerala (47.7 per cent) upstaging Maharashtra (45.2 percent)(MoHUA,2019).

The proportion of urban population continues to be the lowest in Himachal Pradesh with 10.0 per cent followed by Bihar with 11.3 percent, Assam (14.1 percent) and Orissa (16.7 percent).In terms of absolute number of persons living in urban areas, Maharashtra continues to lead with 50.8 million persons which comprises 13.5 percent of the total urban population of the country. Uttar Pradesh accounts for about 44.4 million, followed by Tamil Nadu at 34.9 million.

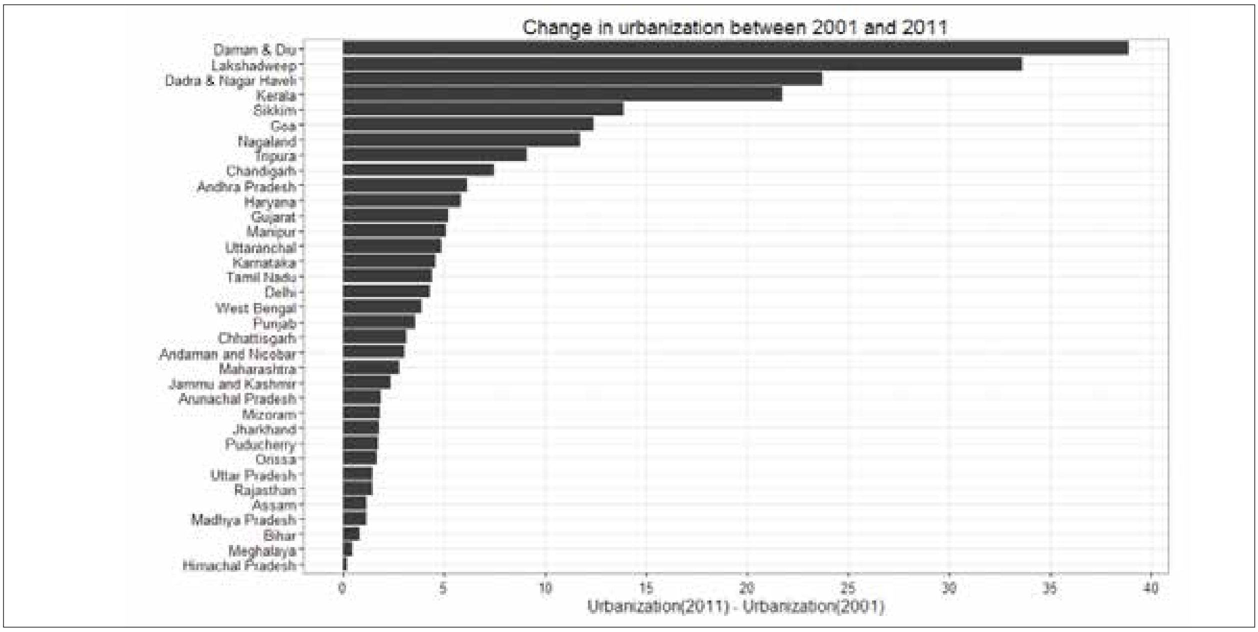
Figure 2: India- Degree of Urbanisation 2007-2017



Source :Statista ,2019,web:https://www.statista.com/statistics/271312/urbanization-in-india

The statistic shows the degree of urbanization in India from 2007 to 2017 and details the percentage of the entire population, living in urban areas. In 2017, approximately 33.6 percent of the total population in India lived in cities.

Figure 3: The State Urbanisatiion Status 2001-2011



Source :URL

The Challenge of Water Supply and Sanitation in the Context of Urbanisation

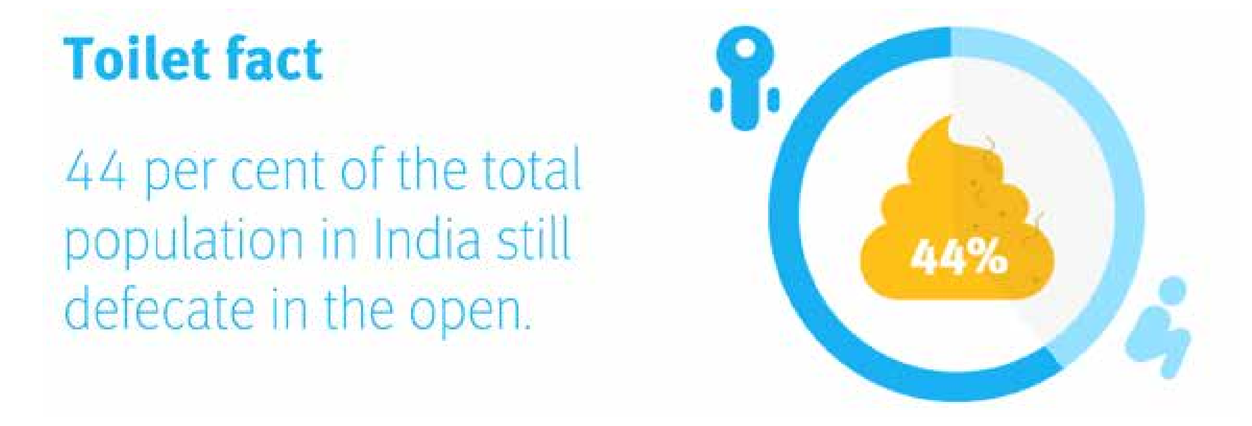
Conventional urban water supply and sanitation management is generally characterised by an unsustainable use of water and nutrients. This represents important environmental, economic and social challenges, which are intensified by the process of urbanisation.

- **Disruption of the natural water cycle:** The conventional urban water cycle is characterised by a linear infrastructure that transports clean water into and wastewater out of urban neighbourhoods. Due to a high percentage of sealed soil and thus impervious surfaces, evapotranspiration and groundwater recharge are reduced and low quality surface runoff is increased – utilities are often left to deal with extremely large volumes of water, especially during wet weather (CORCORAN et al. 2010). Climate change will further intensify these challenges in many regions as it will lead to more erratic patterns of droughts and storms.
- **Pollution of water sources:** Urban settlements are the main source of point source pollution (UNESCO et al. 2004). It is estimated that more than 90% of sewage in the developing world is discharged directly into rivers, lakes, and coastal waters without treatment of any kind (LUETHI et al. 2009). In low- and middle-income countries, leaking on-site sanitation facilities together with the absence of sewerage pipes that dispose the wastewater, result in large volumes of local wastewater soaking into the soil, and eventually seeping into aquifers and polluting groundwater (GROENWALL et al. 2010).
- **Depletion of groundwater sources:** In urban settings, the use of shallow groundwater sources is an especially common feature of many low-income communities in low- and middle-income countries. More than half of the world's megacities depend on groundwater
- **Broken nutrient cycles and impoverished soils:** The "end-of-pipe" paradigm discourages recovery and reuse so that nutrients are lost to water bodies. This waste of valuable resources can lead to eutrophication and cause algal blooms and a depletion of oxygen in receiving water bodies (HOWE et al. 2011). In Africa, 85% of arable land is losing an average of 30kg of nutrients per hectare per year (LUETHI et al. 2009).
- **Waste of resources:** Water treated to potable water is used for non-potable purposes such as toilet flushing, garden use and industry. When water is heavily subsidised or charged based on a fixed rate, users have little financial incentive to use it sparingly (HOWE et al. 2011).
- **High water demand:** The concentration of a great quantity of population and activities on a small area involve the need of a great amount of good quality water (CHOCAT 2002). Urban areas usually have a higher per capita consumption of water compared to rural areas. Water demand is additionally increased as urban population grows and per capita water consumption in many cities is on the rise.
- **Cost-intensive infrastructure for water supply and wastewater collection:** The increase of urban population asks for a continuous expansion of water networks and wastewater networks. Centralised networks are very cost-intensive in terms of construction, operation and maintenance. If the networks are not sufficiently maintained, leakages lead to a loss of valuable resources, unreliable or irregular water supply and low revenue collection for the utilities. Many large cities suffer from chronic water shortages due to over-exploitation of raw water resources, and to losses of water, which sometimes reach up to 60% of the volume of water supplied (UNESCO et al. 2004).

Of the 1.7 billion people who do not have access to toilets (exclusive or shred), nearly 640 million live in India. Effectively, the toilet coverage statistic reduces to 77.3% when you look for only 'improved latrines' (the ones with piped sewer connections, septic tanks, and improved pit

[1]The purpose of doing so would be due to the fact that the census data does not clearly demarcate between improved twin-pit latrines (which are now benchmarked as the minimum criteria for having a toilet) and single-pit latrines. Census describes 'slab/ventilated improved pit latrines' that those that have provision for night soil fall directly into the pit underground, has a slab/platform to prevent water from entering the pit, is easy to clean, and has a ventilation pipe overhead.

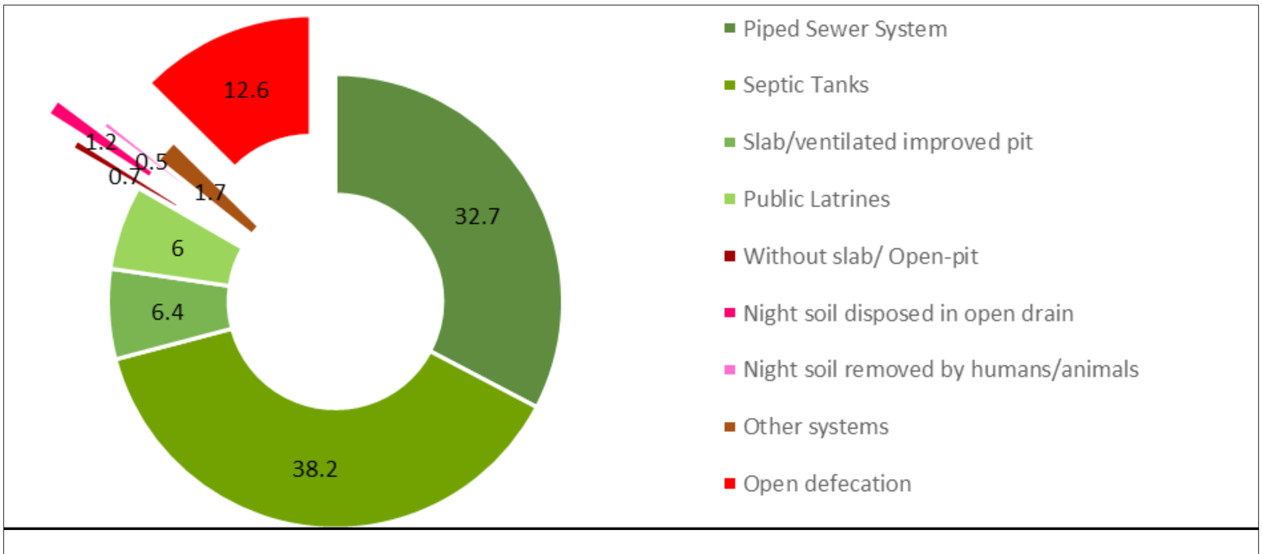
latrines). This again reduces to 70.9% if one discounts the improved pit latrines[1], and even further when one considers the unaccounted/un-assessed dysfunctional and partially functional toilets that we all know exist due to hasty and uninformed construction choices. An outfitted reason for HHs not using their toilets is due to lack of water supply and shallow pits and hence a fear that these will get filled up soon.



Source Wateraid (2016)[2]

As per the Census 2011, every one out of five HHs in urban areas does not have a HH toilet and have to depend on shared facilities. About 17.4% of the urban population dwells in slum areas with 36.1% being in notified slums, 27.6% in recognized slums and 36.3% in identified slums. The coverage of individual toilets in slums is 66% at the national level which is very low as compared to the coverage of 81.5% at a pan-city level. A majority of these HHs thus have to depend on using a community or a public toilet[3].

Figure 5: Types of Toilets in India



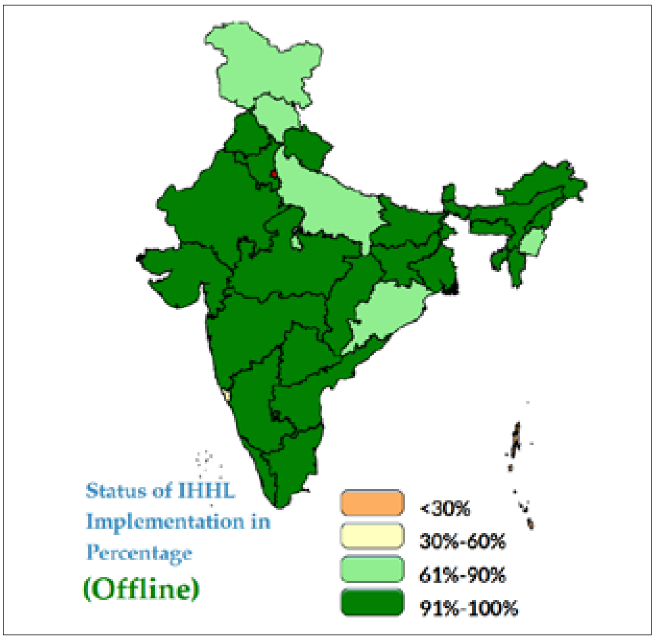
Source::Census 2011

[2] *WASH situation under Swachh Bharat Mission Report of an early assessment in 2016(http://wateraidindia.in/wp-content/uploads/2017/09/SBM-report-1.pdf)*

[3] *http://censusindia.gov.in/2011census/hlo/Data_sheet/India/Latrine.pdf*

However, there are several challenges such as social and caste hierarchy, fragmented institutional roles and responsibilities, lack of an integrated city-wide approaches and reaching the un-served and the poor.

Figure 6: Sanitation coverage status as on October, 2019



Source : swachhbharaturban.gov.in/dashboard/

Urban Sanitation: What are the Challenges?

The challenges fall into four categories:

- Low infrastructure;
- Service coverage;
- Low service usage; and
- Weak institutional arrangements.

Low Infrastructure Coverage

South Asia contains more people without safe sanitation than any other region in the world. While infrastructure coverage is gradually improving, it has so far failed to keep pace with the rate of urban growth. In India, it is estimated that 17 percent of the urban population currently has no access to any sanitary facilities at all, while 50–80 percent of wastewater is disposed of without any treatment (National Urban Sanitation Policy, 2007).

It may take several decades for sewerage and other sanitation services to become available to all of urban India. In the meantime, the vast majority of urban residents will remain dependent on on-site sanitation facilities such as pour flush toilets discharging to leach pits or septic tanks. Municipal sanitation plans should, therefore, include measures to improve on-site sanitation—otherwise, they will meet the needs of just a small portion of the city.

Municipal planners should also recognize that the worst sanitary conditions tend to be found in poor areas. Construction of a toilet is generally regarded as the householder's responsibility but, for poor households, investments in sanitation are often constrained by issues relating to:

- Affordability, including the cost of connecting to sewer networks;
- Uncertainty over land tenure (fear of eviction);
- Space constraints; and
- The low priority is given to sanitation (people may not appreciate its importance).

Special measures may, therefore, be needed to support service improvements for the poorest sections of the community. This does not just mean subsidies and awareness campaigns; technology options are also required that suit the physical conditions in poor neighbourhoods.

Limited Access to Services

- Official coverage figures do not, on their own, give the full picture regarding access to sanitation services. Existing arrangements can be deficient in many ways:
- There may be a complete lack of facilities. For example, there may be settlements with no toilets at all, while facilities for the safe emptying of septic tanks, and the treatment of septage, may be lacking across the entire town.
- Sanitation facilities may be available but could be inconvenient, unpleasant or unhygienic. This may be the result of inappropriate design or construction or inadequate management arrangements. Poor management is often a problem with community toilet blocks.
- Sanitation facilities may be available, but some people have limited access to them. For example, people may not be able to afford to connect to an existing public sewer.
- Sanitation facilities may be in place but are not operated or maintained properly. Poor operation and maintenance of a facility shorten its useful life and could, at worst, result in rapid total failure.
- There may be no provision for the treatment of wastewater or excreta. Local drains and sewers may relocate waste to another part of town where it causes local pollution. Households are primarily concerned about the cleanliness of their immediate surroundings and much less worried about the wider impact on the environment

Low Service Usage

Even where toilets are available, some are not used or are underused, with family members defecating outside most of the time. This might be because the facilities are unacceptable in some way (for example, people may not be willing to share toilets), or because there is a long-held preference for open defecation. Alternatively, people may underuse their toilet because of misunderstandings about its functioning and maintenance.

In the case of twin-pit pour-flush toilets, for example, some people fear that the pits will fill rapidly if the toilet is used too often; and they may not know that the contents of a full pit can safely be removed manually once they have been given time to degrade. Such problems indicate the need for effective communication in sanitation programs, so that community awareness, preferences, and behavior are appropriately understood and then addressed through information, advice, and hygiene promotion.

Weak Institutional Arrangements

State agencies and municipalities sometimes make huge investments in sanitation infrastructure, but these do not always deliver their intended benefits. There can be several reasons for this, for example:

- The investments are made on an ad hoc basis when funds become available, without reference to an overarching strategy or plan.
- Within the state government and municipalities, sanitation has no 'institutional home,' meaning that no single department or agency is accountable for it. Responsibilities for different aspects of sanitation are often assigned to many agencies, and coordination between them is not always good. There have been cases, for example, where a state agency has developed a sewage treatment plant even when there are no sewers in the town, then handed it over to a municipality that does not have the technical capacity or financial resources to operate and maintain it.

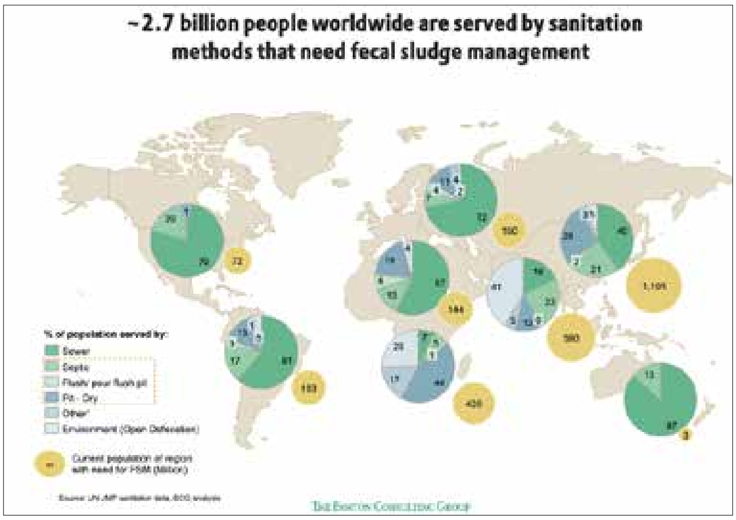
- Significant capital investments are rarely matched with detailed arrangements—both practical and financial—for future operation and maintenance.
- Improvements are often implemented on a norms basis, meaning that technologies are selected without reference to local conditions or the preferences of users. Therefore, the new facilities may not function properly, or may not be used as intended
- Especially in smaller towns, municipal and line agency staff tend to have limited technical expertise or awareness of the range of nontechnical factors that affect the outcome of sanitation investments

Defining faecal sludge, on-site sanitation and FSM?

A sanitation system deals with human excreta from the time it is generated until it is used or disposed of safely. Faecal sludge management includes emptying, transportation, treatment, and use or disposal of faecal sludge from an on-site sanitation technology (like a pit latrine or septic tank). It addresses the last three components of a non-sewered sanitation system.Feacal sludge management is a relatively new term and field that is gaining increased acknowledgement in the sanitation sector. The following definitions help explain the scope of feacal sludge management:

- Excreta is urine and feaces that are not mixed with any flush water. An on-site sanitation technology is made up of the parts included in the first two components of a sanitation system: user interface and excreta storage. Excreta is collected and stored where it is produced (for example, a pit latrine, septic tank, aqua privy, and non-sewered public toilets). Often, the feacal sludge has to be transported off-site for treatment, use or disposal.
- **On-site sanitatio**n is a system of sanitation whose storage facilities are contained within the plot occupied by a dwelling and its immediate surrounding. For some systems (e. g. double-pit or vault latrines), faecal matter treatment is conducted on site and also by extended in-pit consolidation and storage. With other systems (e. g. septic tanks, single-pit or vault installations), the sludge has to be collected and treated off-site. (WHO, 2006)
- **Faecal sludge (FS)** comes from onsite sanitation technologies, and has not been transported through a sewer. It is raw or partially digested, a slurry or semisolid, and results from the collection, storage or treatment of combinations of excreta and blackwater, with or without greywater. Examples of onsite technologies include pit latrines, unsewered public ablution blocks, septic tanks, aqua privies, and dry toilets. FSM includes the storage, collection, transport, treatment and safe enduse or disposal of FS. FS is highly variable in consistency, quantity, and concentration. (Strauss et al., 2002)

Figure 7:Percent of Population Served by Onsite Sanitation Technologies

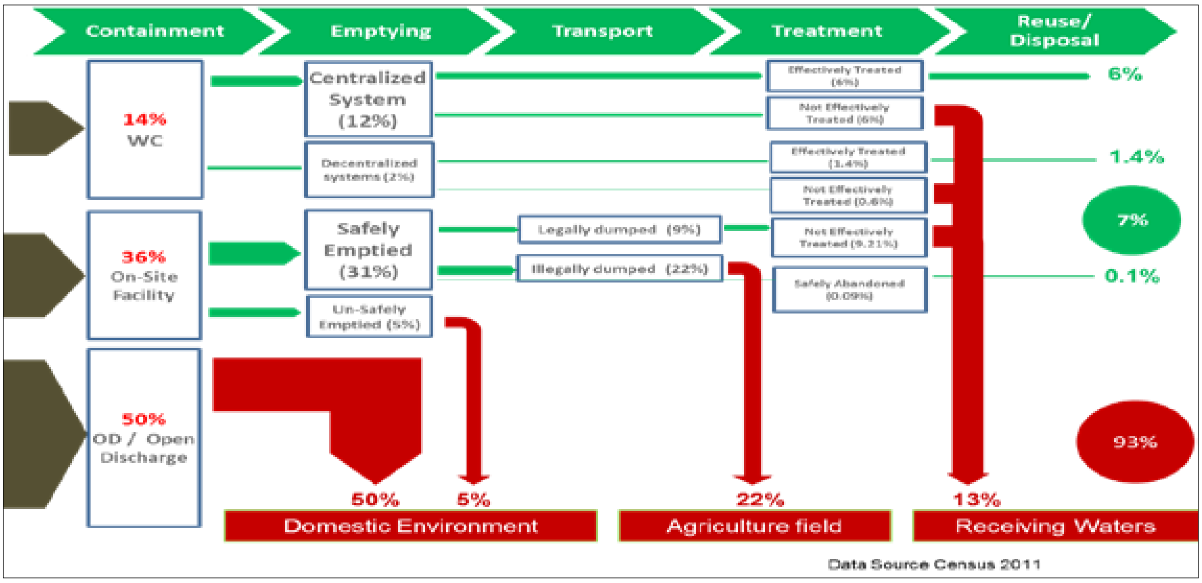


Source: EAWAG, 2014

Shit Flow Diagram

- As per the Census of India 2011, 31.16% of the country was urbanized. Linkages in the sanitation value chain in urban India ha ve been patchy. A shit flow diagram of urban India reveals that only 6.7% of all waste water generated in cities of India is safely disposed[4]. A staggering 93.3% of the waste water is either discharged in the open or agricultural fields or in water bodies. Only 50% of all the waste water is emptied through centralized systems and emptying of OSS systems. Out of this 50%, 34.8% of the waste water is then conveyed to a treatment or disposal site and only 6.6% is treated.

Figure 8 Shit Flow Diagram



Data source: Census 2011, Data Analysis: (Consortium for DEWATS Dissemination Society)

3.2 Activity 02-Policy and programmes

Sanitation has been at the forefront of urban policy in India in recent times. The need to improve sanitation, however, was realised much earlier. Post-independent India was constantly struggling with its image as the symbol of insanitary living conditions. It was not long before the planning commission noted the magnitude of the problem by identifying the blatant disregard for sanitation in the development of towns by local authorities (First Five Year Plan, 1951). But urban policy on basic services in India traditionally linked sanitation with water supply, largely focusing on sewerage services. The Fourth Five Year Plan (1969-74) acknowledged that the "problems of sanitation require to be dealt with on a long term basis" The Sixth Plan (1980-85)finally recognised that urban development is inescapably connected with the provision of safe water supply and adequate sanitation and stated that the position in regard to urban sewerage and sanitation is even less satisfactory than water supply.

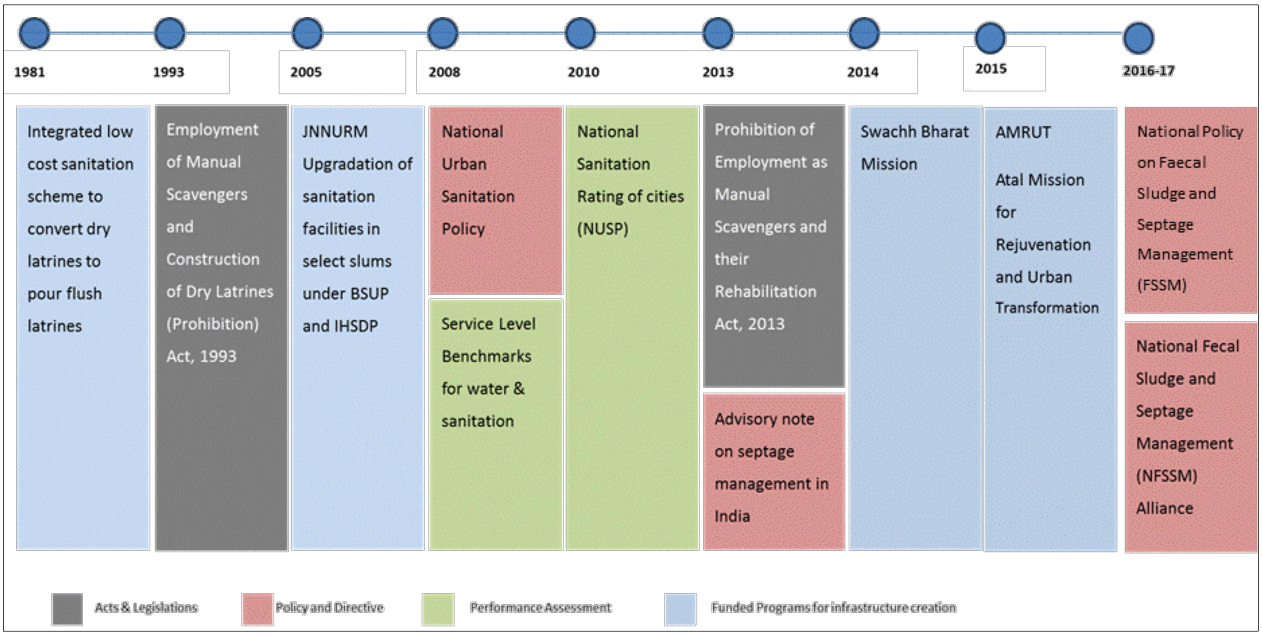
History of Sanitation Efforts and the Shifting Paradigm towards FSSM

Sanitation was included as an agenda item in Government of India's First Five Year Plan (1951-56), but the focus of the Central Government in the fifties was largely on housing and redevelopment of slums. The Slum (Clearance and Improvement) Act was formulated during this period. In the sixties and seventies, urban policy in India began taking a more concrete shape. There was a huge focus on promoting planned development of cities through the implementation of master plans. By eighties, when the 1981 Census revealed that 23.3% of Indian population lived in cities, most

[4]*CDD. (2016). Faecal Sludge Management in India: Case of Devanahalli. Retrieved May 2017, from https://smartnet.niua.org*

cities were characterized by lack of infrastructure, planning and unimproved sanitation facilities.

Figure 9: Initiatives in the Sanitation Sector in India: A Timeline



Source : UMC,2017)

Central government shifted from urban policy to infrastructure development. Sanitation became a prerogative of the local governments only with the passage of the landmark 74th Constitutional Amendment Act in 1992 that recognized cities and towns as the third tier of government through the constitution of ULBs. The Jawaharlal Nehru National Urban Renewal Mission (JNNURM), a massive urban renewal program targeting integrated development of urban infrastructure in 63 identified cities, mandated reforms and preparation of City Development Plans (CDP) that charted out plans by cities as to how they would develop land-use, transport and other basic infrastructure including sanitation. There was provision of funds and focus on creating sewage network and treatment facilities. However, all funds allocated to the sanitation sector were spent on construction of underground sewerage projects[5].

Jawaharlal Nehru National Urban Renewal Mission (JNNURM)

Recognizing the huge infrastructure deficits in Indian cities, the government of India launched JNNURM in late 2005. The programme was meant to infuse capital for infrastructure into select Indian cities as well as initiating a set of urban reforms. The mission focused on 65 selected cities (mostly million-plus), and included two sub-missions: Urban Infrastructure and Governance (UIG), which focused on infrastructure; and Basic Services for the Urban Poor (BSUP), with a focus on shelter for the urban poor. For all other medium and small towns in the country, the Urban Infrastructure Development. Scheme for Small and Medium Towns (UIDSSMT) and the Integrated Housing and Slum Development Programme (IHSDP) were launched with focus areas mirroring those of UIG and BSUP respectively. Sanitation investment went to expansion or retrofitting of sewerage networks, and there is little evidence of funds going to faecal sludge management. Only 6 per cent of the funds went to construction of STPs.

While there was a dedicated fund for the urban poor, it was limited to one-third of the investments.

[5]*Ministry of Urban Development, GoI. (2014, April 29). Completed Projects. Retrieved November 21, 2014, from JNNURM: http://jnnurm.nic.in/wp-content/uploads/2014/04/Completed-Projects-29-04-20141.pdf*

Moreover, most of this funding went to low-cost housing, as opposed to reaching out to larger numbers of urban poor through a range of slum upgrading programmes. JNNURM was designed to enable cities to develop their own priorities on the basis of city-wide planning, and the mission cities were required to submit a City Development Plan before they could access funds. However, most City Development Plans show remarkable similarities in priorities and kinds of projects selected across sectors . While this similarity could be attributed to many factors, one possible constraint could have been that the projects had to be prepared in accordance with Central Public Health and Environmental Engineering Organisation (CPHEEO) manuals– and these listed only sewerage systems, leaving little scope for other technological options. Thus, most investment in urban sanitation in the last decade was directed to networked systems in larger cities. There is little evidence of cities adopting the whole wastewater approach.

National Urban Sanitation Policy (NUSP)

The National Urban Sanitation Policy was launched in 2008. It is remarkable that a policy was actually formulated for urban sanitation, given that there is no matching policy for urban water supply. Along with Indonesia's Sanitation Sector Improvement Programme, the NUSP is one of the few initiatives that has established a broad enabling environment for urban sanitation . The NUSP has several significant features, most of which point to new directions for urban sanitation in India. It recognizes the importance of the entire waste cycle, as well as open defecation free cities, and 100 per cent collection and treatment of waste are explicitly laid out as goals. In a remarkable departure from earlier initiatives, it promotes no particular technological solutions, instead encouraging all kinds of solutions. It also underlines the importance of operation and maintenance of all sanitary installations and facilities. Realizing the vast differences in the cities, it recommends that each state in India prepare a state sanitation strategy, and each city prepare a city sanitation plan.

The NUSP also places the needs of the urban poor right at the centre, highlighting the constraints that might limit their access – legal status, affordability and space constraints. It calls for the urban poor to be provided with sanitation facilities, irrespective of the legal status, and for delinking tenure from service provision. The NUSP addresses most of the priorities laid out in this paper. The biggest policy drawback is the absence of dedicated funding. It has had minimal impact on the nature of JNNURM investments, since the launch/design of JNNURM preceded the NUSP. However, other initiatives have been launched as a result of the NUSP. A rollout of state urban strategies and city sanitation plans as well as some of the initiatives listed below, can at least partly be attributed to the NUSP.

Swachh Bharat Mission (Urban)

The urban component of the Swachh Bharat Mission was launched in 2014 to eliminate open defecation, eradicate manual scavenging as well as implement modern and scientific SWM, generate awareness about sanitation and its linkages to public health, capacity augmentation for ULBs and to create an enabling environment for private sector participation in capex (capital expenditure) and opex (operation and maintenance) (GoI, 2014). The mission is implemented by the Ministry of Urban Development (now Ministry of Housing and Urban Affairs) and is supposed to cover 4,041 statutory towns in India till 2019. At the national level, the infrastructure driven approach started moving towards a holistic, integrated, people centered approach with the release of the NUSP in 2008. The policy moves away from prescribing piecemeal infrastructure solutions such as construction of toilets or STPs towards planning and implementing measures related to

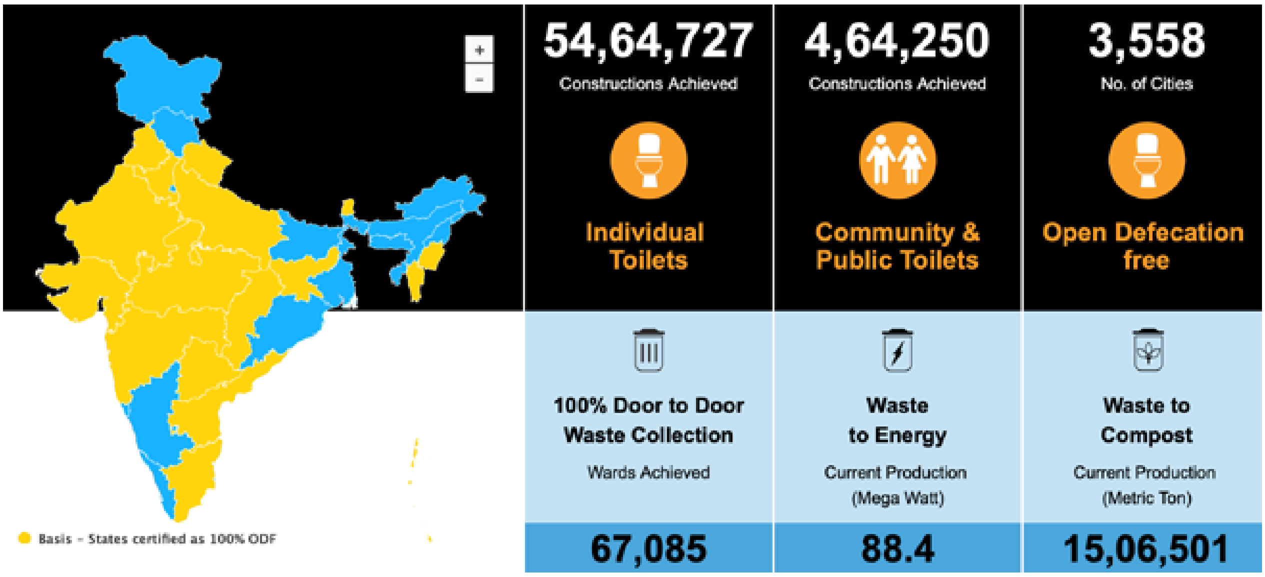
[6] *Wankhade, K (2012), JNNURM: An Opportunity for Sustainable Urbanisation, Indian Institute for human Settlements.*

sanitation in various sectors as a cross-cutting issue.

Key thrust areas of the mission include,

- Elimination of open defecation
- Eradication of Manual Scavenging by converting insanitary toilets to sanitary
- Modern and Scientific Municipal Solid Waste Management
- Effecting behavioural change regarding healthy sanitation practices
- Awareness generation about sanitation and its linkage with public health
- Capacity Augmentation for Urban Local Bodies (ULBs) to create an enabling environment for private sector participation

Figure 10: SBM program coverage as March 2019



National Policy on Faecal Sludge and Septage management(FSSM)

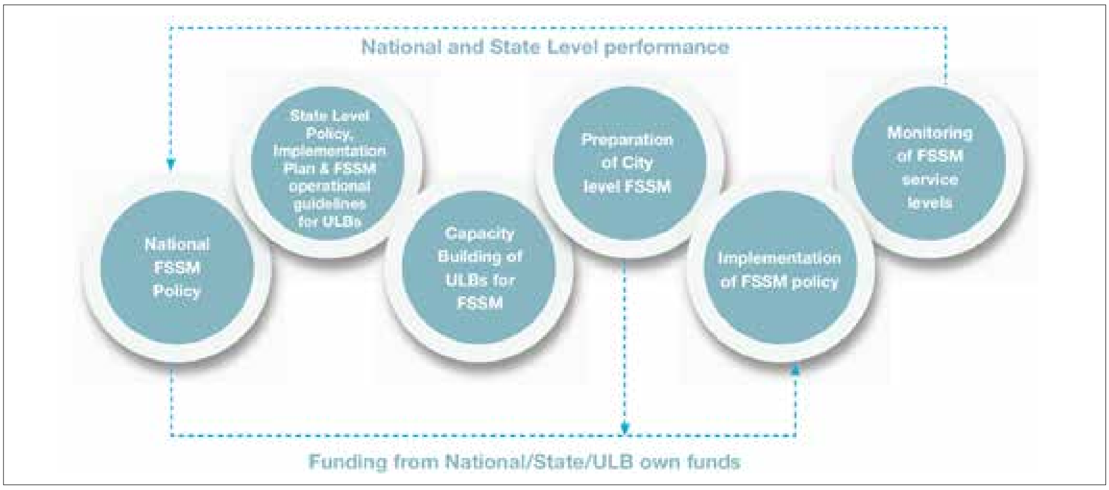
MoUD recognizes that the end objectives and corresponding benefits of SBM cannot be achieved without proper management of faecal sludge and septage across the sanitation service chain. Further, it is well understood that sewerage coverage will not meet the complete sanitation needs in all areas, and a strategy which is a combination of OSS and off-site (decentralised and centralised) must co-exist in all cities and must be given equal attention. Over time the relative proportions of coverage by OSS and off- site systems may change but both will need to be managed well. However, the current policies are not explicit enough and also do not provide an outcome-focused direction on this issue. As a first step, MoUD and a host of research and civil society organisations jointly drafted and signed a National Declaration on Faecal sludge and Septage management (FSSM) on 9th September, 2016. Pursuant to the Declaration, this FSSM Policy is being promulgated to address the gaps and provide the necessary directions to diverse stakeholders engaged in provision of FSSM services. The key objective of the urban FSSM Policy is to set the 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.

Only on-site sanitation facilities and areas served by such facilities would fall under the purview of this FSSM Policy. It does not seek to cover network or conventional sewerage system (including treatment plants) of wastewater/sewage management. However it will address synergies between FSSM and sewerage systems or municipal solid waste (MSW) management, e.g., co-treatment of faecal sludge and septage at sewage treatment plants or co-treatment and management of faecal sludge and septage, and MSW.

Unless otherwise specified, the scope of this Policy extends to all the projects, programs and schemes of the Central Government that facilitate and support sanitation services, urban development and improved delivery of services in urban and peri-urban areas of India. It also covers the initiatives undertaken and/or supported by all Central Government Ministries, Departments, Agencies, Authorities and Public Sector Undertakings that have a bearing on sanitation services in urban and peri-urban areas. Further, the Policy applies to every urban local body, outgrowths in urban agglomerations, census towns as declared by the Registrar General and Census Commissioner of India, notified areas, notified industrial townships, areas under the control of Indian Railways, airports, airbases, Ports and harbours, defence establishments, special economic zones, State and Central Government organisations, places of pilgrimage, religious and historical importance as may be notified by respective 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 the projects, programs and schemes related to provision of onsite sanitation services in their respective jurisdictions, irrespective of the source(s) of funding for these projects, programs and schemes.

Figure 12: Implementation process of FSSM Policy



Source:FSSM guidelines,2016

Allocation of Funding for Urban Sanitation

Figure 13 Fund allocation under SBM, AMRUT and 13th Finance Commission (FC)

	Budgetary Allocation	Duration	Sectors covered
SBM Mission	Rs. 62,009 Crore	2014-19	Solid Waste Management, Sanitation, IEC and Capacity Building
AMRUT Mission	Rs. 50,000 Crore	2014-19	Sewerage and Septage Management, Water Supply, Storm Water Drainage, Urban Transport, Capacity Building, Reform Implementation, Development Of Green Space And Parks
13th FC	Rs. 87,519 Crore	2010-15	Untied grant, which can be used across various sectors (especially basic infrastructure services such as water supply, wastewater, solid waste and storm water) based on ULB's preference
14th FC	Rs. 87,143 Crore	2015-20	

Data source: SBM and AMRUT mission guidelines, 13th and 14th FC report

The total fund allocation under the 13th Finance Commission[7] for the period of 2010-15, for all urban and rural local bodies was 87,519 crore. The number of urban and rural local bodies covered was 3,842 and 2,46,076 respectively. The allocation of share is based on the share of population in the respective state and hence, under the 13th FC, Uttar Pradesh was given 12,740.5 crore which was the highest amount of allocation while Goa was given 172 crore which was the lowest allocation. (Ministry of Finance, Government of India, 2009). Fund allocation under 14th FC for the period of 2015-20, for all urban and rural local bodies is 87,143 crore of which, 22,338 crore has already been released till September 2017 (Finance Commission India, September 2017).

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Session

02

Existing Situation and Challenges

1. Session Objectives

- Understanding sanitation systems and challenges
- Understanding flow of various types of waste water in different city context/ scenario

2. Session Plan

Activity	Time	Material /Methods
Exercise – Understanding sanitation systems	25 min	Hands–on exercise on flip charts
Presentation by each group	20 min	Presentation and discussion
Presentation on the shit flow diagram	45 min	Presentation and discussion

3. Key Facts/ Messages

- A system is a set of technologies, each processing the products until they are ultimately disposed of. Most of the cities in India have either partial or no sewerage systems and are dependent on on-site sanitation systems.
- The components of a FS service chain consist of access (to toilets), collection (of faecal sludge), conveyance (transport of faecal sludge), treatment and disposal/reuse.
- Due to limited attention to these components, the sludge is either not collected or treated appropriately posing risks to human and environmental health.
- Addressing the service chain presents various challenges at the users as well as service providers' end. Hence a comprehensive approach should be adopted starting from evaluation of existing status to understand gaps and their impact on the performance of the system and what can be done for improvement at each step in the service chain.
- Onsite technologies can represent viable and more affordable options, only if the entire service chain, including collection, transport, treatment and safe reuse or disposal, is managed adequately.
- A Shit Flow Diagram (SFD) is an advocacy and decision support tool that summarizes and presents a visual representation of what happens to excreta in urban areas. It is a tool to readily understand and communicate how excreta physically flows through a city or town.

4. Learning notes

4.1 Group work: Understanding sanitation systems

Terminologies *(Source: SANDEC training tool, EAWAG)*

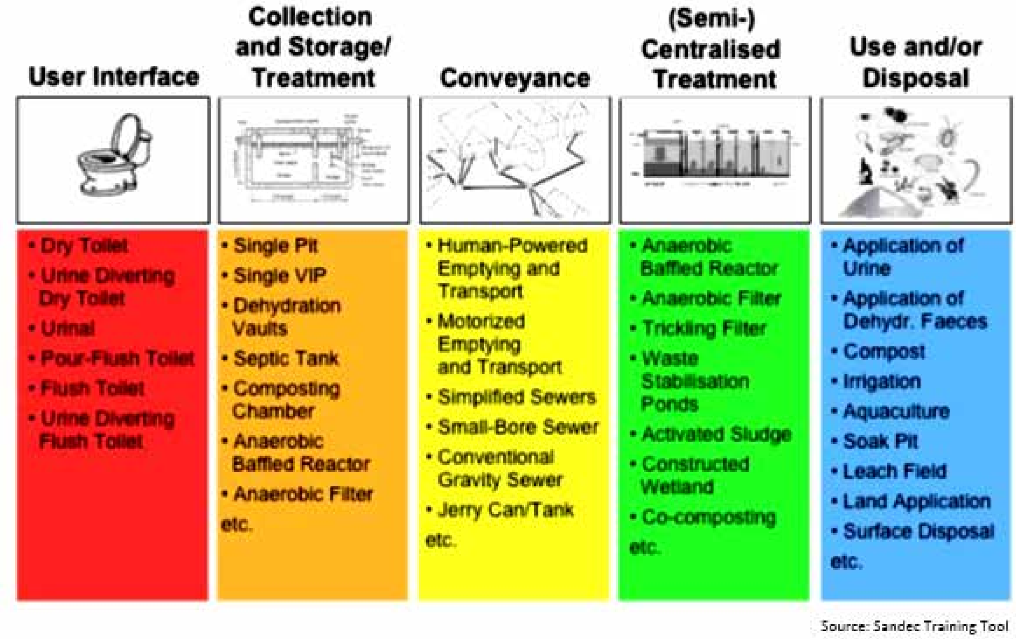
Blackwater is the mixture of urine, faeces and flushing water along with anal cleansing water (if anal cleansing is practiced) or dry cleansing material (e.g. toilet paper).

Greywater is used water generated through bathing, hand-washing, cooking or laundry. It is sometimes mixed or treated along with blackwater.

Domestic wastewater comprises all sources of liquid household waste: blackwater and greywater. However, it generally does not include stormwater.

What are sanitation systems? *(Source: SANDEC training tool, EAWAG)*

Figure 1 Sanitation systems - Functional groups



(Source: SANDEC training tool, EAWAG)

- A sanitation system is a combination of technologies through which the products flow.
- Technologies which perform the same or similar function are grouped into 'Functional Groups'.
- Only selected combinations of technologies will lead to functional systems.

A sanitation system should consider all the products generated and all the functional groups these products are subjected to prior to being suitably disposed of. Domestic products mainly run through five different functional groups, which form together with a system. Addressing only the first functional group i.e. user interface does not suffice unless the management of faecal sludge generated from the toilets and management of liquid effluent flowing untreated open drains is ensured. Hence, a comprehensive approach to sanitation addressing all the functional groups starting from the generation of septage to its disposal or reuse is urgently needed.

Selection of appropriate sanitation systems

Though processes and products in each functional group are pre-listed, selection of the appropriate option is important. The selection should be context specific and should be made on the basis of the local situation, site context, culture, and available resources. Assessment of these is essential before finalizing the desired system.

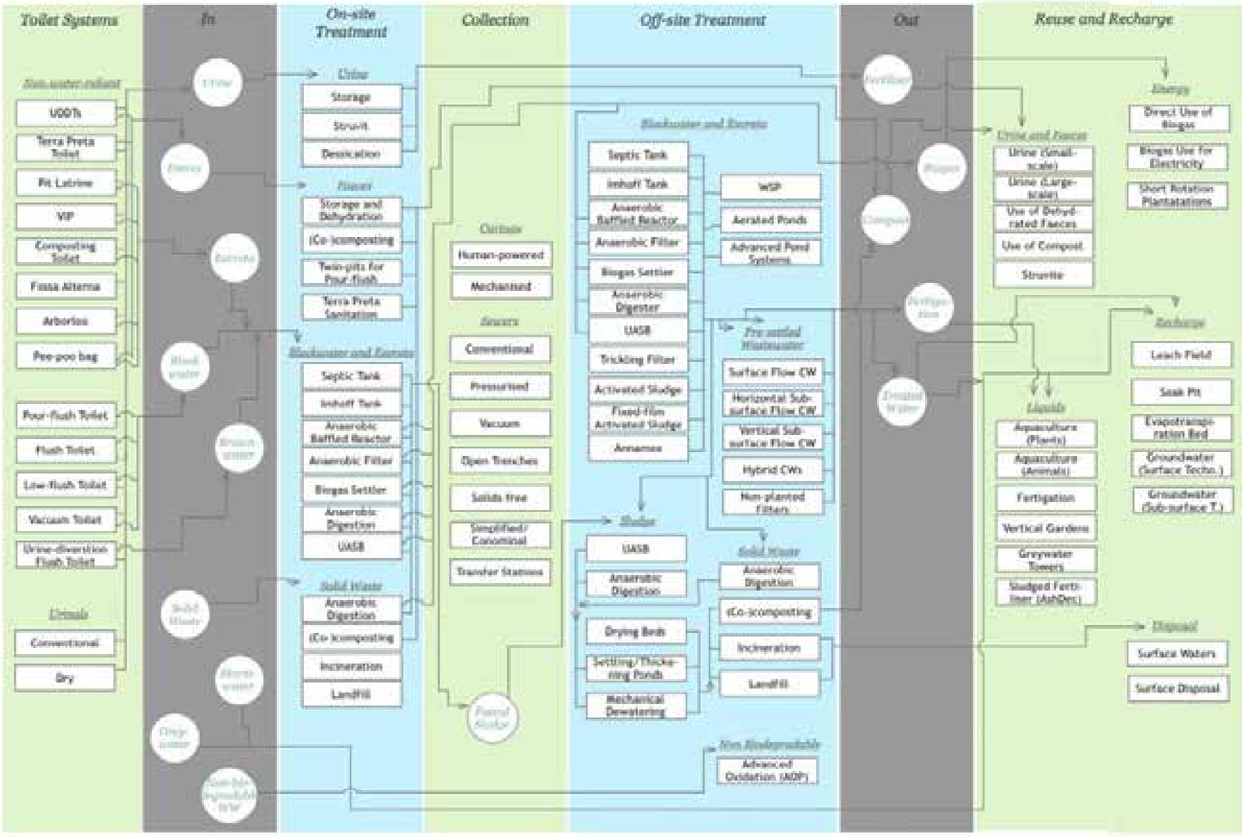
Group work

The participants are expected to divide their sheets into two sections and draw the current sanitation system that exists in the majority of their cities. Through discussion and brainstorming in their groups, participants observe gaps in the sanitation service chain drawn by them. After this, an envisaged system which will serve the city in a safe and adequate manner should be drawn in the second half of the sheet.

The participants are handed a sheet which shows different functional units in the service chain as described in the Sustainable Sanitation and Water Management (SSWM) toolbox and how they are interlinked. *(Source:http://archive.sswm.info/category/implementation-tools/reuse-and-recharge/hardware/introduction/sanitation-systems).*

Participants are expected to assess the options available in each component and come up with an ideal functional service chain for their cities. All groups are expected to present their systems after completion.

Figure 2 Overview of sanitation systems - SPLUHER 2010

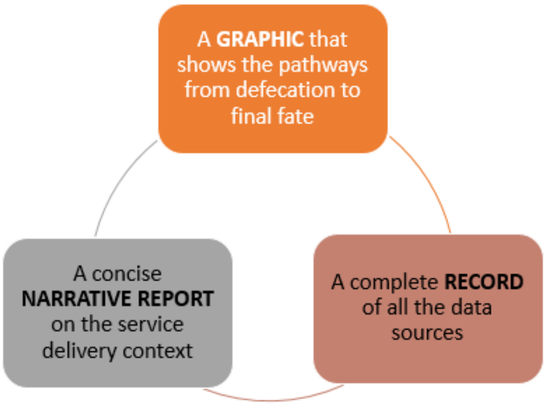


4.2 What is a shit flow diagram

A first step towards providing adequate sanitation services in urban areas is to monitor the sanitation service chain, is to identify its strengths and weaknesses, from containment, including emptying, transport, treatment, and safe disposal or resource recovery. SFDs can help achieve this by offering a new and innovative way to engage sanitation experts, political leaders, and civil society in coordinated discussions about excreta management in their city.

A Shit Flow Diagram (SFD) is an advocacy and decision support tool that summarizes and presents in a concise report what happens to excreta in urban areas. SFDs are a new way of visualizing excreta management in cities and towns. The fate of excreta produced by urban populations across the globe is often poorly understood. Particularly in low- and middle-income countries with rapidly expanding cities, excreta management represents a growing challenge; generating significant negative public health and environmental risks.

Figure 3 What is an SFD?



(Source: https://www.cseindia.org)

4.3 Why prepare an SFD?

- An SFD presents a clear picture of how wastewater and faecal sludge management (FSM) services are delivered in a city and the resulting challenges.
- The SFD is a diagnostic tool that helps to identify the aspects of service delivery where improvements are needed.
- An SFD primarily provides technical and non-technical stakeholders with an advocacy tool to support decision-making on urban sanitation planning and programming.
- Importantly, an SFD does not provide a "shortcut" around integrated sanitation planning, promotion, investment, design, construction, operation, and maintenance. These remain very necessary components for implementing successful urban sanitation.

(Source: https://sfd.susana.org/about/the-sfd)

4.4 Components of an SFD report

Completing an SFD Report, including service delivery context information and the SFD Graphic, involves two broad aspects:

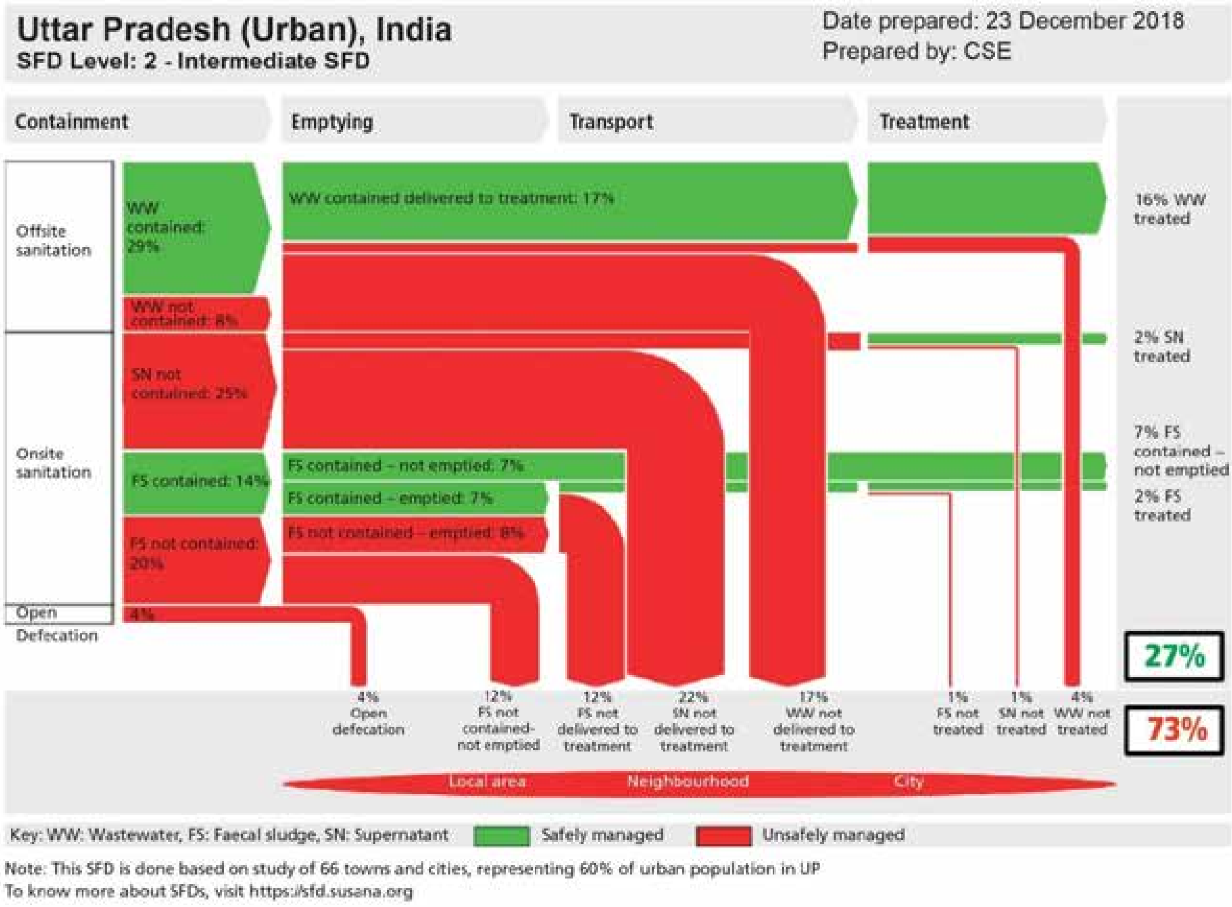
- Collect information about the service delivery context in order to assess the status of sanitation services within the defined area
- Using this information, assess the situation with regards to all sanitation services and management of excreta, from which an SFD Graphic will be prepared

(For more details: https://sfd.susana.org/knowledge/the-sfd-manual)

4.5 SFD For Uttar Pradesh

The SFD for Uttar Pradesh was prepared by CSE in December 2018 based on a study of 66 towns and cities. Some general observations are that sanitation provision through sewer systems increases with an increase in the population of the cities. The interpretation from this intermediate level of SFD can be listed as below

Figure 4 Example of an SFD (made for Uttar Pradesh by CSE)



KEY OBSERVATIONS FROM SFD OF UP

- More than 60% of the population is dependent on on-site sanitation systems like septic and pit latrines. Out of which the excreta of only 4% population is treated.
- The effluent from the septic tanks of 50% of the population is discharged directly into the open drains of which 2% is treated by tapping nullahs and drains.
- 29% of the population has sewage connection of which sewage of 16% population is treated.
- Excreta of 8% of the population is directly discharged in drains
- 4% of the population still defecates in the open
- Excreta of 27% of the population is safely managed and 7% of which is safely stored in the containment system

5. Further readings and references

- Sustainable Sanitation Alliance, April 2018 SFD Manual Vol.1 and 2 version 2.0, SFD promotion initiative (https://sfd.susana.org/knowledge/the-sfd-manual)
- EAWAG/SANDEC (2008): (Sandec Training Tool 1.0, Module 5). Duebendorf: Swiss Federal Institute of Aquatic Science (EAWAG), Department of Water and Sanitation in Developing Countries (SANDEC)
- https://www.eawag.ch/en/department/sandec/projects/faecal-sludge-quantification-and-characterisation/sandec
- http://archive.sswm.info/category/implementation-tools/reuse-and recharge/hardware/introduction/ sanitation-systems

Session

03

Option 1:

Role of Stakeholders in FSSM Planning Process

Option 2:

Planning for Emptying Services

Session 3 can either be planned as 'Role of stakeholders in FSSM planning process' which outlines the role of each stakeholder through a group activity or 'Planning for emptying services' outlining demand based and schedule based emptying in detail. Based on the target audience, the trainer can conduct a session that is more apt for the participants.

Option 1: Role of stakeholders in FSSM planning process

1. Session objective

To understand the role of various stakeholders in the process of planning and implementation of FSSM services.

2. Session plan

Group exercise followed by a discussion

Time: 90 min

Activity	Time	Material /Methods
Group Exercise	45 min	Hands-on exercise on flip charts in groups
Discussion	45 min	Presentation on the flip chart

3. Key learning

To make participants understand the role and responsibility of each stakeholder for activities across the service chain and to deliberate the efforts and expectations each stakeholder has from the other stakeholders for effective planning and implementation of FSSM activities.

4. Learning notes

In this exercise, the participants are expected to identify and list various important stakeholders involved in the process of planning and implementation of FSSM. After discussion, the following are identified as important stakeholders:

- State Government
- ULB – Municipal Officials
- ULB – Elected Representatives
- NGOs
- Private Sector
- Citizens

After this, the participants are divided into 6 groups – each as one of the above listed stakeholder. Each group had to brainstorm their responsibilities as the identified stakeholder and what is expected from the other stakeholders. Additional questions like key challenges faced by stakeholders and their top priorities which need to addressed can also be added to the exercise.

After the discussion time, each group presents their listed responsibilities and expectations in the role of the particular stakeholder.

A debate regarding the expectation, their roles and responsibilities is evolved through such discussion which enables cross learning and sensitization among the participants. A comprehensive list of the roles and responsibilities of each stakeholder is thus prepared to make everyone understand their tasks and efforts required in the process and the outcome expected by other stakeholders.

Example of output is given below:

<table>
<tr><th colspan="5">Stakeholder: State Government</th></tr>
<tr><td colspan="5">Key Responsibilities</td></tr>
<tr><td colspan="5">1. FSSM policy for the state
2. Strategy formulation (e.g. Target setting etc.)
3. Technical and administrative support to cities
4. Review and monitoring mechanism for implementation in cities (through guidelines, GRs, SOPs etc.)
5. Financial support through funds/schemes or supporting ULBs in mobilizing funds from other sources.
6. Capacity building and exposure of ULBs</td></tr>
<tr><th colspan="5">Expectations from</th></tr>
<tr><th>ULB – Municipal officials</th><th>ULB – elected representatives</th><th>NGOs</th><th>Private sector</th><th>Citizens</th></tr>
<tr><td>• Planning for FSSM based on the state FSSM policy.
• Implementation of the FSSM plan.
• Ensure the involvement of other relevant stakeholders for various activities.
• Capacity building of stakeholders.</td><td>• Support ULB for FSSM activities.
• Create awareness among citizens for FSSM activities.</td><td>• Ill effects of poor construction of containment systems and their impact on human and environmental health.
• Awareness related to regular desludging of septic tanks.</td><td>• Desludging of septic tanks.
• Disposing septage at the dedicated treatment site.</td><td>• Regular desludging of septic tanks
• Regular payment to ULB for services.</td></tr>
</table>

Option 2: Planning for emptying services

1. Session objective

To understand existing practices of desludging in cities and planning for emptying services for a city.

2. Session plan

Presentation followed by discussion and hands-on exercise

Time: 90 min

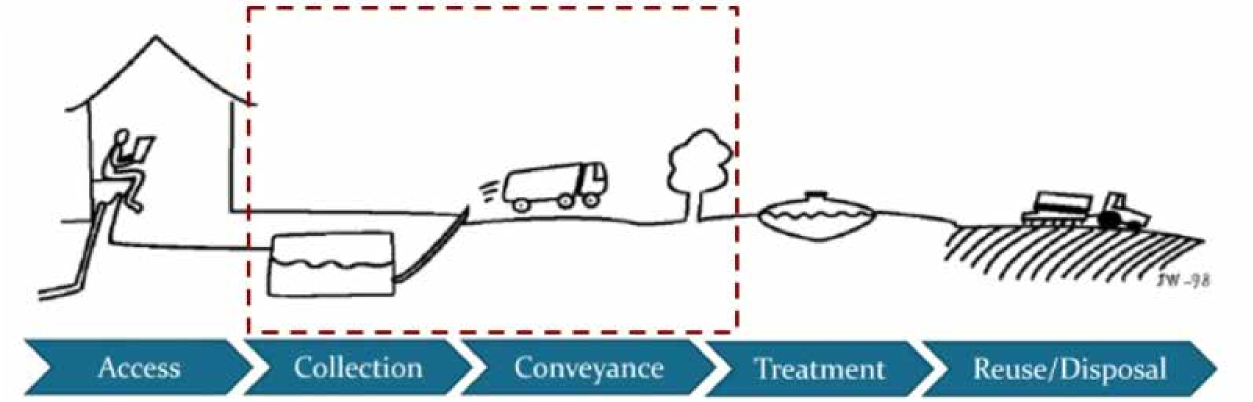
Activity	Time	Material /Methods
Presentation on planning for emptying services	60 min	Presentation and Discussion
Discussion – Q and A	10 min	Discussion
Exercise – Calculation of infrastructure requirements for the conveyance	20 min	Hands – on Exercise

3. Key Facts/ Messages

- Conveyance refers to safe emptying and transportation of sludge collected from the septic tanks and it's emptying at a dedicated treatment facility.
- It is commonly observed in cities that septic tanks are often cleaned only when they become full and start to overflow. Once the effluent enters the open drains, it poses a serious risk to environmental and health.
- After a period of 3 to 5 years, sludge decomposes, solidifies, and can no longer be removed by suction alone. Improper disposal of septic tank effluents and septage can pose direct and indirect socio-economic impacts in addition to health and environmental hazards.
- As per the CPHEEO Manual on Sewerage and Sewage Treatment, 2013 septic tanks should be cleaned at least once in two-three years, provided the tank is not overloaded due to use by more than the number of persons for which it is designed.
- The Prohibition of Employment as Manual Scavengers and their Rehabilitation Act came into force in December 2013. According to this act, there is a prohibition on insanitary latrines and employment and engagement of any person for cleaning of Sewers or septic tanks as manual scavengers.
- The type of conveyance trucks should be purchased based on an assessment of local conditions in the city.
- Human-powered or motorized vehicles are largely used for desludging septic tanks in cities. They usually accompanied by a driver and a helper.
- It is important to ensure that the septage transportation vehicle operator is well trained and uses personal protective equipment.
- Demand-based desludging refers to a model wherein the household calls the ULB or the private operator to desludge the septage once the septic tank is full and overflowing. This is essentially a complaint redressal system.
- Schedule based desludging refers to scheduled/planned emptying of septic tanks or other containment systems at an interval of 2-3 years as recommended by CPHEEO Sewerage & Sewage Treatment Manual and the MoHUA Advisory on Septage Management (2013).
- For effective operation of scheduled septic tank emptying service and treatment facilities, ULB may also explore the option for private sector inclusion for emptying services.
- It is necessary to assess the current role of private sector providers as well as their potential role in a citywide service provision.

4. Learning notes

4.1 Current status of emptying services



Collection refers to the collection systems of septage like septic tanks, twin pits, etc. Addressing collection systems include converting insanitary toilets to sanitary toilets, refurbishing septic tanks if needed and designing new septic tanks as per norms. Conveyance refers to safe emptying and transportation of sludge collected from the septic tanks and it's emptying at a dedicated treatment facility.

In India, a very common practice is to construct large septic tanks/ containment systems against specified norms to avoid frequent emptying due to high desludging charges and irregular services. Outlet pipes of the containment systems are often connected to open drains or sewerage network, wherever present. Once the effluent enters the open drains, it poses a serious risk to environmental and health. Limited capacities and resources with Urban Local Bodies result in little or no regulation of maintenance and cleaning of septic tanks and pits –due to which households do not report cleaning for a number of years. Some ULB's have desludging equipment or there are private players providing cleaning services but the supply of desludging services is far from adequate.

4.2 Need for periodic cleaning of septic tanks

It is commonly observed in cities that septic tanks are often cleaned only when they become full and start to overflow. People build oversized septic tanks to avoid frequent cleaning. As per the CPHEEO Manual on Sewerage and Sewage Treatment, 2013 "yearly desludging of septic tanks is desirable, but if it is not feasible or economical, then septic tanks should be cleaned at least once in two-three years, provided the tank is not overloaded due to use by more than the number of persons for which it is designed."

Septic tank effluent and septage, with appreciable levels of organics, nitrogen, and pathogens, disposed of without proper treatment are a cause of concern on account of the organic carbon (measured as BOD), nitrogen, phosphorus and pathogens in the effluent. The pollutants in the effluent and septage from septic tanks systems and their potential impacts on ground and surface water resources are summarized below:

Table 1 Pollutants in the effluent of on-site treatment Systems

Pollutant	Reason for concern
Total suspended solids	In surface waters, suspended solids can settle and form sludge deposits that smother benthic invertebrates, fish eggs and can contribute to benthic enrichment, toxicity and sediment oxygen demand. Colloidal solids can block sunlight, affect aquatic life and lower the ability of aquatic plants to increase the dissolved oxygen in the water.
Biodegradable organics (BOD)	Biological degradation of organics can deplete the dissolved oxygen in surface waters resulting in anoxic conditions, harmful to aquatic life.
Nitrogen	Nitrogen could lead to eutrophication and dissolved oxygen loss in surface waters. High levels of nitrate nitrogen in drinking water can cause methemoglobinemia in infants and pregnancy complications for women. Livestock can also suffer from drinking water high in nitrogen.
Phosphorus	Phosphorus would also lead to eutrophication and reduction of dissolved oxygen in surface waters.
Pathogens	Parasites, bacteria and viruses can cause communicable diseases through body contact, ingestion of contaminated water or shellfish. Transport distances of some pathogens (bacteria and viruses) can be quite significant.

(Source: Advisory note on septage management in urban India, 2013)

Studies have shown that after a period of 3 to 5 years, sludge decomposes, solidifies, and can no longer be removed by suction alone. Improper disposal of septic tank effluents and septage can pose direct and indirect socio-economic impacts too.

There are many benefits of regular desludging of on-site sanitation systems. These include:

1. Increased efficiency of septic tanks:
Septic tanks perform well when detention time in the tank is maximized. As accumulated sludge reduces available tank volume, the resulting decrease in detention time impacts the tank's function and ability to separate heavier solids from lighter fats and oils.

2. Better discharge quality:
Septage has a much higher concentration of pollution constituents than septic tank effluent. The concentration of BOD and total suspended solids is much lower in effluent compared to sewage or septage. The quality of the effluent reduces with time.

4.3 Prohibition of employment as manual scavengers and their rehabilitation act 2013

The Employment of Manual Scavengers and Construction of Dry Latrines (Prohibition) Act, 1993 put a ban on dry latrines, i.e., latrines with no water-seal or flushing mechanism, and the employment of persons for manually carrying human excreta. This was supplemented in 2013 with the Prohibition of Employment as Manual Scavengers and their Rehabilitation Act, 2013 by which hazardous cleaning in relation to sewers and septic tanks is also banned. The emptying of tanks should be undertaken only by mechanical devices like vacuum emptier trucks. Manual scavengers should be identified through surveys and their rehabilitation through housing and financial assistance should be provided.

Given the safety and health risks of manual desludging, it is critical for cities to take measures to urgently put a stop to this demeaning practice. This must include strict restrictions and punishing measures for all private parties or likewise offering manual septage cleaning services. Local governments should also be brought under strict vigil to prohibit any manual cleaning, and the full adoption of mechanical devices, safety gear for occupational safety and practices that reduce to the minimum risk of physical contact as well as protect against hazards posed by harmful gases while cleaning septic tanks, pits or sewer systems.

4.4 Technologies for desludging

The type of conveyance trucks should be purchased based on an assessment of local conditions in the city. For deciding the conveyance systems following parameters need to be taken into consideration:

- The distance **of the treatment site, access to the site, traffic congestion**: to comprehend the number of trips that can be made in a day.
- **Road width**: to understand the size of vehicles that need to be purchased.
- **Characteristics of septage and size of septic tanks**: to assess the amount of septage that can be desludged at a time which will consequently affect the number of trips.
- **Fuel requirement:** to understand its implications on OPEX.
- The financial **budget of emptying services:** to assess feasibility before planning for conveyance system.

Types of vehicles

Human-powered and motorized vehicles are largely used for desludging septic tanks in cities. They have been instrumental in eradicating manual scavenging in the country. Many types of equipment are available to cater to the needs in different terrains and street typologies. These desludging trucks collect septage at the household level and transport it to treatment or disposal sites. Charges for emptying vary between Rs. 500–3,000 across the country.

Conventional vacuum tanker:

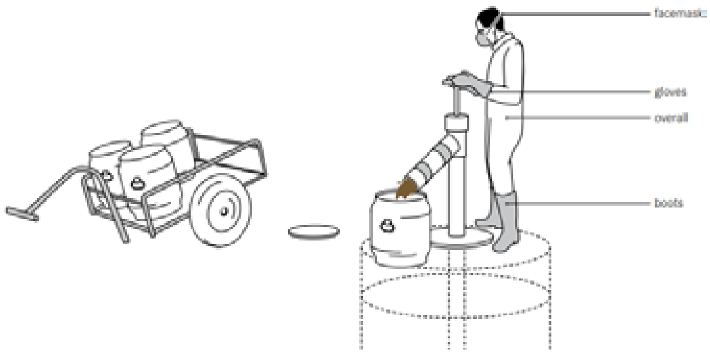
For access roads with sufficient widths (more than 3m), conventional vacuum trucks can be used. These are generally of capacity starting from 3000 liters up to 10000 litres or more depending on market availability. The total number of machines depends on the desludging services required per day as the frequency of cleaning of septic tanks is once in 2–3 years and also the distance from the location of septic tanks to the septage treatment facility. It is to be noted that the requirement of machines also varies depending upon the capacity of vehicles, road width etc. In the case of bigger cities having sufficient width of roads, vehicles having larger capacities may be adopted.

Mini vacuum tanker/ Vacutugs:

For narrow lanes in the city, smaller vehicles called vacutugs may be used. They are from 200 up to 2,000 litres capacity and are recommended for use in areas inaccessible to large desludging vehicles. The vacutug is mounted on wheels and can be attached to a small vehicle. It can be manufactured locally to offer flexibility and mobility without losing the capacity to collect a substantial volume of faecal sludge within one operation.

Gulper:

Smaller mechanized tricycles called gulpers with 20 -40 liters capacity may work in slum settlements. Gulpers work on the same concept as water hand pumps: the bottom of the pipe is lowered into the pit/ tank while the operator remains at the surface. As the operator pushes and pulls the handle, the sludge is pumped up and is then discharged through the discharge spout. The sludge can be collected in barrels, bags or carts, and removed from the site with little danger to the operator provided that the necessary PPEs are adopted as shown below .



Mechanized systems are usually accompanied by a driver and a helper (sometimes two helpers). It is important to ensure that the septage transportation vehicle operators (whether from the ULB or private sector) are well trained and equipped with protective safety gears (such as gloves, boots, hat, face mask, Davy's lamp), uniforms, tools and proper vacuum trucks, for safe handling of septage.

Technology options for conveyance are further elaborated in chapter 4.

4.5 Demand and schedule based desludging

Demand based desludging

Demand based desludging refers to a model wherein the HHs calls the ULB or the private operator to desludge the septage once the septic tank is full and overflowing. This is essentially a complaint redressal system. Currently, demand based desludging is prevalent in most of the cities in India. Since this is a market-driven model, the prices per trip for septic tank desludging is quite high.

If the city wants to adopt/continue with demand based desludging, it should be regulated heavily. HHs should be made aware to desludge their tanks periodically and regulations should be made and followed for the same.

Schedule based desludging

Schedule based desludging refers to scheduled/planned emptying of septic tanks or other containment systems at an interval of 2-3 years as recommended by CPHEEO Sewerage & Sewage Treatment Manual and the MoHUA Advisory on Septage Management (2013).

In this, a septage conveyance plan or a schedule is drafted. For any plan to be effective, robust data on volumes and locations is required. The ULBs should make efforts to collect baseline data – the type of sanitation systems connected to toilets, effluent disposal system, size and age of collection systems, when they were last cleaned and most importantly, their access, to plan for workable desludging schedules. It is advisable to divide the city into working zones for the same. Pilot desludging schedules can be implemented to learn operational issues and devise solutions, before scaling up to the whole ULB. While formulating zones, availability of septage disposal and treatment site/ existing STPs and their distance from the zone should be taken into consideration.

It is recommended that households in the demarcated septage management zone should be within 30 km. travel distance from identified disposal sites, for workability. (Advisory Note on Septage Management in Urban India, 2013)

Prior to this planning, the ULB shall first assess its role and capacity for implementation of the septage management plan. ULB should assess various aspects of septic tank emptying like how many septic tanks are required to be emptied annually as per CPHEEO norm versus how many are emptied in a year, how many vacuum emptying trucks/ capacity of trucks are required if number of septic tanks emptied as per CPHEEO norms 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. (Guidelines for Septage Management in Maharashtra, 2016)

Steps for Scheduled septic tank emptying services: (Guidelines for Septage Management in Maharashtra, 2016)

- ULBs should initiate pre-determined scheduled septic tank emptying services and develop a route plan for the same.
- Mobilize or procure an 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 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.
- ULBs should either provide the emptying services themselves or enter into appropriate management contracts with private agencies. In the case of private sector contract, ULBs should certify and license private septage transporters to de-sludge and transport waste to the designated treatment facility.
- All septage transporters need to maintain a collection and transport receipts. This needs to be filled duly by the private / ULB service provider and submitted to the ULB office.

Table 2 Scheduled and demand based desludging

Scheduled Desludging	Demand Desludging
• Services at the predefined regular schedule (generally 3-5 years) as determined by the city. • City divided into zones for desludging. • Works as a public service model. • Service either by ULB or registered private sector. • Charges can either be taken through user charges or sanitation tax (can be levied if desludging provided as a service to the citizens).	• Services upon request i.e. demand based • Works as a complaint redressal model • Service by ULB (depending on capacity) or private sector depending (may or may not be licensed) and user charges are taken from households.
Pros: • Pro-active system wherein desludging is offered as a public service to the HHs. • Services are offered to all HHs in the city thereby comparatively more equitable. • More cost-effective due to efficiency gains and optimal business structure. • Comparatively more affordable to HHs since charges to be paid every year are low. • Positive implications on the health of the community and environment over a period of time.	**Pros:** • HHs decide when to avail to desludging services.

Scheduled Desludging	Demand Desludging
Cons: • Participation by HHs and their willingness to desludge every 3-5 years which may need extensive IEC activities. • Comparatively more infrastructure requirement.	**Cons:** • Very low desludging frequency by HHs. • No control over desludging charges. Can vary substantially with generally high prices per trip. • Need strict monitoring so that septage is disposed at the designated site and not in any other area in and around the city. • Low efficiencies of septic tanks with poor quality effluent overflow being released in rivers/water bodies causing negative environmental impact

Private sector participation

For effective operation of scheduled septic tank emptying service and treatment facilities, ULB may also explore the option for private sector inclusion for emptying services. It is necessary to assess the current role of private sector providers as well as their potential role in a citywide service provision.

Following points to be taken into consideration by ULB:

- Assessment and inventory of the existing private operators within the city as well as in nearby cities.
- Exploring their participation for various activities like procurement, operations and maintenance of the suction emptier trucks, involvement in schedule desludging, construction and operations of the septage treatment facility and possible re-users of treated septage.
- Assess the willingness of private operators to provide services to the ULB.
- Develop performance-based contracts such that payment is linked to the performance of the private sector for providing the services.

4.6 Case-study: Behrampur, Odisha

In Berhampur of Odisha State, the Municipal Corporation has introduced the referral system for increasing the demand generation of emptying and reducing the instances of manual scavenging. Berhampur Muncipal Corporation(BeMC) has taken an innovative step of introducing a revenue generating model for increasing requests for mechanized cesspool emptying operations through referrals received from SHGs. This is in line with the SBM model of toilet construction wherein the Swachhagrahis are provided an incentive, referral model for cesspool demand generation is based on the similar concept wherein the SHGs are provided an incentive of INR 20 per request generated from each household.

OBJECTIVE

To serve the purpose of increased mechanized emptying, reducing instances of manual scavenging, and generating alternate sources of income for SHGs through CLC on incentive mechanism.

PROCESS

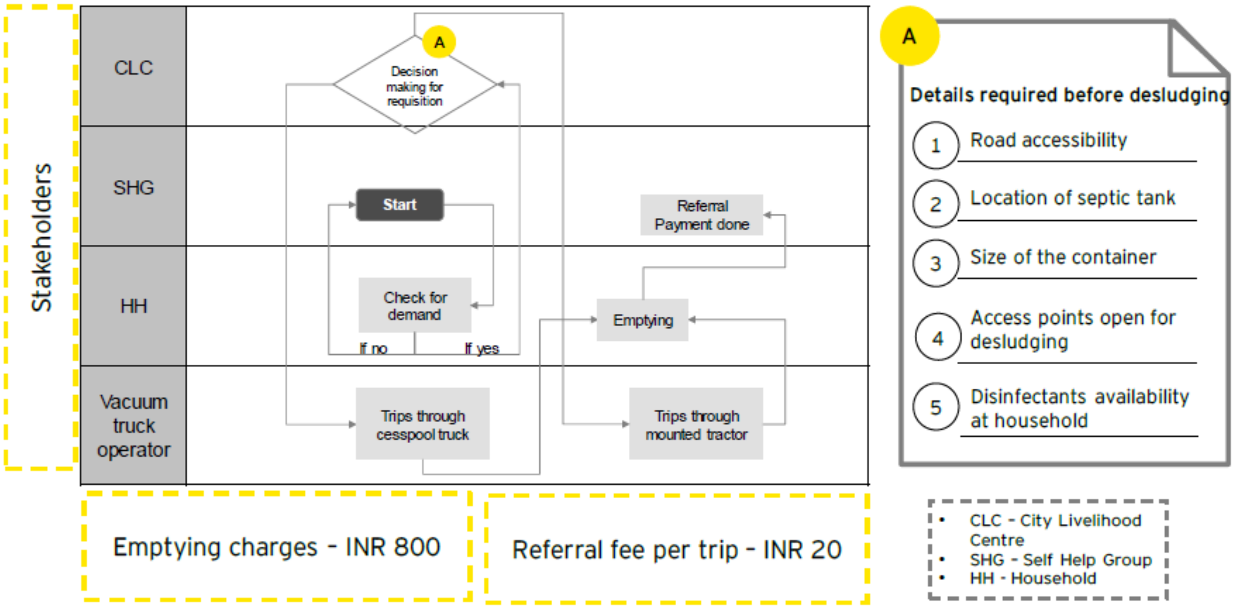
A three step approach focusing on orienting and training was considered for onboarding stakeholders – SHG, CLC and cesspool operator.

- **Step 1:** The first step was to conduct training for SHGs on the importance of FSSM, frequent desludging and monetary benefits for SHGs.
- **Step 2:** The second step was to build a consensus between SHG and cesspool operator for sharing the referral fee.
- **Step 3:** The third step was to orient SHGs on the action plan for convincing households to desludge septic tank frequently

The referral system is replicable in places where SHGs have been working in sanitation sector or are inclined towards working in this sector. The incentive can be negotiated with the ULB based on the scenario in each city.

OPERATING PROCEDURE

Figure 5 Process of referral demand generation



BeMC has appointed CLC to act as a bridge between self-help groups and private vacuum truck operators for systematically channelized desludging requisitions. As mentioned above, the SHGs convinces neighboring households to desludge. CLC maintains service order records to ensure transparency and financial accountability. CLC also takes responsibility to advertise desludging services in their office. By the end of the month, the referrals are tallied at CLC and the total amount to the SHG is handed over by the operator through CLC. The payment is currently being made through cheques and the amount gets transferred to the SHG bank account.

To ensure the sustainability of this initiative, BeMC has signed a contract with the private operator (valid for a year), wherein, the vacuum truck operator agrees to provide trips per the agreed ULB rate and pay the referral amount to SHG post completion of the services. The operator will also maintain database of the trips undertaken in a month.

4.7 Group exercise: Calculation for infrastructure requirements for conveyance in a city

In this exercise, participants are divided in groups of two or three depending on the type of participation. For participants with a technical background, this exercise can be done for their own city/ town individually.

An example of a city is given with its input details like population, HHs, HHs with septic tanks, number of CT/PTs, and the average volume of septic tanks etc. Based on these figures, participants are expected to calculate the number of septic tanks to be emptied daily, the number of trucks required and volume of septage to be treated in that city. The calculations are broken down with formulae given under each indicator. With such a hands-on exercise, participants understand the requirements for planning of conveyance systems and can gauge the current status and requirements to regularize conveyance in their cities.

Table 3 Input data of a city for Calculation

Sr. No	Description	No.
	Input details	
A	Population	65251
B	Total households (HHs)	13112
C	HHs having toilets with septic tanks	9900
D	No. of community/ public toilets having septic tanks	21
E	Average volume of household and community toilet septic tanks (cum)	5
F	Septic tank cleaning cycle for HHs (Years)	3
G	Septic tank cleaning cycle for CT/PT (Days)	7
H	No. of working days in an year	300
I	No. of trips possible per emptying vehicle per day (trip/day/vehicle)	4

- **Number of tanks to be emptied daily** = _______daily
  HHs toilets connected to septic tank / cleaning cycle for HHs = _____annually
  HHs toilets to be cleaned daily = annual cleaning / number of working days = _______daily
  CTs connected to septic tank / cleaning cycle for CTs = _____daily
- **Number of trucks required** = ____ nos.
  Number of tanks to be emptied daily / Number of trips per day = ____ nos.
- **Volume of septage to be treated** = ______ cum/day
  Average volume of HHs and CTs septic tanks x Total Number of trips per day = ___ cum/day

5. Further readings and References

- Ministry of Housing and Urban Affairs, Government of India (Feb-2017). *National Policy on Faecal Sludge and Septage management*
- Urban Development Department, Government of Maharashtra (Feb-2017). *Guidelines for Septage Management in Maharashtra*
- Ministry of Housing and Urban Affairs, Government of India (January-2013). *Advisory Note on Septage Management in Urban India*
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- Centre for Science and Environment (2017). *Septage Management, A Practitioner's guide: Urban India's Journey beyond ODF.*
- David M. Robbins (Dec-2007). *Septage Management Guide for Local Governments*
- Ernst & Young LLP (May 2019) - Referral system for increasing demand generation

Session

04

Technology Options – Containment, Conveyance and Treatment

1. Session Objective

To discuss the technology options in FSSM for conveyance and treatment of septage in terms of

- To understand different on-site containment systems.
- To understand different conveyance methods or techniques of FS and Septage.
- To understand the requirement of transfer stations and types.
- To understand the treatment chain for Integrated Faecal Sludge and Septage Management (IFSM).
- To understand the criteria for the selection of appropriate FSS treatment options.
- To understand the different treatment technologies.

2. Session Plan

Activity	Time	Material /Methods
Technology Options – Containment and Conveyance	60 min	Presentation and Discussion
Exposure Visit specific Technology used and its implementation	45 min	Discussion with State and City Officials

3. Key Facts/ Messages

There are various technologies available for containment, conveyance, and treatment. It is important to understand the function, pros and cons for each for selection of most appropriate technology.

- On-site containment system describes the ways of receiving, storing, and sometimes treating the products generated at the user interface.
- The main types of containment systems are twin pit pour flush, septic tanks, anaerobic baffle reactor and anaerobic up-flow filter.
- Conveyance describes the way in which products are moved from one process to another usually between containment system and treatment system.
- The emptying of the containment system and conveyance systems can be human powered with shovels, manually operated pumps etc as well as motorised emptying and transport using vacuum trucks.
- Transfer stations or underground holding tanks which act as intermediate dumping points for faecal sludge when it cannot be easily transported to a treatment facility. They are normally permanent storage type or mobile transfer stations. There are some multi-functional permanent tanks which provide storage capacity and can also accept fresh FS from a public toilet, and/or provide partial sludge treatment.
- The technologies available for treatment of sludge discussed here are Co-treatment at STP, Deep Row entrenchment, Imhoff tanks, anaerobic digestion, settling thickening tanks, unplanted sludge drying beds.
- There are mechanical options available like belt press, screw press and frame filter press.
- Sludge can also be co-treated with SWM. There are thermal options of treatment like incineration, and thermal drying & pelletising.
- Geo tubes can also be used for treatment at places where dewatering takes place and the moisture content is reduced from the sludge to dry it.

4. Learning Notes

4.1 Containment System

This section explains how the output products of a user interface can be collected, stored, and treated on-site. The functional group on-site containment system describes the ways of receiving, storing, and sometimes treating the products generated at the user interface. The treatment provided by these technologies is often the function of storage, and is usually passive, without requiring energy input. Products that emanate from these technologies often require subsequent treatment before use or disposal. There's quite a wide range of technologies which belong to this functional group. The technical and physical criteria for choosing appropriate collection, storage and treatment technology are as follows;

- Ground condition (Soil and strata (percolation and cost of construction)
- Groundwater level and contamination (Cross contamination (pathogens))
- Climate-Temperature (degree of treatment) and rainfall (percolation rate)

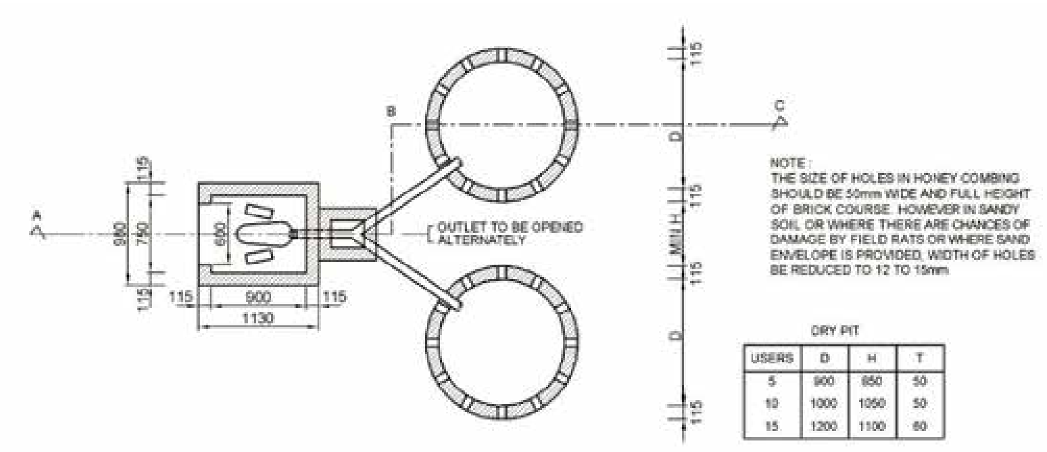
Twin pit for pour flush toilet

This technology consists of two alternating pits connected to a pour flush toilet. The blackwater (and in some cases greywater) is collected in the pits and allowed to slowly infiltrate into the surrounding soil. Over time, the solids are sufficiently dewatered and can be manually removed with a shovel. The twin pits for pour flush technology can be designed in various ways; the toilet can be located directly over the pits or at a distance from them. The superstructure can be permanently constructed over both pits, or it can move from side to side depending on which one is in use. No matter how the system is designed, only one pit is used at a time. While one pit is filling, the other full pit is resting.

As liquid leaches from the pit and migrates through the unsaturated soil matrix, pathogenic germs are sorbed onto the soil surface. In this way, pathogens can be removed prior to contact with groundwater. The degree of the removal varies with soil type, distance traveled , moisture and other environmental factors.

The difference between this technology and the double VIP or Fossa Alterna is that it allows for water and it is not necessary to add soil or organic material to the pits. As this is a water-based (wet) technology, the full pits require a longer retention time (two years is recommended) to degrade the material before it can be excavated safely

Figure 6: Twin pit pour flush toilet system



(source: CPHEEO, 2013)

Twin pits for pour flush are a permanent technology appropriate for areas where it is not possible to continuously build new pit latrines. If water is available, this technology is appropriate for almost every type of housing density.

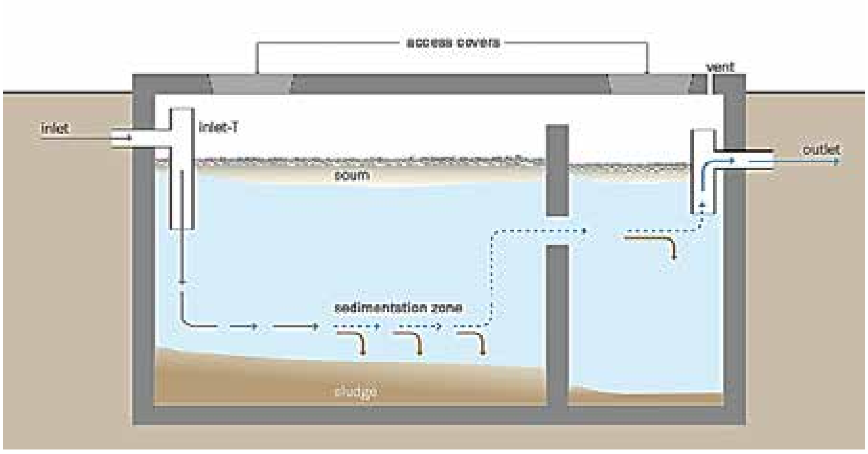
Pros	Cons
• Because double pits are used alternately; their life is virtually unlimited • Excavation of humus is easier than faecal sludge • Potential for the use of stored faecal material as a soil conditioner • Flies and odours are significantly reduced (compared to pits without a water seal) • Can be built and repaired with locally available materials • Low (but variable) capital costs depending on materials; no or low operating costs if self-emptied • Small land area required	• Manual removal of pit humus is required • Clogging is frequent when bulky cleansing materials are used • Higher risk of groundwater contamination due to more leachate than with waterless system

Septic Tank

A septic tank is a watertight chamber made of concrete, fibreglass, PVC or plastic, through which blackwater and greywater flow for primary treatment. Settling and anaerobic processes reduce solids and organics, but the treatment is only moderate.

Liquid flows through the tank, and heavy particles sink to the bottom, while scum (mostly oil and grease) floats to the top. Over time, the solids that settle to the bottom are degraded anaerobically. However, the rate of accumulation is faster than the rate of decomposition, and the accumulated sludge and scum must be periodically removed. The effluent from the septic tank must be dispersed by using a Soak Pit or Leach Field or transported to another treatment technology via a Solids-Free Sewer. The removal of 50% of solids, 30 to 40% of BOD and a 1-log removal of E. coli can be expected in a well-designed and maintained the septic tank, although efficiencies vary greatly depending on operation and maintenance and climatic conditions.

Figure 7: Schematic diagram of septic tank



(source: Titley et all, 2014)

The design of a septic tank depends on the number of users, the amount of water used per capita, the average annual temperature, the desludging frequency and the characteristics of the wastewater. The retention time should be 48 hours to achieve moderate treatment. The retention time should be 48 hours to attain moderate treatment.

Table 4: Recommended size of septic tanks upto 20 users

No. of Users	Length (m)	Breadth (m)	Liquid depth (m) (cleaning interval of)	
			2 years	3 years
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

(Source: CPHEEO, 2013)

Table 5: Recommended size of septic tank for housing colony upto 300 users

No. of Users	Length (m)	Breadth (m)	Liquid depth (cleaning interval of)	
			2 years	3 years
50	5.0	2.00	1.0	1.24
100	7.5	2.65	1.0	1.24
150	10.0	3.00	1.0	1.24
200	12.0	3.30	1.0	1.24
300	15.0	4.00	1.0	1.24

(Source: CPHEEO, 2013)

This technology is most commonly applied at the household level. Larger, multi-chamber septic tanks can be designed for groups of houses and public buildings (e.g., schools).

A septic tank is appropriate where there is a way of dispersing or transporting the effluent. If septic tanks are used in densely populated areas, onsite infiltration should not be used. Otherwise, the ground will become oversaturated and contaminated, and wastewater may rise up to the surface, posing a serious health risk. Instead, the septic tanks should be connected to some Conveyance technology, through which the effluent is transported to a subsequent Treatment or Disposal site. Even though septic tanks are watertight, it is not recommended to construct them in areas with high groundwater tables or where there is frequent flooding.

Pros	Cons
• Simple and robust technology • No electrical energy is required • Low operating costs • Long service life • Small land area needed (can be built underground)	• Low reduction in pathogens, solids and organics • Regular desludging must be ensured • Effluent and sludge require further treatment and appropriate discharge

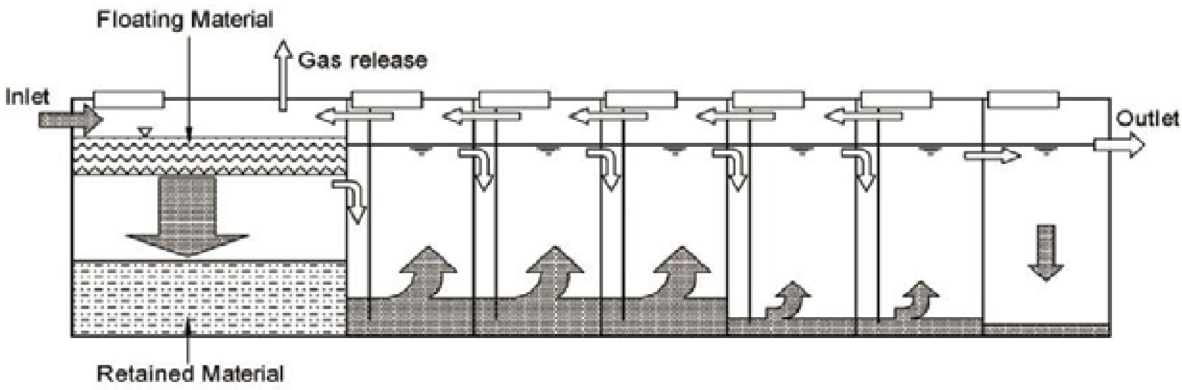
Because the septic tank must be regularly desludged, a vacuum truck should be able to access the location. Often, septic tanks are installed in the home, under the kitchen or bathroom, which makes emptying difficult. Septic tanks can be installed in every type of climate, although the efficiency will be lower in colder climates. They are not efficient at removing nutrients and pathogens.

Anaerobic Baffle reactor

An anaerobic baffled reactor (ABR) is mainly a small septic tank (settling compartment) followed by a series of anaerobic tanks (at least three). Most of the solids are removed in the first and largest tank. Effluent from the first tank then flows through baffles and is forced to flow up through activated sludge in the subsequent tanks. Each chamber provides increased removal and digestion of organics: BOD may be reduced by up to 90%. Increasing the number of chambers also improves performance. (Tilley 2008)

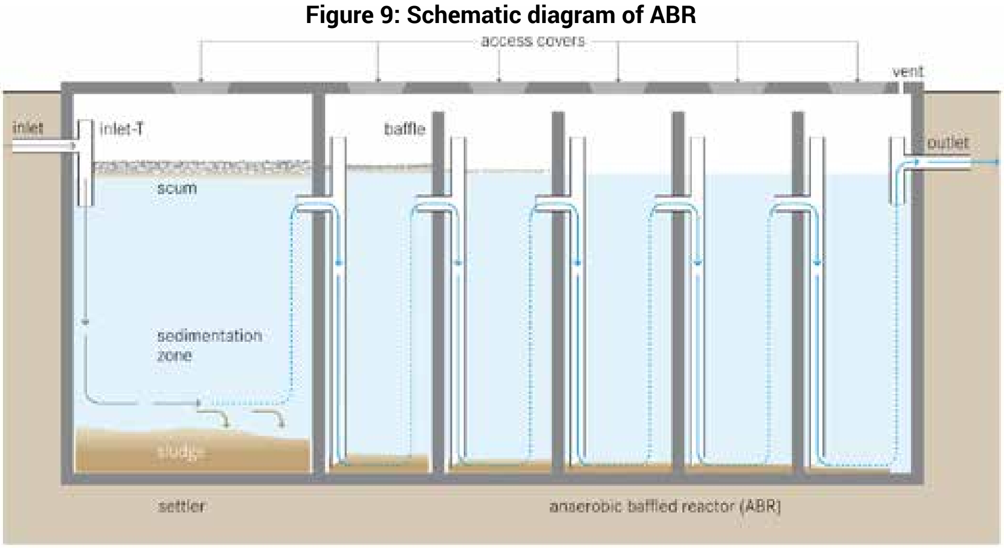
The majority of settleable solids are removed in a sedimentation chamber in front of the actual ABR. Small-scale stand-alone units typically have an integrated settling compartment, but primary sedimentation can also take place in a separate Settler or another preceding technology (e.g., existing Septic Tanks). Designs without a settling compartment are of particular interest for (Semi-) Centralized Treatment plants that combine the ABR with other technologies, or where prefabricated, modular units are used.

Figure 8: Schematic Diagram of ABR



(Source: CPHEEO, 2013)

Figure 9: Schematic diagram of ABR



(source: EAWAG,2005)

This technology is easily adaptable and can be applied at the household level, in small neighbourhoods or even in bigger catchment areas. It is most appropriate where a relatively constant amount of blackwater and greywater is generated. A (semi-) centralised ABR is applicable when there is a pre-existing Conveyance technology, such as a Simplified Sewer.

This technology is suitable for areas where land may be limited since the tank is most commonly installed underground and requires a small area. However, a vacuum truck should be able to access the location because the sludge must be regularly removed (particularly from the settling compartment).

ABRs can be installed in every type of climate, although the efficiency is lower in colder climates. They are not efficient at removing nutrients and pathogens. The effluent usually requires further treatment.

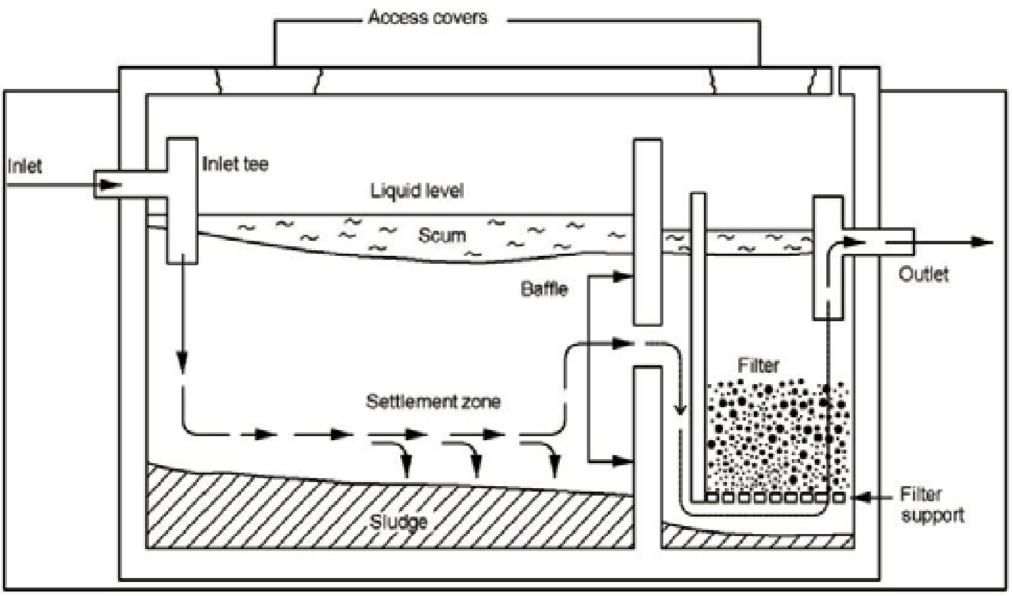
Pros	Cons
• Low cost when divided among members of a housing cluster or small community • Minimum operation and maintenance • Resistant to organic and hydraulic shock loads • Reliable and consistent treatment	• Requires expert design and skilled construction; partial construction work by unskilled labourers • Requires secondary treatment and discharge

Anaerobic up-flow filter

An anaerobic up-flow filter is a fixed-bed biological reactor with one or more filtration chambers in series. As wastewater flows through the filter, particles are trapped, and organic matter is degraded by the active biomass that is attached to the surface of the filter material.With this technology, suspended solids and BOD removal can be as high as 90% but is typically between 50% and 80%. Nitrogen removal is limited and usually does not exceed 15% regarding total nitrogen (TN).

Pre- and primary treatment is essential to remove solids and garbage that may clog the filter. The majority of settleable solids are removed in a sedimentation chamber in front of the anaerobic filter. Small-scale stand-alone units typically have an integrated settling compartment, but primary sedimentation can also take place in a separate Settler or another preceding technology (e.g., existing Septic Tanks). Designs without a settling compartment are of particular interest for (Semi-) Centralized Treatment plants that combine the anaerobic filter with other technologies, such as the Anaerobic Baffled Reactor (ABR).

Figure 10: Basic Schematic of Up-flow Anaerobic Filter

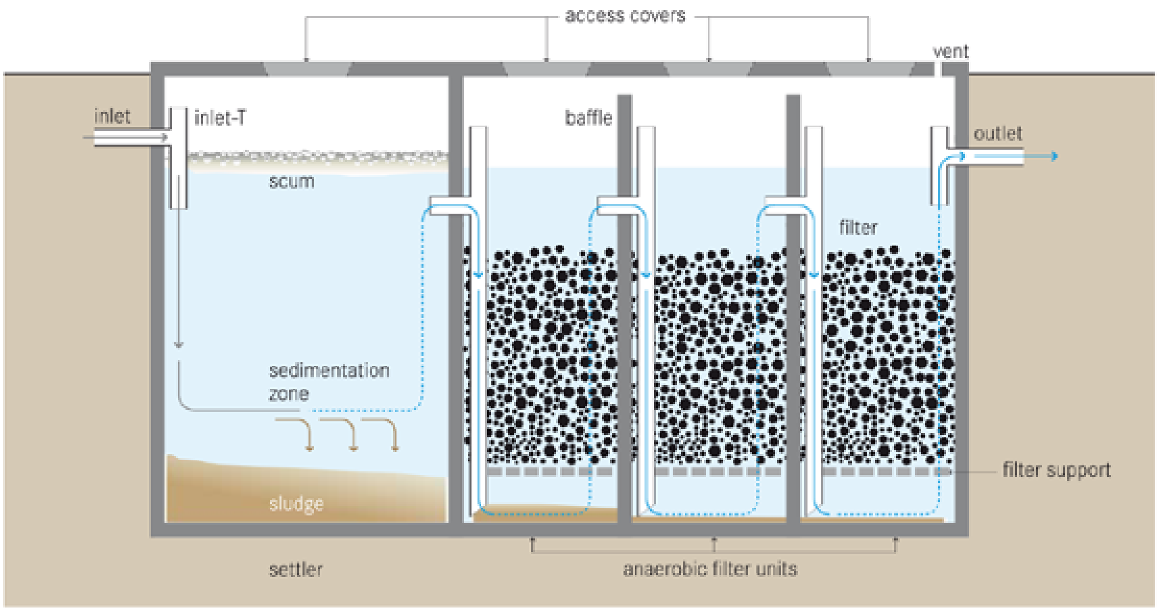


(Source: CPHEEO, 2013)

These filters are usually operated in upflow mode because there is less risk that the fixed biomass will be washed out. The water level should cover the filter media by at least 0.3 m to guarantee an even flow regime. The hydraulic retention time (HRT) is the most critical design parameter influencing filter performance. An HRT of 12 to 36 hours is recommended.

The microbial growth is retained on the stone media, making possible higher loading rates and efficient digestion. The capacity of the unit is 0.04 to 0.05 m3 per capita or 1/3 to 1/2 the liquid capacity of the septic tank it serves. BOD removals of 70% can be expected. The effluent is clear and free from odour. This unit has several advantages viz, (a) high degree of stabilization; (b) little sludge production; (c) low capital and operating cost; and (d) low loss of head in the filter (10 to 15 cm) in normal operation. (Source: CPHEEO, 2013)

Figure 11: Schematic diagram of Anaerobic Up flow filter



(source: EAWAG,2005)

The ideal filter should have a large surface area for bacteria to grow, with pores large enough to prevent clogging. The surface area ensures increased contact between the organic matter and the attached biomass that efficiently degrades it. Ideally, the material should provide between 90 to 300 m2 of surface area per m3 of occupied reactor volume. Typical filter material sizes range from 12 to 55 mm in diameter. Materials commonly used include gravel, crushed rocks or bricks, cinder, pumice, or specially formed plastic pieces, depending on local availability.

The connection between the chambers can be designed either with vertical pipes or baffles. Accessibility to all chambers (through access ports) is necessary for maintenance. The tank should be vented to allow for controlled release of odorous and potentially harmful gases.

This technology is easily adaptable and can be applied at the household level, in small neighbourhoods or even in bigger catchment areas. It is most appropriate where a relatively constant amount of blackwater is generated. The anaerobic filter can be used for secondary treatment, to reduce the organic loading rate for a subsequent aerobic treatment step, or for polishing.

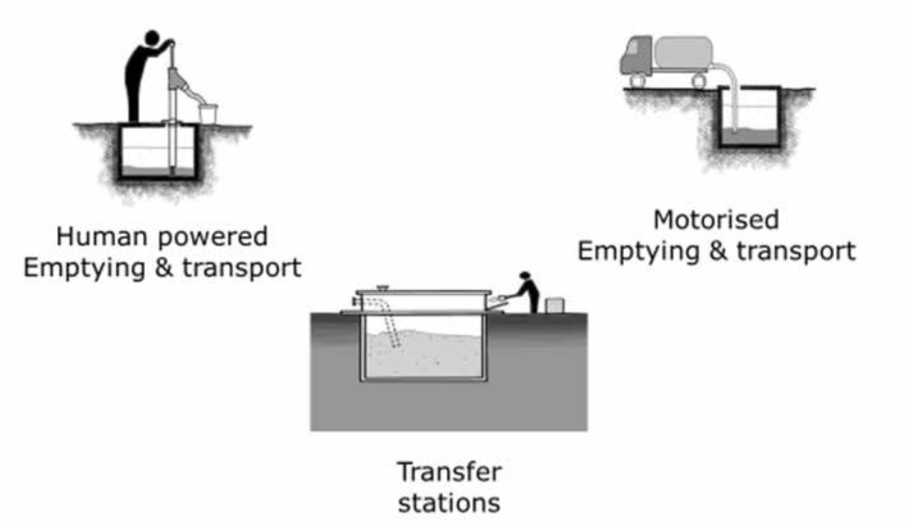
This technology is suitable for areas where land may be limited since the tank is most commonly installed underground and requires a small area. Accessibility by vacuum truck is important for desludging.

Pros	Cons
• No electrical energy is required • Low operating costs • Long service life • High reduction of BOD and solids • Low sludge production; the sludge is stabilized • Moderate area requirement (can be built underground)	• Requires expert design and construction • Low reduction of pathogens and nutrients • Effluent and sludge require further treatment and appropriate discharge • Risk of clogging, depending on pre- and primary treatment • Removing and cleaning the clogged filter media is cumbersome

4.2 Conveyance

If waste products cannot be safely disposed of or even suitably reused on site, they have to be transported elsewhere. Conveyance describes the way in which products are moved from one process to another. Although products may need to be moved in various ways to reach the required process, the longest and most important gap lies between on-site storage and (semi-) centralised treatment.

Figure 12: Conveyance systems in FSSM



(source: SSWM tool box)

The technical and physical criteria for choosing appropriate conveyance technology/system are as follows

- Water availability,
- Ground condition,
- Groundwater level and contamination.

Human-powered emptying

Human-powered emptying and transport refer to the different ways in which people can manually empty and/or transport sludge and solid products generated in on-site sanitation facilities.

Human-powered emptying of pits, vaults, and tanks can be done in one of two ways:

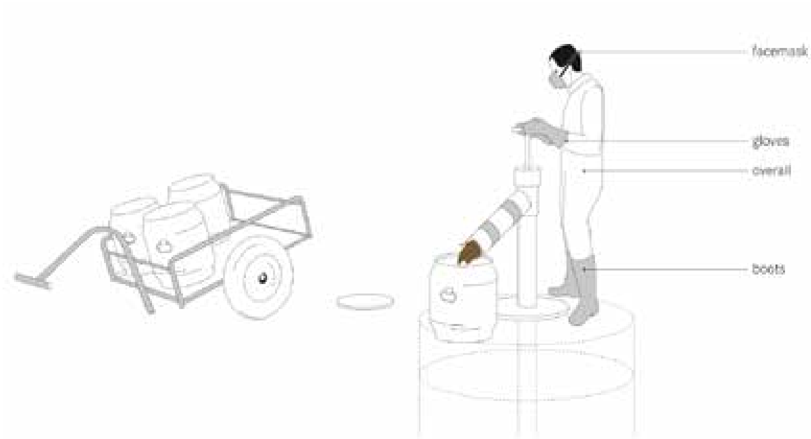
- using buckets and shovels, or
- using a portable, manually operated pump specially designed for sludge (e.g., the Gulper, the Manual Diaphragm Pump or the MAPET).

Manual sludge collection falls into two general categories, namely ‘cartridge containment’ and ‘direct lift’. Cartridge containment and direct lift methods can be practiced safely when operators perform their tasks with the proper equipment following appropriate procedures. For instance, descending into pits as currently practiced in several areas of our country is not safe and legally banned through manual scavenging act.

Dumping of FS directly into the environment rather than discharging at a transfer or treatment site must also be avoided. In addition, local government can help promote hygienic FS collection by highlighting best practices, imposing restrictions on unsafe practices, and providing incentives such as training, capacity building, and licensing. Formalising the informal sector through training and licensing will drive the demand for improved services, will improve hygiene, and enable business development and job creation.

Manual sludge pumps like the Pooh Pump or the Gulper are relatively new inventions and have shown promise as being low-cost, effective solutions for sludge emptying where, because of access, safety or economics, other sludge emptying techniques are not possible. Sludge hand pumps work on the same concept as water hand pumps: the bottom of the pipe is lowered into the pit/tank while the operator remains at the surface. As the operator pushes and pulls the handle, the sludge is pumped up and is then discharged through the discharge spout. The sludge can be collected in barrels, bags or carts, and removed from the site with little danger to the operator. Hand pumps can be locally made with steel rods and valves in a PVC casing.

Figure 13: Human-powered emptying and transport - Gulper



(source: TItley etall,2014)

Pros	Cons
• Potential for local jobs and income generation • Simple hand pumps can be built and repaired with locally available materials • Low capital costs; variable operating costs depending on transport distance • Provides services to areas/communities without sewers	• Spills can happen which could pose potential health risks and --generate offensive smells • Time-consuming: emptying pits out can take several hours/days depending on their size • Garbage in pits may block pipe • Some devices may require specialized repair (welding)

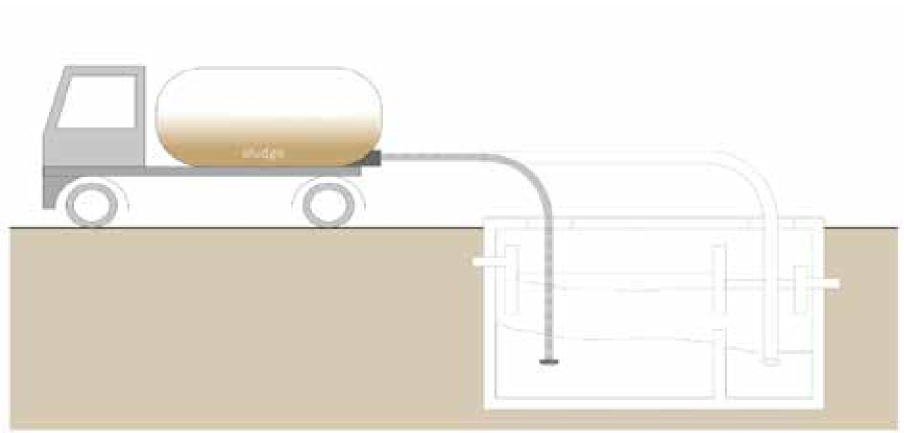
Manually operated diaphragm pumps are simple low-cost pumps capable of extracting low viscosity FS that contains little non-biodegradable materials. They typically consist of a rigid, disc-shaped body clamped to a flexible rubber membrane called a diaphragm. An airtight seal between the diaphragm and the disc forms a cavity. To operate the pump, the diaphragm is alternately pushed and pulled causing it to deform into concave and convex shapes in the same way a rubber plunger is used to unblock a toilet. A strainer and non-returning foot valve fitted to the end of the inlet pipe prevents non-biodegradable material from entering the pump and stops the backflow of sludge during operation respectively.

Figure 14: Manually Operated Diaphragm Pump used in Bangladesh

Motorised Emptying and Transport

Motorized emptying and transport refer to a vehicle equipped with a motorised pump and a storage tank for emptying and transporting faecal sludge and urine. Humans are required to operate the pump and manoeuvre the hose, but sludge is not manually lifted or transported. A truck is fitted with a pump which is connected to a hose that is lowered down into a tank (e.g., Septic Tank) or pit, and the sludge is pumped up into the holding tank on the vehicle. This type of design is often referred to as a vacuum truck.

Figure 15:Schematic diagram of motorised emptying and transport



(EAWAHG,2005)

The typical volume of trucks used for the collection of FS ranges from 4,000 litres to 12,000 litres. Various factors influence the selection of a vacuum truck by a service provider including,

- typical volume of the tanks or vaults that will be serviced;
- road widths and weight constraints;
- distance to the treatment plant;
- availability;
- budget; and
- skill level of the operators.

Conventional vacuum tankers are typically fitted with either a relatively low cost, low-volume sliding vane pump or a more expensive liquid ring pump. The former is more appropriate for low-capacity vacuum tankers where high vacuum and low airflow sludge removal techniques are used. Vacuum conveyance techniques work best for removing low-viscosity sludge such as that found in septic tanks.

Figure 16: Representative Vacuum Trucks

Depending on the Collection and Storage technology, the sludge can be so dense that it cannot be easily pumped. In these situations, it is necessary to thin the solids with water so that they flow more easily, but this may be inefficient and costly. Garbage and sand make emptying much more difficult and clog the pipe or pump. Multiple truckloads may be required for large septic tanks.

Although large vacuum trucks cannot access areas with narrow or non-driveable roads, they remain the norm for municipalities and sanitation authorities. These trucks can rarely make trips to remote areas (e.g., in the periphery of a city) since the income generated may not offset the cost of fuel and time. Therefore, the treatment site must be within reach from the serviced areas.

In Vacutug, the storage tank is mounted on a cart which can be manually or pulled by smaller vehicles. It is equipped with a vacuum pump with a smaller capacity. It is useful to access the smaller lanes. It is also suitable for the densely populated area and slums.

Table 6: Different Types of Vacutug (Source: FSM Book, IWA)

Type	Capacity (Litres)	Relative Width	Travel Distance	Mounting & Propulsion	Cost (INR)
I & II	500	Very Narrow	Short-Haul	Mounted on self-propelled chassis	6,50,250
III	1900	Average	Long-Haul	Mounted on trailer chassis and propelled by tractor or pick-up	13,00,500
IV	700	Narrow	Medium-Haul	Mounted on chassis of motorised tricycle	9,75,375
V	1000	Narrow	Medium Haul	Mounted on chassis of motorised tricycle	9,75,375

Transfer Stations and adequate treatment are also crucial for service providers using small-scale motorised equipment. Field experiences have shown that the existing designs for dense urban areas are limited regarding their emptying effectiveness and travel speed, and their ability to negotiate slopes, poor roads, and very narrow lanes. Moreover, demand and market constraints have prevented them from becoming commercially viable. Under favourable circumstances, small vehicles like the Vacutug can recover the operating and maintenance costs. However, the capital costs are still too high to run a profitable business sustainably.

Both the sanitation authority and private entrepreneurs may operate vacuum trucks, although the price and level of service may vary significantly. Private operators may charge less than public ones but may only afford to do so if they do not discharge the sludge at a certified facility. Private and municipal service providers should work together to cover the whole faecal sludge management chain.

Pros	Cons
• Fast, hygienic and effective sludge removal • Efficient transport possible with large vacuum trucks • Potential for local job creation and income generation • Provides an essential service to non-sewered areas	• Cannot pump thick, dried sludge (must be thinned with water or -manually removed) • Garbage in pits may block hose • Cannot empty deep pits due to limited suction lift • Very high capital costs; variable operating costs depending on use and maintenance • Hiring a vacuum truck may be unaffordable for poor households • Not all parts and materials may be locally available • May have difficulties with access

Mobile Faecal Sludge Treatment Unit (MTU)

The Mobile Treatment Unit (MTU) is an onsite faecal sludge treatment technology developed by the Water, Sanitation and Hygiene Institute (WASH Institute). It is a treatment system mounted on the bed of a small truck and treats the effluent of septic tanks on-site. The on-site Mobile septage Treatment Unit works with the concept of solid-liquid separation, sludge thickening and effluent treatment processes. While the liquid is separated from the solid, the effluent passes through the treatment process and disposes the treated effluent. The sludge thickening process helps to further reduce the moisture content in the sludge. The operational capacity of the MTU varies from 3000 to 6000 lits/hr.

Figure 17: Picture of Mobile Faecal Sludge Treatment Unit (MTU)

(Source: WASH Institute)

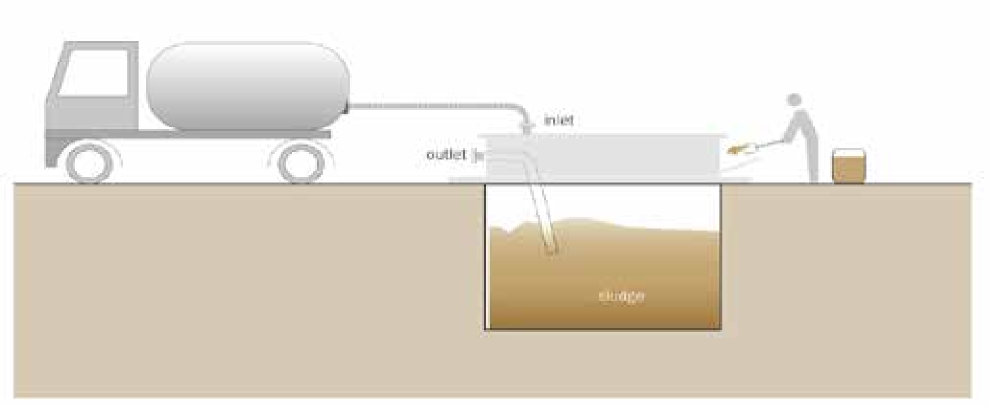
Transfer stations

Transfer stations or underground holding tanks act as intermediate dumping points for faecal sludge when it cannot be easily transported to a Faecal Sludge or Septage Treatment facility. A vacuum truck is required to empty transfer stations when they are full.

Operators of human-powered or small-scale motorised sludge emptying equipment (see Human-

Powered and Motorized Emptying and Transport) discharge the sludge at a local transfer station rather than illegally dumping it or travelling to discharge it at a remote treatment or disposal site. When the transfer station is full, a vacuum truck empties the contents and takes the sludge to a suitable treatment facility. Municipalities or sewerage authorities may charge for permits to dump at the transfer station to offset the costs of operating and maintaining the facility.

Figure 18: Schematic presentation of Transfer STATION



(Source: EAWAG,2005)

In urban settings, transfer stations have to be carefully located. Otherwise, odours could become a nuisance, especially, if they are not well maintained. A transfer station consists of a parking place for vacuum trucks or sludge carts, a connection point for discharge hoses, and a storage tank. The dumping point should be built low enough to minimise spills when labourers manually empty their sludge carts.

Additionally, the transfer station should include a vent, a trash screen to remove large debris (garbage) and a washing facility for vehicles. The holding tank must be well constructed to prevent leaching and surface water infiltration. A variation is the sewer discharge station (SDS), which is like a transfer station but is directly connected to a conventional gravity sewer main. Sludge emptied into the SDS is released into the sewer main either directly or at timed intervals (e.g., by pumping) to optimise the performance of the sewer and of the wastewater treatment plant, and reduce peak loads.

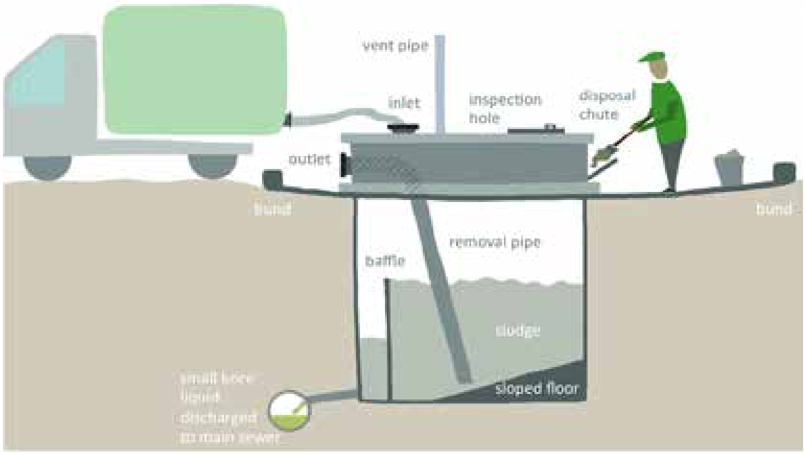
Transfer stations can be equipped with digital data recording devices to track the quantity, input type and origin, as well as collect data about the individuals who dump there. In this way, the operator can collect detailed information and more accurately plan and adapt to differing loads.

The system for issuing permits or charging access fees must be carefully designed so that those who most need the service are not excluded because of high costs, while still generating enough income to sustainably operate and maintain the transfer stations.

Pros	Cons
• Makes sludge transport to the treatment plant more efficient, especially where small-scale service providers with slow vehicles are involved • May reduce the illegal dumping of faecal sludge • Costs can be offset with access permits • Potential for local job creation and income generation	• Requires expert design and construction • Can lead to odours if not properly maintained

Permanent Storage Type Station

Figure 19: Permanent Storage Type Transfer Station

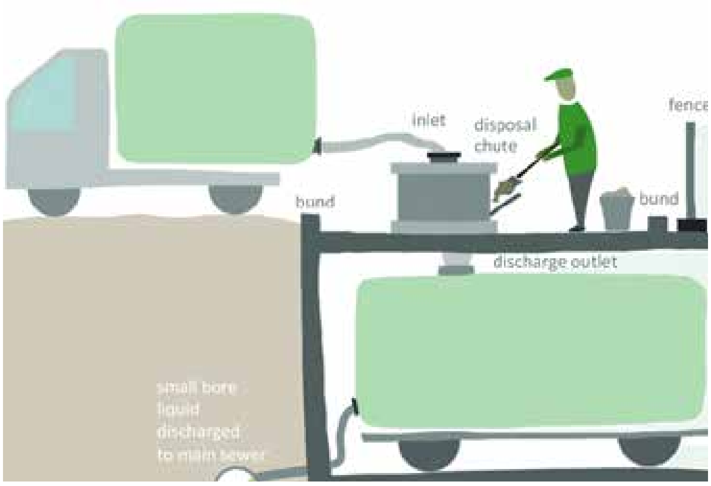


(Source: IWFSM Book, IWA)

Permanent storage tanks are constructed as vault-like concrete structures, these tanks are designed to provide storage capacity for FS over a short period of time without the capacity for treatment. An example of such tanks are the underground holding tank (UHT) in Ghana with capacities of approximately 23 m3, the UHTs were designed to provide access to pan latrine collectors (primary transport) and vacuum trucks (secondary transport). However, the natural solid-liquid separation and siltation that takes place when FS is stored over relatively long periods soon became an operational issue for local authorities. As a result, many UHTs fell into disuse as de-silting became a prohibitively costly and time-consuming process.

Mobile Transfer Station

Figure 20: Modular Type Transfer Station



(Source: IWFSM Book, IWA)

Modular transfer station has been developed using portable containers to replace the concrete vault. These come in various sizes such as:

- small sized (e.g. 200-litre metal drums, McBride, 2012);
- medium-sized (e.g. Intermediate Bulk Containers (IBCs) made of plastic liner and metallic frame, 500 – 3,000 litres);

- large-sized (e.g. customised metallic tanks or skips, >2,000 m^3 (Macleod, 2005; Strauss and Montangero, 2002)

Multifunctional Permanent Tank

Multi-functional permanent tank in addition to providing storage capacity, it can also accept fresh FS from a public toilet, and/or provide partial sludge treatment. This latter design feature could include processes such as dewatering (settling tanks, drying beds, geotubes - ERE Consulting Group and Indah Water Konsortium, 2012) or anaerobic digestion (e.g. septic tanks, anaerobic baffled reactors, biogas digesters). The main advantage of stations providing both access to fresh FS and treatment capacity is easier siting due to acceptance by the community and a reduction in secondary transport fees due to dewatering. Furthermore, treatment byproducts (e.g.liquid effluent or biogas) could be used if further treatment is provided.

Figure 21: Multifunctional Permanent Tank

(Source: FSM Book, IWA)

4.3 Treatment Chain of Faecal Sludge and Septage Management (FSSM)

The faecal sludge and septage contain more than 95% water, hence as the first step of treatment, the easily settleable solids are removed using sedimentation process. These solids are then treated biologically to digest and stabilize. In case of well digested septage, the solids can be directly sent to dewatering or drying stage, where the bound water and moisture is removed and the solids are completely dried. The pathogen reduction happens after that and is usually carried out by further sun drying the sludge or co-combustion. The end product thus obtained can be numerous uses.

Figure 22: Treatment Chain in Faecal Sludge and Septage Management

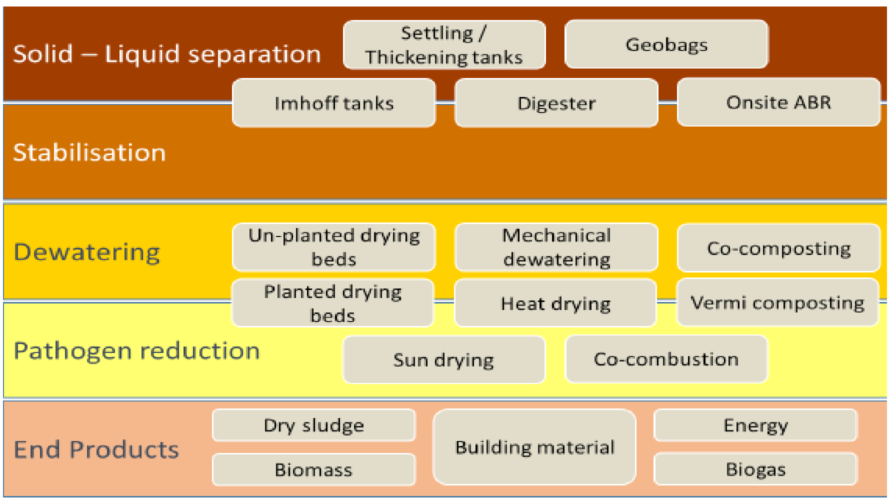
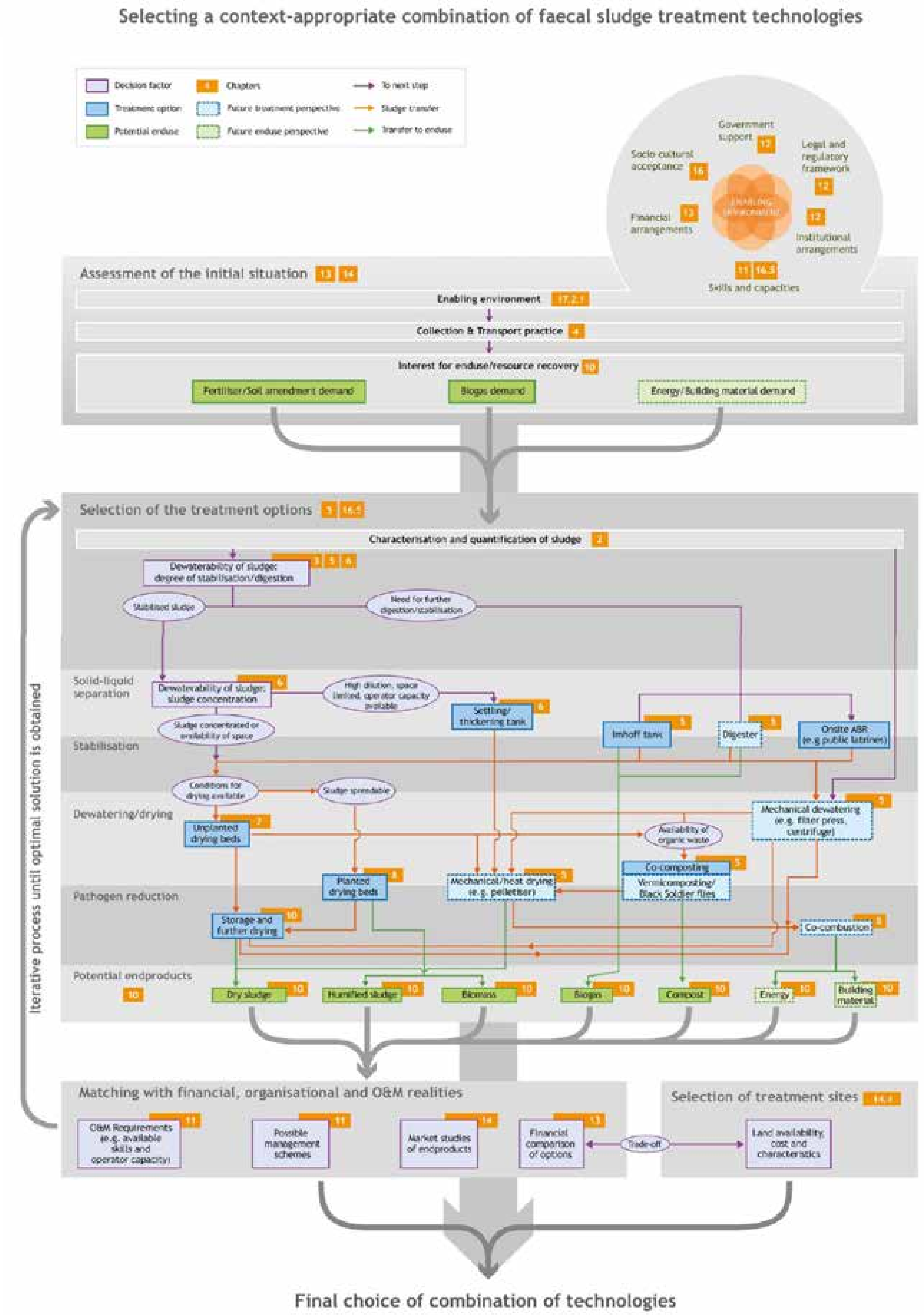


Figure 23: Selecting a context appropriate Technology



(Source: FSM Book, IWA)

4.4 Selecting Context – Appropriate Treatment Options

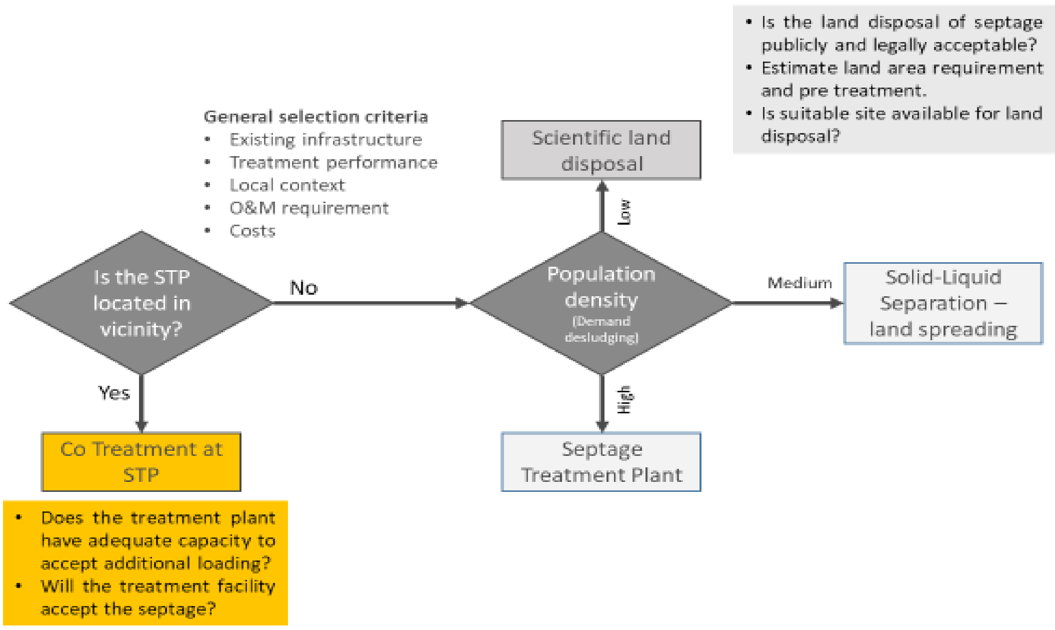
Setting up an FSM system is not only about the selection of single technological options, but about finding a sustainable combination of services that guarantees the appropriate collection, conveyance, treatment and disposal or enduse of FS, in a way that ensures household satisfaction, broad coverage and cost recovery.

An FSM system should be efficient and flexible, i.e. able to function normally and adapt to the frequency of sludge delivery and sludge quantities and characteristics, cope with climatic variations, produce end-products that are safe for use, be able to guarantee that the investment and O&M costs are acceptable and that are skilled employees for operation. Eleven criteria for the selection of a combination of technologies are proposed, divided into four categories: treatment performance, local context, O&M requirements and costs.

Table 7: Criteria for the selection of treatment options

Treatment performance	Local context	O&M requirements	Costs
• Effluent and sludge quality according to national standards	• Characteristics of sludge (dewaterability, concentration, degree of digestion, spreadability) • Quantity and frequency of sludge discharged at the FSTP • Climate • Land availability and cost • Interest in enduse (fertiliser, forage, biogas, compost, fuel)	• Skills needed for operation, maintenance and monitoring available locally • Spare parts available locally	• Investment costs covered (land, infrastructure, human resources, capacity building) • O&M costs covered • Affordability for households

Figure 24: Situation Specific Approach for selection of FSS Treatment Technology



It is important to realize that for the conversion of FS into a product that is safe for end use or disposal, several processes need to take place. FS typically contains large volumes of water and hence needs to be dewatered, which can be achieved on its own, or in combination with solid/liquid separation. Depending on the end-goal, further treatment needs could include converting organic matter into a stabilized form and/or pathogen reduction. One of the key elements in designing any particular series of technologies is to keep the final goal in mind. If the final goal is to make a dry product that can be reused in agriculture, then particular care has to be paid to dewatering and pathogen reduction. If the goal is to incinerate the sludge for energy production, then dryness is very important while pathogens do not play a role (outside of worker protection).

In cases where STP is located in vicinity, co treatment of septage at STP can be practiced provided transportation of septage and cost of co treatment is economically viable. In regions where co treatment is not possible, population density and frequency of desludging of septic tanks should be checked. If setting up of treatment plant is economically not viable then to avoid indiscriminate disposal of septage, it is recommended to practiced safe disposal practice as an interim measure.

- In ULBs where the population density is low and demand desludging is practiced, scientific land disposal (ex. Deep row entrenchment) can be practiced.
- ULBs where population density is medium and demand for desludging of septic tanks is low, solid liquid separation (Ex. Geotube) or scientific land disposal can be practiced. Liquid filtrate from the geotube needs further treatment. The quantum of this liquid as compared to the septic tank effluent between two desludging is insignificant. If the ULB does not have a treatment plant for sullage then it is wise to check economic viability of liquid filtrate treatment in such ULBs.
- In ULBs where population density is high and demand for desludging is moderate, it is recommended to have faecal sludge and septage treatment plant. In this case, not only the solids, but the liquid also will have to be treated as per the discharge norms.

4.5 Treatment Technologies

Co-treatment of FS in STP

One of the approaches for FS treatment is co-treatment with sewer-based wastewater treatment technologies. However, appropriate treatment facilities are needed at sewage treatment plants to receive, pre-treat, and distribute the septage into the appropriate process units. Septage which may be considered high strength wastewater can be either dumped into an upstream sewer or added directly into various unit processes in a sewage treatment plant. The considerably higher solids content of faecal sludge may lead to severe operational problems such as solids deposition and clogging of sewer pipes. This is mostly because the diameter and slope of sewers are designed for the transport of municipal wastewater typically containing 250 to 600 mgTSS/L rather than the 12,000 to 52,500 mgTSS/L present in FS. Hence, the first step in designing a co-treatment system includes determining how the FS will be transported to the treatment facility and discharged into the influent stream. Common problems with co-treatment of FS in STPs range from the deterioration of the treated effluent quality to overloading tanks and inadequate aeration.

Deep Row Entrenchment

Deep row entrenchment consists of digging deep trenches, filling them with sludge and covering them with soil. Trees are then planted on top, which benefits from the organic matter and nutrients that are slowly released from the FS. In areas where there is adequate land available, deep row entrenchment can present a solution that is simple, low cost has limited O&M issues and produces no visible or olfactory nuisances. Benefits are also gained from the increased production of trees. However, the availability of land is a major constraint with deep row entrenchment, as is the distance/depth to clean groundwater bodies. Deep row entrenchment is considered most feasible in areas where the water supply is not directly obtained from the groundwater source and where sufficient land is available, which means the sludge would have to be transportable to rural and peri-urban areas. In many countries' legislation is still lacking for this option.

Advantages and Constraints

The main advantage of deep row entrenchment is that very little is needed for it: no expensive infrastructure or pumps that are very susceptible to poor maintenance. In addition, growing trees has many benefits such as extra CO2 fixation, erosion protection, or potential economic benefits.

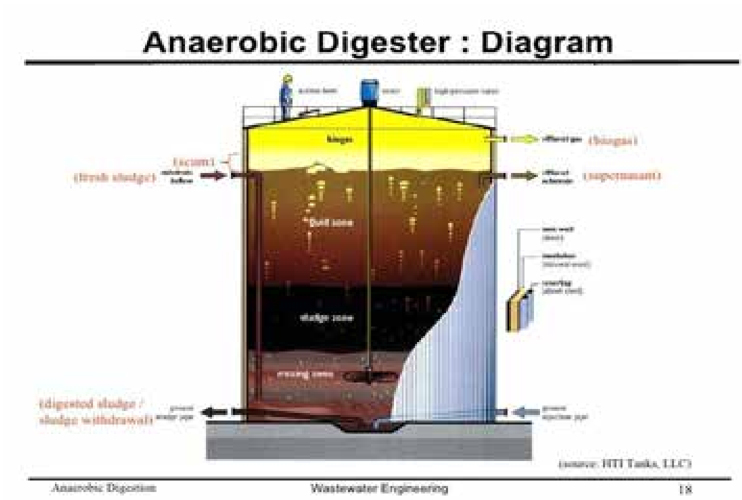
Constraints are that sufficient land has to be available in an area with a low enough groundwater table and, moreover, the legislation still needs to catch up in many countries to allow for this technology.

Anaerobic Digestion

Anaerobic digestion treats organic waste in airtight chambers to ensure anaerobic conditions. Anaerobic digestion has been widely applied in centralized wastewater treatment facilities for the digestion of primary sludge and waste activated sludge, typically with plug flow (PFR) or continuously stirred reactors (CSTRs). The main design parameters for anaerobic digesters are the hydraulic retention time (HRT), the temperature and the loading pattern. Operating conditions that play an important role in the design and operation of anaerobic digesters include:

- solids retention time (SRT);
- HRT;
- temperature;
- alkalinity;
- pH;
- toxic/inhibiting substances; and
- bioavailability of nutrients and trace elements.

Figure 25: Representative Image of Anaerobic Digestor



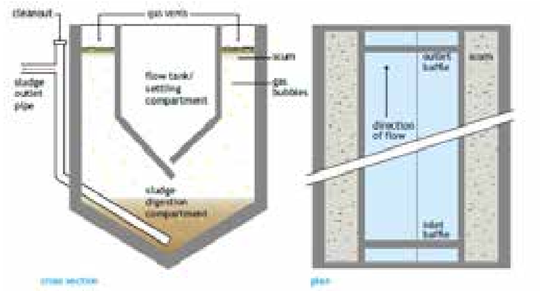
Advantages and Constraints

Anaerobic digestion has the potential to produce biogas while stabilising FS, reducing sludge volume and odours. However, operation and maintenance (O&M) of anaerobic digesters require a relatively high level of skilled operation. Inhibition of digestion needs to be considered due to the inconsistent nature of FS, and also detergents and heavy metals should be addressed at the household level.

Imhoff Tanks

An Imhoff tank is a compact sized tank that combines the effect of a settler and an anaerobic digestion system in one. It is a compact system which is well-known for wastewater treatment and has been implemented in Indonesia for FS treatment. Imhoff tanks are most often used as a primary treatment technology in wastewater treatment where it serves as a solid-liquid separation system including partial digestion for the settled sludge. The Imhoff tank is a high raised tank (up to nine meters for wastewater sludge) where sludge settles at the bottom and biogas produced by the anaerobic digestion process rises to the top. The settling compartment has inclined walls (45° or more) and a slot at the bottom, which allows the sludge to slide down to the center into the digestion compartment. The gas transports sludge particles to the water surface, creating a scum layer. T-shaped pipes or baffles are used at the inlet and the outlet to reduce velocity and prevent scum from leaving the system. The sludge accumulates in the sludge digestion chamber and is compacted and partially stabilized through anaerobic digestion.

Figure 26: Representative Schematic of Imhoff Tank



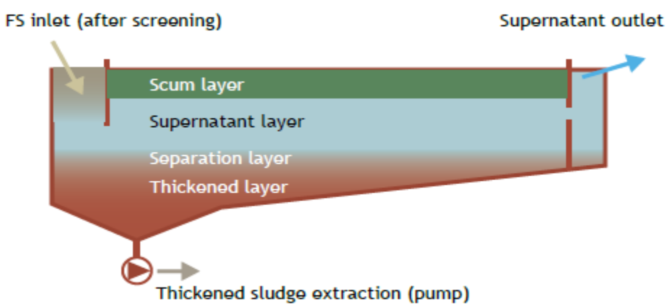
(Source: FSM Book, IWA)

Advantages and Constraints

The main advantages of Imhoff tanks compared to settling-thickening tanks are the small land requirement, the possibility of operating only one tank, and the physical separation between the settled sludge and the liquid fraction. The main constraints compared to settling thickening tanks are the increased operational complexity, slightly higher costs as the Imhoff tanks require an additional elevation to accommodate the inclined baffles, and the risk of damage to the sludge draw-off pipe in case of an inadequate draw-off frequency. Operation and maintenance of an Imhoff system is not as complex as some technologies, but it requires skilled operators. Cleaning of flow paths, the sides of the tank as well as the removal of scum is very important.

Settling / Thickening Tanks

Figure 27: Representative Diagram of Settling-Thickening Tank

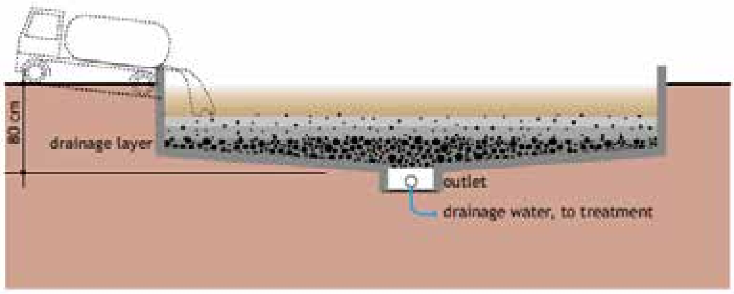


Settling-thickening tanks are used to achieve separation of the liquid and solid fractions of faecal sludge (FS). Settling-thickening tanks for FS treatment are rectangular tanks, where FS is discharged into an inlet at the top of one side and the supernatant exits through an outlet situated at the opposite side, while settled solids are retained at the bottom of the tank, and scum floats on the surface. During the retention time, the heavier particles settle out and thicken at the bottom of the tank as a result of gravitational forces. Lighter particles, such as fats, oils and grease, float to the top of the tank. As solids are collected at the bottom of the tank, the liquid supernatant is discharged through the outlet. Quiescent hydraulic flows are required, as the designed rates of settling, thickening and flotation will not occur with turbulent flows. Baffles can be used to help avoid turbulence at the inflow, and to separate the scum and thickened sludge layers from the supernatant.

Unplanted Sludge Drying Beds

Unplanted sludge drying beds are shallow filters filled with sand and gravel with an under-drain at the bottom to collect leachate. Sludge is discharged onto the surface for dewatering. The drying process in a drying bed is based on drainage of liquid through the sand and gravel to the bottom of the bed, and evaporation of water from the surface of the sludge to the air. Depending on the faecal sludge (FS) characteristics, a variable fraction of approximately 50-80% of the sludge volume drains off as a liquid (or leachate), which needs to be collected and treated prior to discharge. After reaching the desired dryness, the sludge is removed from the bed manually or mechanically. Further processing for stabilization and pathogen reduction may be required depending on the intended end use option. When considering the installation of a drying bed, the ease of operation and low cost needs to be considered against the relatively large footprint and odour potential.

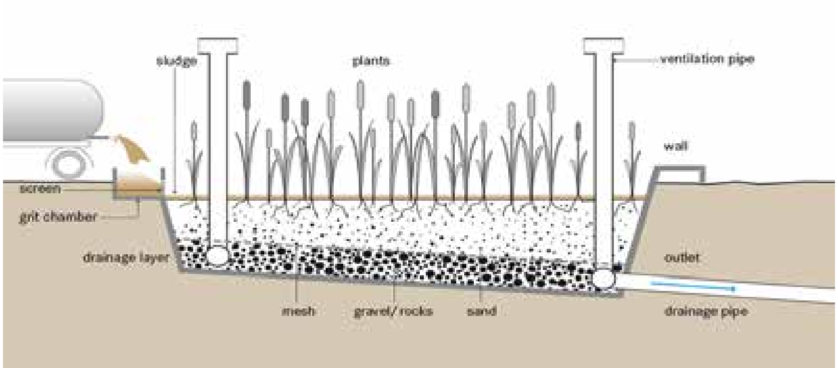
Figure 28: Representative Diagram of Unplanted Drying Beds



(Source: FSM Book, IWA)

Planted Drying Beds

Figure 29: Representative Diagram of Planted Drying Beds



(Source: Tilley et al. 2014)

Planted drying beds (PDBs), also sometimes referred to as planted dewatering beds, vertical-flow constructed wetlands and sludge drying reed beds, are beds of porous media (e.g. sand and gravel) that are planted with emergent macrophytes. PDBs are loaded with layers of sludge that are subsequently dewatered and stabilized through multiple physical and biological mechanisms. The dewatering, organic stabilization and mineralization performance of the PDB depends on a variety of factors such as the media type and size, the type of plants, the maturity of the beds, climatic factors, and the sludge characteristics, as well as operational factors such as the hydraulic loading rate (HLR), the solids loading rate (SLR), and the loading frequency.

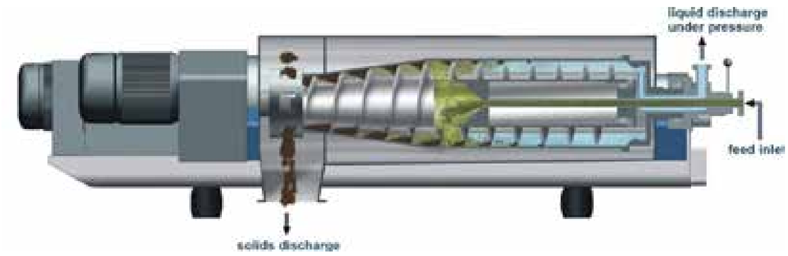
Mechanical Sludge Treatment

Mechanical dewatering or thickening can be carried out prior to or following other treatment steps. Dewatering and thickening are important for reducing the volume of sludge that needs to be further treated or managed. After the sludge thickening process, additional reduction of the water content is often necessary and this can be done either naturally or by machine processes such as centrifugation or pressing. Four technologies that are widely used for dewatering WWTP sludge are the belt filter, the centrifuge, the frame filter press, and the screw press.

Centrifuge

Centrifuge technology dries the FS as it is squeezed outwards on the surface of a cylinder rotating around its horizontal axis, due to the centrifugal force. The flocculated sludge is injected into the middle of this cylinder, and the particles are pushed outward against the surface. An Archimedean screw transports the released liquid to the side where the sludge entered, while another transports the sludge to the other end. The main disadvantage of the centrifuge is high energy requirements.

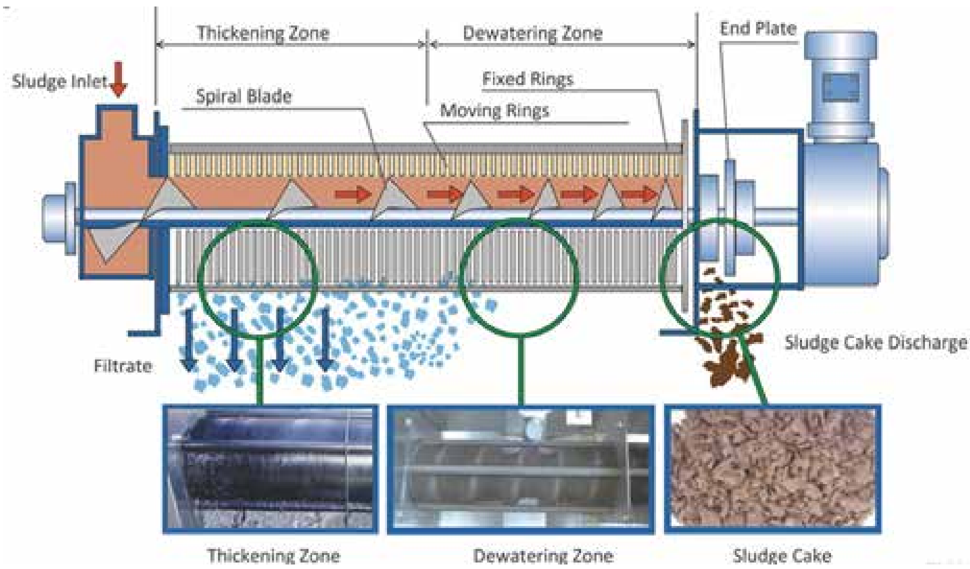
Figure 30: Representative Diagram of Centrifuge



(Source: www.flottweg.com)

Screw Press

Figure 31: Representative Diagram of Screw Press



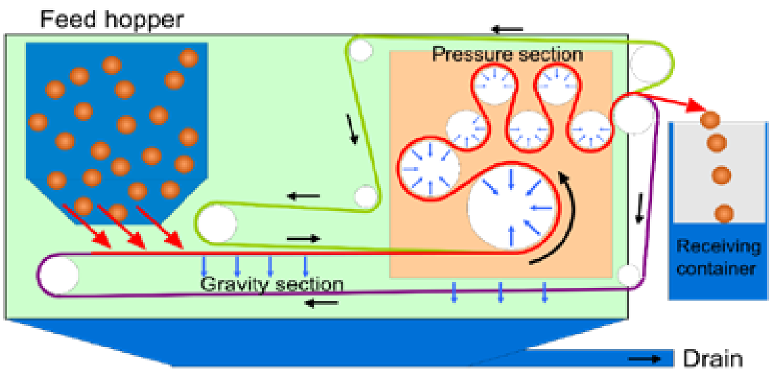
(Source: www.ecologixsystems.com)

A screw press consists of a rotational screw placed in a perforated cylinder. The sludge is loaded at one end, it is pressurised due to a diminishing distance between the screw and the cylinder, and the liquid that is squeezed out is removed through the pores in the cylinder. The dewatered sludge is discharged at the other end. Screw presses provide dewatering at relatively low equipment and operational costs, and minimal maintenance skills are required. However, the dewatering is comparatively lower than other mechanical dewatering technologies.

Belt Press

Belt filter press: This allows the water to be squeezed out of the sludge as it is compressed between two belts. The main disadvantages of a belt filter press compared to other mechanical dewatering techniques are the need for skilled maintenance and the difficulty in controlling odours. The system consists of:

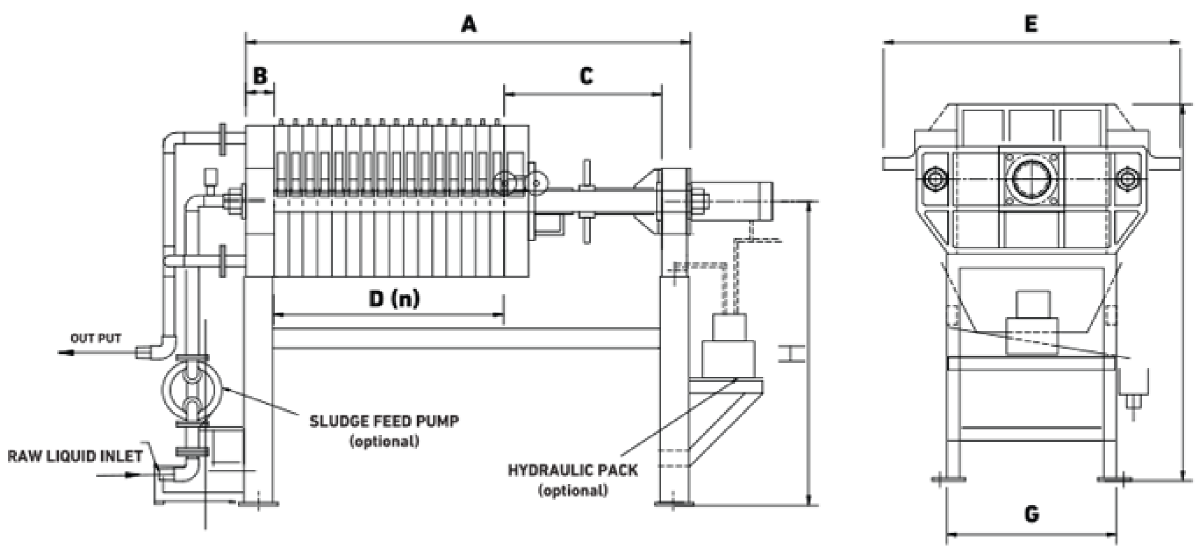
Figure 32: Representative Diagram of Belt Press



- A gravity drainage zone where the flocculated sludge is deposited and conveyed on a porous and mobile belt;
- A compression zone where a second belt is applied on the upper layer of the sludge, and compresses it to a pressure that can reach 7 bars; and
- A zone where the belts are separated and the dewatered sludge is released.

Frame-Filter Press

Figure 33: Representative Diagram of Frame-Filter Press



(Source: https://www.fantasirekasembada.com/filter-press/)

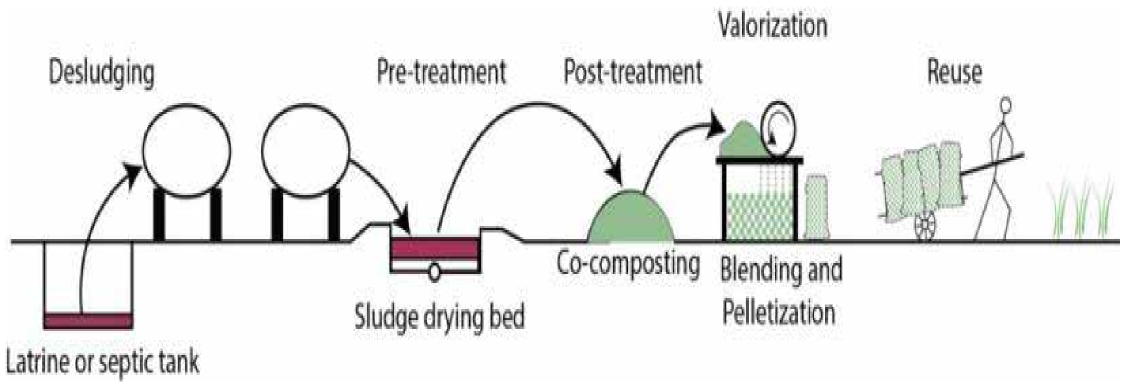
Frame-filter press system consists of porous vertical frames fixed in two walls that are positioned in front one of the other to create a chamber. This is a batch process in which the sludge is filled into the chamber at high pressure (up to 15 bars resulting in the leachate being released through the porous frames and the dewatered sludge being released through the opening of the lower wall).

Co-composting of FS

Composting is a biological process that involves microorganisms that decompose organic matter under controlled predominantly aerobic conditions. The resulting end product is stabilized organic matter that can be used as a soil conditioner. It also contains nutrients which can have a benefit as a long-term organic fertilizer. Co-composting of FS with MSW is best implemented with sludge that has undergone dewatering (e.g. settling-thickening tanks or drying beds).

Advantages and Constraints

Figure 34: Representative Process of Co-composting



(Source: www.wateratleeds.com)

The main advantage of co-composting is formed by the thermophilic conditions and the resulting pathogen inactivation. The output of co-composting is a good soil conditioner which provides the potential for income generation depending on the demand for compost. However, operating a co-composting plant and generating a safe product with value requires technical and managerial skills, which can be limiting if not available.

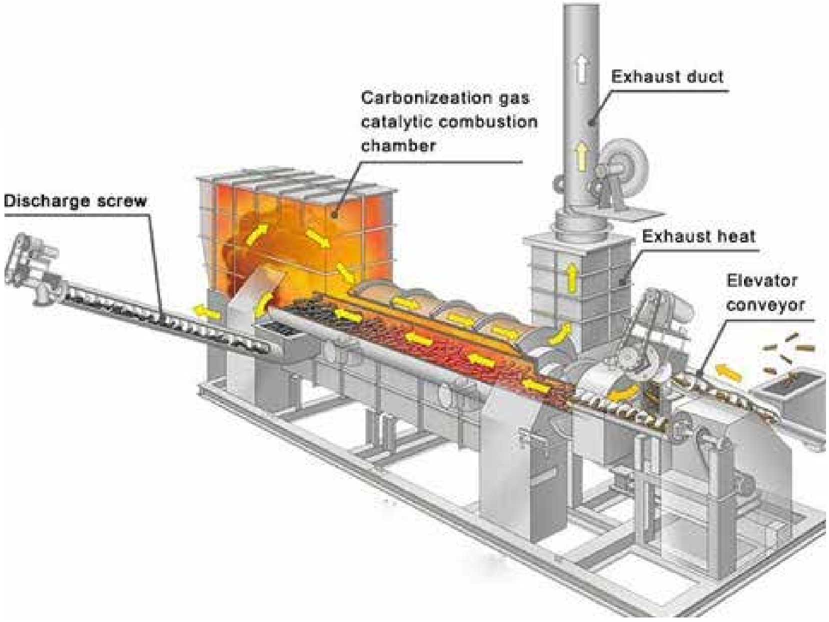
Sludge Incineration

Incineration of sludge is a form of disposal which involves the burning of sludge at temperatures between 850-900°C. It does not typically take advantage of the potential for resource recovery, however, energy can be captured from the incineration of sludge, for example in cement kilns. The ash that is produced from incineration could potentially be used, for example as a cover material for urine diversion dry toilets or in construction, or it can be disposed of in landfill sites. Sludge needs to be dewatered prior to combustion, but stabilization treatment is not necessary as it decreases the volatile content of the sludge. Commonly used incineration systems are multiple-hearth incineration, fluidized-bed incineration and co-incineration with municipal solid waste.

Advantages and Constraints

Disadvantages include: the potential emission of pollutants; the need for highly skilled operating and maintenance staff, high capital and O&M costs; and residual ashes. Advantages are that the sludge volume is substantially reduced and all pathogens are removed.

Figure 35: Representative Picture of Sludge Incineration Plant



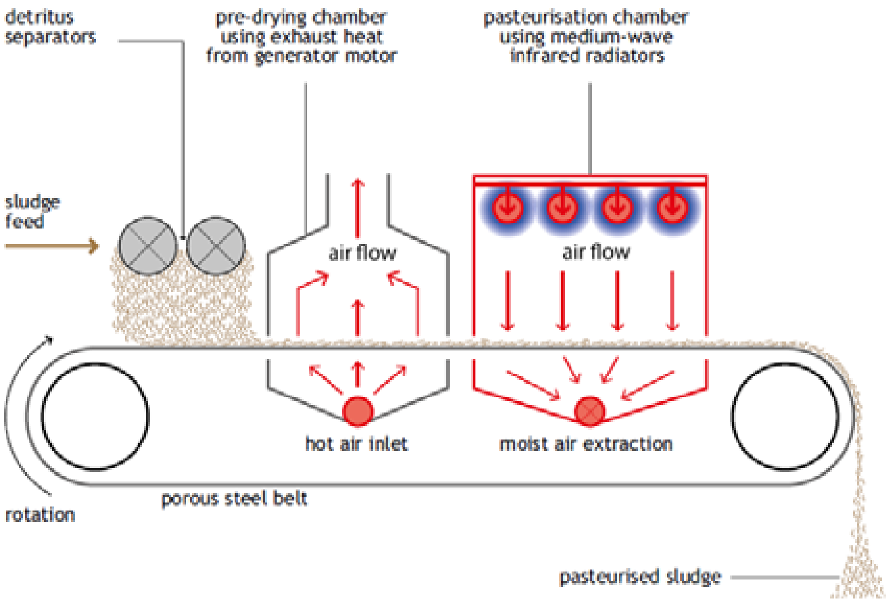
(Source: www.carbonizationfurnace.com)

Thermal Drying and Pelletising – LaDaPa System

These systems require preliminary dewatering if used for sludge that is high in water content. Indirect thermal driers, the hot air or gases are mixed with the dewatered sludge, as they pass through it, or are transported with it. In indirect thermal driers, a heat exchanger is used, which allows the heat convection to the sludge. In this case, the heat carrying media is often steam or oil and does not come in direct contact with the sludge, which reduces the operational need to separate the sludge from the heat carrier. In both cases, the vapour produced by the evaporated water needs to be collected and transported out of the dryer. Gas treatment can be an issue depending on environmental requirements and the odours produced. Indirect thermal dryers produce less contaminated vapour.

Advantages and Constraints

Figure 36: Representative Diagram of LaDaPa System



(Source: FSM Book, IWA)

Thermal drying results in a significant reduction in volume as well as pathogen content. Dried sludge is easy to handle and to market, and can be used in agriculture. The main constraints are the expense, high energy requirements, the potential risks of fire or explosion due to the gas and dust in the system, and the high maintenance requirements.

Pelletizing combines mechanical dewatering and thermal drying technologies. The dried pellets can then be used as an energy source or soil conditioner, and are relatively easy to transport and to market.

Geotubes

Geotubes are of high-strength, permeable, specially engineered textiles designed for containment and dewatering of high moisture content sludge and sediment. They are available in a variety of sizes, depending on your volume and space requirements.

Figure 37: Geobags and its Application for Solid -Liquid Separation

Advantages and Constraints

The advantage is as high flow rate allows residual materials to dewater, whilst containing solids and Custom fabricated with seaming techniques that withstand pressure during pumping operations. The main constraint is it has to be disposed of after first use and can't reuse it for the second.

5. Further readings and References

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- Rezek, J. and Cooper, I. Septage Management. U.S. Environmental Protection Agency, Washington, D.C., EPA/600/8-80/032
- https://cfpub.epa.gov/si/si_public_record_Report.cfm?Lab=ORD&dirEntryID=4

Session

05

Site Visit to Treatment Plants

1. Session Objective

To discuss the technology and on-site implementation of treatment plants

2. Session Plan

One day site visit to the treatment plants

Activity	Time	Material /Methods
Site visit to the treatment plant	8 hours including travel	Site visit, observation, discussion and Q/A

3. Key Learnings

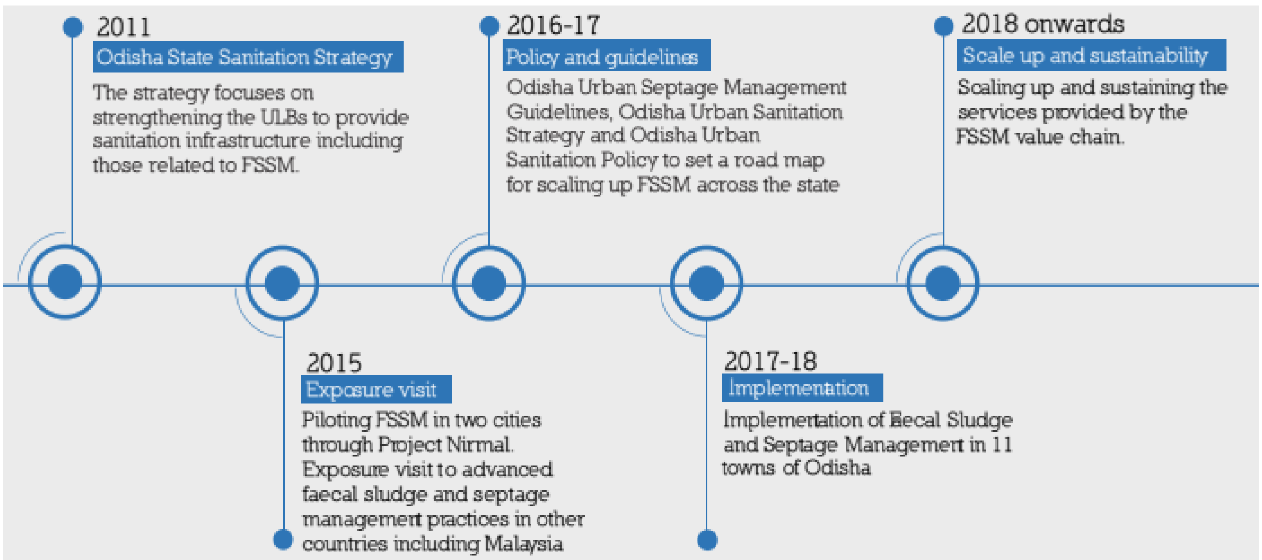
- Understanding of functioning of FSTPs through on-ground experience.
- Discussion with the project engineer to understand all the components of the treatment plant.
- Discussion with officials for on ground mechanism, challenges faced and their possible solutions.
- Visit to HHs/community toilets to demonstrate scheduled desludging adopted by the city.
- Discussion with the desludging operator on the willingness of HHs and on ground challenges faced record keeping etc. during desludging.

4. Learning Notes

4.1 Odisha – State level approach towards FSSM

Odisha is experiencing a fast pace of urbanization (27% decadal urban growth rate) which is accompanied by challenges of providing people of the state with good quality basic amenities such as water and sanitation. As the Government of Odisha has been committed to the cause of ensuring safe, healthy and sanitized towns and cities in the state, it took initiatives four and a half years ago to focus on safe containment, safe transportation, safe disposal and safe treatment of faecal matter. Considering the preponderance of on-site systems in the urban Odisha, the government realized that sewer networks cannot be the only solution for wastewater management. Hence, the government has decided to opt for low cost, impactful non- sewer sanitation systems to make cities environmentally clean and safe for the citizens.

Journey of Odisha in FSSM



- Odisha has constructed Septage Treatment Plants (SeTPs) and Faecal Sludge and Septage Treatment Plants (FSTPs) for safe treatment of waste.
- The state has also procured cesspool vehicles of varying sizes especially to negotiate narrow lanes/ streets and SeTPs to ensure safe emptying and transportation of the contained faecal waste.
- Eight AMRUT towns have the approval to construct SeTPs i.e. Balasore, Baripada, Berhampur, Bhubaneswar, Cuttack, Puri, Rourkela & Sambalpur town through AMRUT programme. Out of these, five SeTPs have been completed & commissioned in Bhubaneswar, Puri, Berhampur, Sambalpur and Rourkela. Construction of SeTPs in three towns i.e. Cuttack, Balasore and Baripada is under progress.
- Construction of three SeTPs have been taken under ''Project Nirmal' in Dhenkanal, Angul and Choudwar, out of which SeTP in Dhenkanal is completed and commissioned. The other two SeTPs are under construction.
- Some plants have adopted co-treatment and co-location options, which optimize the capacity and land requirements. The plants employ a decentralized wastewater system (DEWATS).

4.2 Bhubaneswar Septage Treatment Plant

Introduction

The treatment plant in Bhubaneswar is first of its kind septage treatment plant in India which treats both solids and liquids parts of septage in an integrated manner. The capacity of the plant is 75 KLD constructed by Odisha Water Supply and Sewerage Board under the AMRUT programme at a cost of 3.54 crore.

The Septage Treatment Plant (SeTP) is designed to treat the liquid part of the septage using DEWATS technology. The technology requires the least mechanical and electrical interventions to run the process and is cost effective as compared to other technologies. Solar plant of 10 KW capacity installed at the SeTP as a special feature.

Bhubaneswar treatment plant treats both solid and liquid parts of septage in an integrated way. The low cost technology, easy operation and maintenance demonstrate a scalable and sustainable model for septage management in India.

City overview

Bhubaneswar, the capital of Odisha, is located in the eastern coastal plains along the Eastern Ghats. The area under the jurisdiction of the Bhubaneswar Municipal Corporation covers 186 square kilometers.

Name of the city and state	Bhubaneswar, Odisha
Population (census 2011)	8,46,402
Existing sanitation situation	Connectivity to sewer network is 26% Majority of the population of the city are dependent upon Onsite Sanitation

Approach

Planning

The Septage Treatment Plant (SeTP) of Bhubaneshwar has been constructed under the Atal Mission for Rejuvenation and Urban Transformation (AMRUT) programme by Odisha Water Supply and Sewerage Board (OWSSB). The operation and maintenance of the plant are also done by OWSSB. The criteria for technology selection was for it to be low cost and non-mechanized so that operation and maintenance can be done by the local staff.

Conveyance

Odisha Government purchased cesspool vehicles for ULBs using state funds in early 2015 and ensured the availability of cesspool vehicles with all the ULBs for safe collection and transport of faecal sludge/septage. The GoO has taken measures to facilitate private sector engagement in FSSM by providing cesspool emptying licenses. The private operators are responsible for operating and maintaining the cesspool emptier vehicles. Currently, desludging activity is carried out in the state by both ULB-operated and ULB-contracted cesspool emptier vehicles (operated by private players). Licensing of cesspool emptier vehicle operators to private players has also resulted in a substantial reduction in the tariff payable by the customer.

ULBs in Odisha are using technology as an enabler to integrate and improve FSSM service delivery. Under Smart City Mission, Bhubaneswar Municipal Corporation (BMC) is implementing the smart FSSM system, which enables the components of FSSM, to be remotely monitored using wireless sensors installed inside the tank of cesspool emptier vehicles. The waste collection shall then be managed via a web portal from the Intelligent City Operations Management Centre (ICOMC). Radio-frequency identification (RFID)-based system allows real-time tracking of faecal sludge dumping by the corporation.

Technology

Septage treatment plant at Bhubaneswar is of 75KLD capacity spread over the area of 1 Ha. There is a receiving/inlet chamber for the sludge where it is screened and goes into the settler cum thickener tank. Settler cum thickening tanks are constructed for the separation of solid and liquid components of the faecal sludge.

The SeTP is designed to treat the liquid part of the septage using DEWATS technology. DEWATS is chosen as a preferred technology, given the comparative advantage of technology, in terms of its minimum electricity requirement and ease of operations through semi-skilled personnel. The solids from the settler tank go to the sludge drying bed with movable sheds. After drying the sludge goes to the compost shed. After composting the sludge is reused.


Sludge drying beds with movable sheds


Planted gravel filter


Anaerobic Baffled Reactor + AF

The SeTP covers an area of 2.47 acres out of which 1.3 acres have been utilized for landscaping and plantation which not only enhances the aesthetics of the plant but it also helps in garner citizens support and raise awareness on the importance of treating faecal sludge and septage.

Financing

The project has been constructed under AMRUT by 50:50 cost sharing basis. The total project cost is 3.5 crores which includes O&M cost of 5 years.

Sources

- Odisha's Journey of Faecal Sludge and Septage Management, towards sustainable sanitation goals by Ernst & Young LLP.
- Septage Treatment Facility in Bhubaneswar & Puri, Design Approach and overview of SeTP-Presentation by Binod Kumar Sahoo, Project Director, OWSSB

4.3 Co-treatment of Septage at Puri STP

Introduction

Puri SeTP employs a co-treatment method for treatment of septage where solids are treated through drying beds and the liquid faction is treated in Sewerage Treatment Plant (STP) co-located with SeTP.

City overview

Puri is a city in the state of Odisha in eastern India. It is situated on the Bay of Bengal, 60 kilometers south of the state capital of Bhubaneswar. With the 12th-century Jagannatha Temple located in its heart, Puri is a pilgrimage town with high floating population.

Name of the city and state	Puri, Odisha
Population (census 2011)	2,00,564
Existing sanitation situation	Majority of the population of the city are dependent upon onsite sanitation

Approach

Planning

The SeTP of Puri has been constructed under the Atal Mission for Rejuvenation and Urban Transformation (AMRUT) programme by Odisha Water Supply and Sewarage Board (OWSSB). The plant in Puri employs co-treatment for septage management.

Conveyance

In October 2017, Puri Municipality appointed a private contractor to provide emptying services Rs. 790/- per trip. As a result of lower price and in time services, the Municipality saw an increase in the number of trips being emptied at the plant.

Cesspool vehicles: Odisha Government purchased cesspool vehicles for ULBs using state funds in early 2015 and ensured availability of cesspool vehicles with all the ULBs for safe collection and transport of faecal sludge/septage. The Puri Municipality has 6 numbers of cesspool vehicles out of which 4 were procured by the OWSSB and handed over to the ULB while the other two were procured by the ULB. The 4 newly procured vehicles are of 3000 L capacity and have been handed over to the private agency under the contract.

Technology

A SeTP of 50 KLD capacity was constructed by Orissa Water Supply and Sewerage Board (OWSSB) in October 2017. The treatment plant was constructed under AMRUT scheme. The septage at this treatment plant is co-treated by treating solids in SeTP and the liquid in the co-located STP.

The septage is emptied at the receiving chamber. It then goes to the settling cum thickener tank of SeTP which allows heavier particles of the unloaded septage to settle down to the bottom of the tank while the lighter part of septage (i.e. water and oil) remains above. The sludge (settled soils) gets thickened in the settling-cum-thickener tank and removed by pumping at regular interval to the sludge drying bed for removal of moisture content. These sludge drying beds are the underutilized drying beds of STP which have been modified for treating septage to save infrastructure cost. The leachate from sludge drying bed is collected in the leachate sump which is pumped to the pre-treatment unit of Sewage Treatment Plant (STP) which is co-located with the SeTP for further treatment and disposal.

Figure 38: Treatment process flow diagram

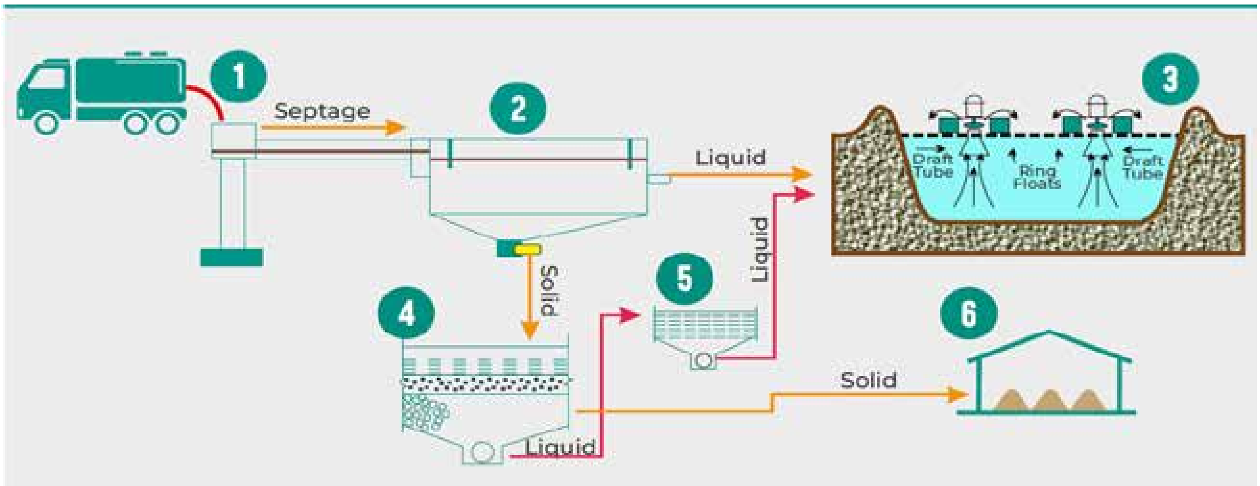


Figure 39 Site pictures of treatment plant

Financing

The project has been constructed under AMRUT by 50:50 cost sharing basis. The total project cost is 1.75 crores.

Sources

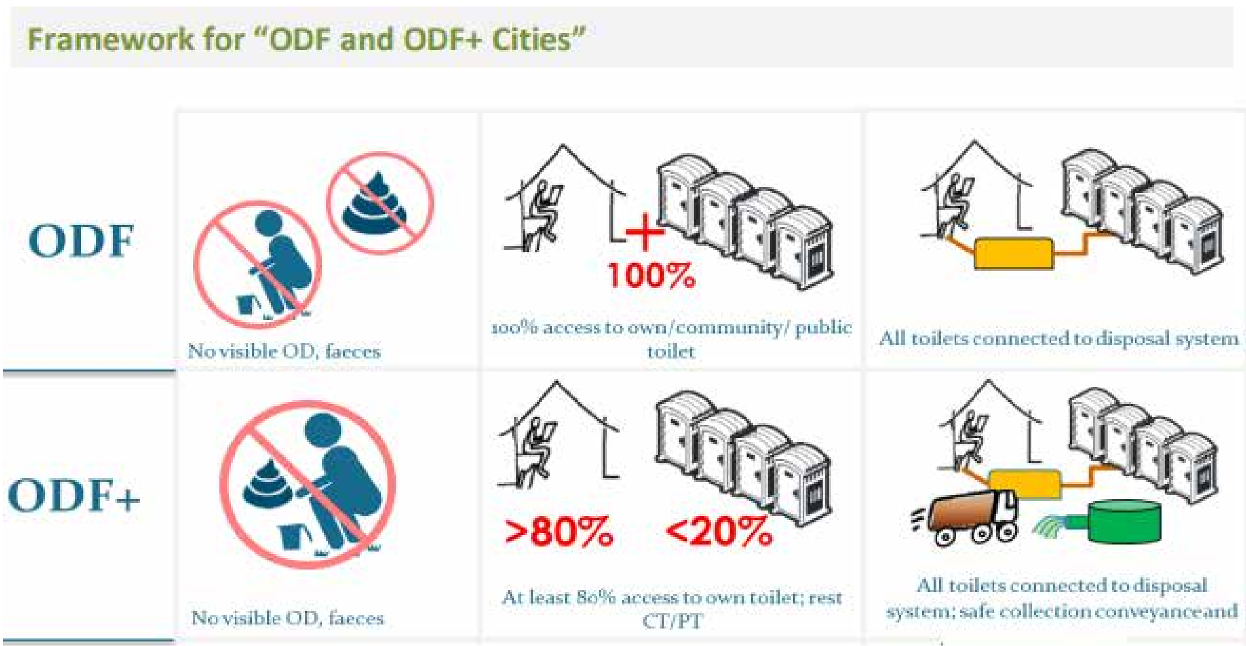
- Odisha's Journey of Faecal Sludge and Septage Management, towards sustainable sanitation goals by Ernst & Young LLP.
- Septage Treatment Facility in Bhubaneswar & Puri, Design Approach and overview of SeTP-Presentation by Binod Kumar Sahoo, Project Director, OWSSB

4.4 Maharashtra – State level approach towards FSSM

In Maharashtra, only 32 cities are partially covered with sewer systems. The majority of household toilets are connected to onsite systems like septic tanks or pits. The new toilets constructed since the launch of Swachh Maharashtra Mission, Urban (SMMU) in 2015 by are being connected to septic tanks.

Under Swachh Maharashtra Mission (Urban), Government of Maharashtra envisages 'ODF Communities' moving towards 'ODF+ and ODF++ Communities' by addressing the entire service chain of sanitation and not focusing only on number of toilets constructed in the cities. Government of Maharashtra has adopted a systematic approach by keeping in view city as a unit and encouraging city managers for moving towards improved sanitation by prioritizing access and use of own toilets and implementing plans for safe management of faecal waste.

State framework for ODF+ cities



Maharashtra has launched septage management guidelines as well as step-by-step approach for ULBs to implement septage management plans in their cities.

4.5 Faecal Sludge Treatment Plant at Wai

Introduction

Wai city has moved from a demand-based emptying system to a regular service oriented emptying system by implementing scheduled desludging.

City overview

Name of the city and state	Wai, Maharashtra
Population (census 2011)	~ 43,000 (census - 36,025)
Existing sanitation situation	• More than 80% of households have individual household toilets. The rest have access to well-maintained community toilets. • The city does not have any underground drainage system and toilets in the city are connected to septic tanks and pit latrines.

Approach

Planning

The journey of Wai towards the improvement of sanitation in2013 started with the making of a City Sanitation Plan with an innovative approach to adopting non-sewered options for waste water management. After achieving the ODF status, city aimed at sustaining the ODF status which focused on increasing the individual toilet coverage and achieving ODF++ status as per MoHUA's protocol which deals with safe collection and disposal of faecal matter. The city through its city-wide septage management plan planned and implemented:

- Regularly desludging the septic tanks of all the properties once in every 3 years
- Treating the septage in a scientific and safe manner prior to disposal

This city is one of the first cities in India to implement a schedule septic tank emptying service.

Conveyance

The city formulated a scheduled emptying plan wherein all the septic tanks in the city would be emptied once in 3 years and the collected septage will be treated at a dedicated septage treatment facility. To achieve the same, the entire city is divided into 3 zones and the city aims to empty the septic tanks of 1 zone per year. Initially, around 2% (~100) septic tanks were cleaned annually in Wai and these services were being provided by two WMC operated truck against a charge. However, Wai is now going to empty 33% i.e. 2000 septic tanks annually. This service is being provided by a private contractor which was selected through a competitive tendering process. A service based contract for 3 years has been signed.

Figure 40 Site pictures of emptying of septic tanks

Impact of scheduled desludging

In Wai, scheduled desludging is operational since 30th May 2018. Since the implementation of scheduled emptying of septic tanks 7-8 tanks, septic tanks are desludged every day as compared to 7-8 tanks being emptied every month. Within 5 months 350+ tanks have been desludged.

Technology

Wai Municipal Council allocated land near the solid waste management processing site for an FSTP of capacity 70 cu.m/day. The FSTP and schedule emptying service in Wai was inaugurated in May 2018. It is a thermal FSTP with engineered pasteurization, dewatering and wastewater treatment unit. The reuse of energy produced during the pyrolysis of faecal sludge makes the setup more efficient and saves valuable energy. Reuse of treated septage and water is being explored and discussions are going on with local farmers, government officials and agro based industries for reuse.

Figure 41 The Thermal Faecal Sludge and Septage treatment process

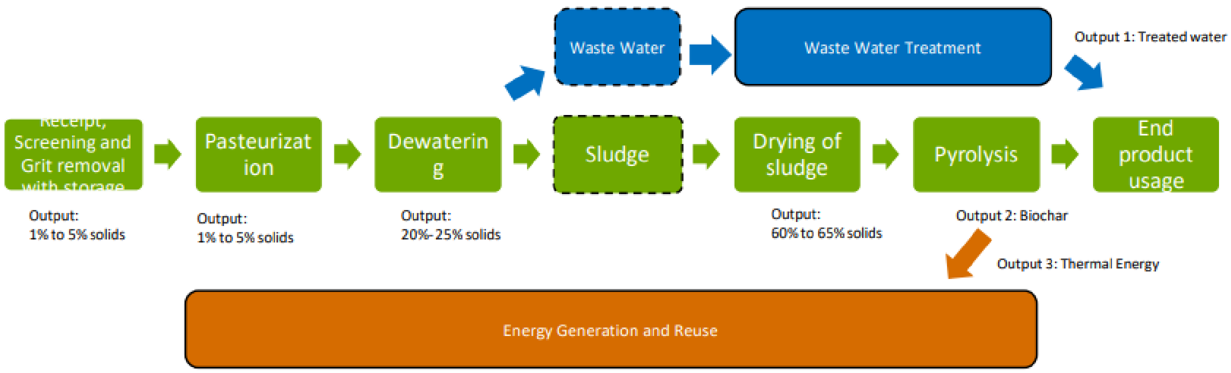


Figure 42 Site pictures of the treatment plant

Financing

The FSTP at Wai was initiated as a pilot project wherein capital cost was funded by BMGF. Wai Municipal Council opened an independent escrow account for payment of private contractor for emptying service which protected it against payment delay. The scheduled desludging service is financed through the city governments' own funds. A sanitation tax is levied on the citizens which amounts to much less than what each family needed to pay for emergency desludging. This tax, along with surplus from property tax collection, funds the O&M of emptying and treatment.

Sources

- Wai Municipal Council
- www.pas.org.in

Session

06

Financing and Contracting Options

1. Session Objective
To discuss the financing aspects of FSSM for conveyance and treatment of septage

2. Session Plan
Presentation followed by hands on exercise

Activity	Time	Material /Methods
Financing and Contracting Options	40 min	Presentation and Discussion
Exercise – Sanitation Tax Calculation	20 min	Hands-on Exercise

3. Key Facts/ Messages
- The potential financial transactions in FSSM are Budget Support, Capital investment, Sanitation Tax, Discharge fee, Discharge incentives, Discharge license, Emptying fee, Operation and Maintenance, Purchase price etc.
- Levying Sanitation tax is a potential source of finance for covering OpEx of conveyance and treatment if desludging is provided a service and User charges or emptying fees in case of demand based desludging.
- There are various stakeholders household level toilet users, government authorities, private enterprises, non-government organizations, end-use industries etc. between whom various financial transactions take place for FSSM services across the service chain
- The different financial models that can be implemented are
  - Discrete collection and treatment model
  - Integrated collection, transport and treatment model
  - Parallel tax and discharge fee model
  - Dual licensing and sanitation tax model
  - Incentivized discharge model
- Integrated FSSM plan is based on various activities or contracts which are a part of the service value chain based on component wise performance. Thus, when contracts are bundled they have tangible benefits over unbundled contracts as they are linked.
- Calculation of Sanitation tax can be done based on the minimum infrastructure required for the city. The operation and maintenance cost of the infrastructure for conveyance and treatment is calculated. This O&M cost need to be equally split over the number of the household to get the Sanitation Tax to be levied per household for recovering the O&M cost

4 Learning Notes
4.1 Overview of FSSM Finance
The financial sustainability aspect of any project is very important. It refers to ensuring a steady flow of funds for capital and operating expenses and generating revenue for maintaining and continuing the work. There is a significant need for funds to implement projects across the sanitation service value chain.

Global reviews of sanitation finance suggest that public finance is now being recognized as a major source of funds. It is also recognized that it is necessary to use these to leverage additional funds from private and commercial sources.

The National Policy on FSSM suggests that the Government of India may provide assistance for funding projects proposed as part of FSM Plans through its ongoing urban development schemes and programs but the emphasis will be on improving the efficiency of existing sanitation infrastructure and service delivery. It also states that State Governments should prioritize funds to implement the FSSM plan at City level. The policy also suggests the promotion of private sector participation and levying of sanitation tax/user charges for effective FSSM operations.

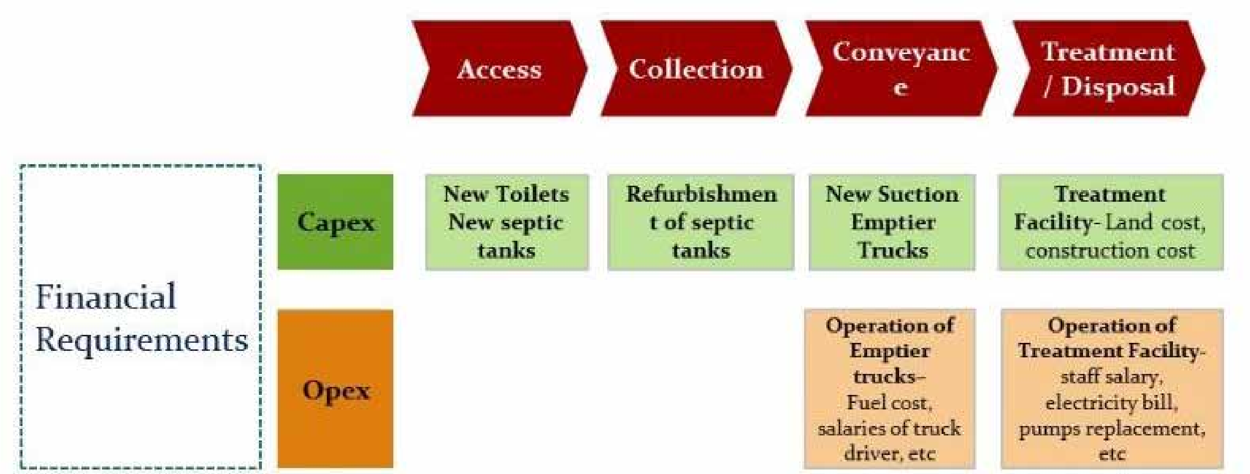
FSSM activities have involvement of Public, politics and finances at multiple levels of service chain causing complexity in implementation. Hence special framework and the environment with local level challenges is required to boost the activities at scale across cities.

4.2 Financial Requirement of FSSM

Financial requirements categorized in two sets, capital expenditure are the one-time expenses for acquiring or upgrading service and operational expenditure are the recurring expense for operation and maintenance of service delivery. The primary step of the financial assessment is to understand the financial requirements for various proposals across the service chain for improving the service delivery or creating new infrastructure in terms of its CapEx and OpEx. The financial requirements essentially based on the cost of achieving the various improvements activities planned.

Sanitation financing is required across the entire value chain. Through SBM a partial subsidy is available for access to sanitation or constructing toilets but the other components still need to be addressed. The financial requirements as capital Investment and O+M costs of FS collection and treatment must be determined on a case-to-case basis as local conditions are decisive. The main components of CapEx are new toilets and new septic tanks, refurbishment of old toilets and tanks, new vacuum trucks, land acquisition cost construction cost of FSTP etc. The OpEx are mainly for conveyance and treatment components like O&M of trucks and FSTP.

Figure 43: Component wise financial requirement for FSSM

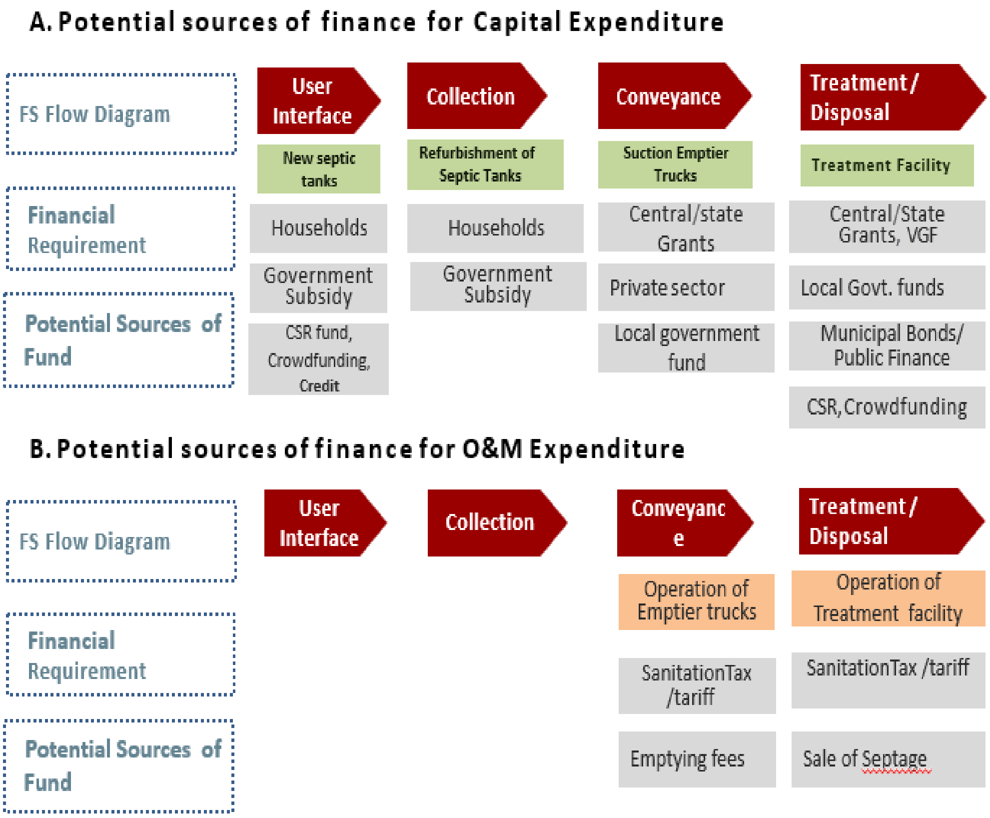


4.3 Potential Sources of Finance

The costs for Capex and Opex can have multiple potential sources of finances. Some of the important sources which are crucial in the proper financial fulfillment of the system are e.g. central or state government grants, government subsidy, local level service taxation, CSR fundings etc.

For Capex of access and containment components like toilets and septic tanks the main source of finances are households and government subsidies, CSRs, Credit if available. Central and State Govt grants and local govt. funds and PPP are the potential sources for Capex of Conveyance and Treatment.

Figure 44: Potential sources of Finance



Purchase of suction emptier trucks requires investment at an earlier stage, which can be meet through funds earmarked by the state government for ULBs. For demand based emptying the private sector and ULB are already catering the demand for desludging but in case of schedule based emptying the private sector is willing to bring in investment for vacuum trucks as it generates enough business.

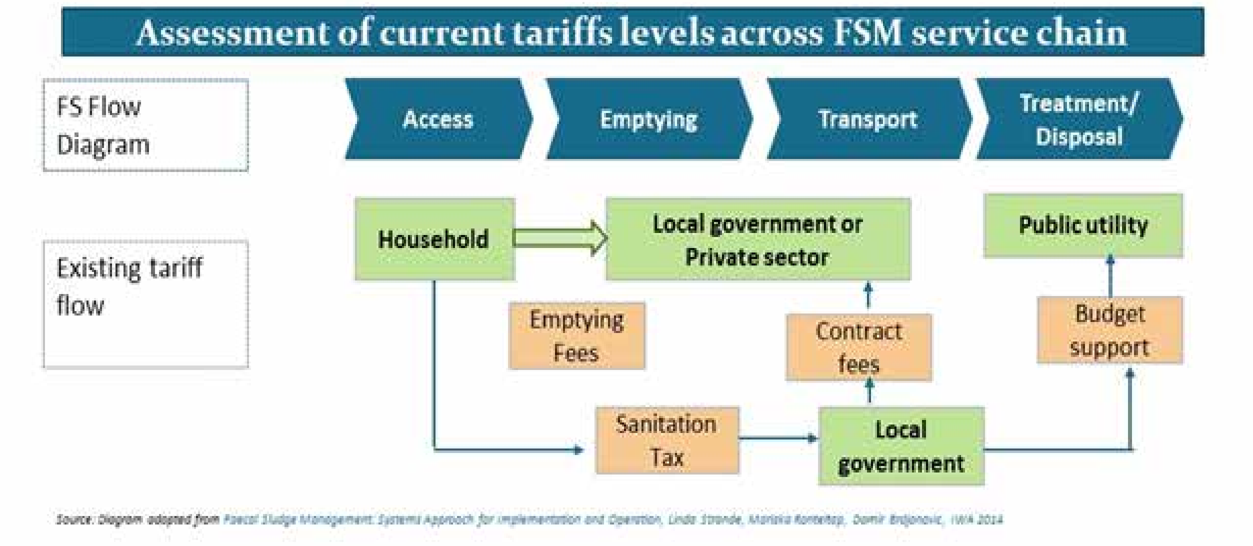
For the capital expenditure of treatment plant, central/state grants can be used. Large cities can use their own funds for the same. In case of scheduled service, large cities may use funds from national level programmes while smaller cities can mobilize funds from 14th Finance Commission. Viability gap funding can be used to involve the private sector where more funds may be required. Innovative finance methods can be used by ULBs for treatment facility like donor funding, CSR etc. Other sources like municipal bonds, Public finance, CSR and crowdfunding can also be used for Capex of treatment plant.

Levying Sanitation tax is a potential source of finance for covering Opex of conveyance and treatment if desludging is provided with a service and User charges or emptying fees in case of demand based desludging.

4.4 Potential Revenue Sources

It is important to explore various revenue sources to recover O&M cost. Besides O&M the ULB requires surplus funds to repay for obligations and expenses occurred in addition to CaPex. To achieve a financially sustainable business model, revenue model needs to be established. For this purpose, exploring the potential revenue sources is important. It is imperative for a good investment plan to always contain the revenue options. In FSSM since financial payment transfers are occurring for various activities across the service chain there are multiple sources of revenue.

Figure 45: Tariffs across sanitation service chain



The current tariff flow shows that HHs pay either emptying fees to private sector/ ULBs or sanitation tax to ULBs. ULBs also pay contracting fees to the private sector for desludging. Additional budget support may be required for O&M treatment facility. The various potential sources can be

Sanitation Tax

- It is a tax /fee for emptying and treatment of faecal sludge collected either once, or at regular intervals.
- It is a continuous income and can be used for operations and maintenance of emptying services and treatment plant.
- For introducing a sanitation tax, various states have legal provisions in their tax structure for charging tax and are already charging fees in terms of sanitation tax/user charge, which is a major source of revenue. Gujarat, Maharashtra, Uttar Pradesh, Uttarakhand and Punjab have provisions for taxations in different heads like general sanitation tax for Gujarat, Special sanitary tax for Maharashtra etc.
- In the case of West Bengal, Punjab, Haryana, Rajasthan there are provisions for fees and user charges for drainage, scavenging etc.

Emptying Fees

- It is a fee for emptying and disposal that is charged at the household level for providing the services.
- It may be charged by ULB or Private based on who is providing the service
- The charges of emptying fees vary as per location, service provider, the market volume of sludge etc
- In absence of any fee regulations, the private operators may charge higher fees .
- This type of model encourages households to opt for the services only in case of dire necessity and not regularly as per requirement.

Contracting Fees

- It is a fee charged from the private operator or contractor in order to provide a license to them for operating the emptying services.
- It regularizes the private operator in the conveyance

Budget Support

- Cash transfers within ULB from the general budget and other sources to support operations of FSSM activities.
- It may be long-term and non-conditional
- Property tax can be used as a source to subsidize the cost of FSSM services to be provided.

Sale of End Product

- The revenue generated by sales of the end product is also a source of revenue
- The selling price is dependent on supply, demand, and any subsidies that may be available in the location.
- Assessment of end user willingness to reuse and pay for treated products is important
- Market at a city level and nearby area should be analysed in terms of acceptance of treated sludge for farming and willingness to pay for the same.

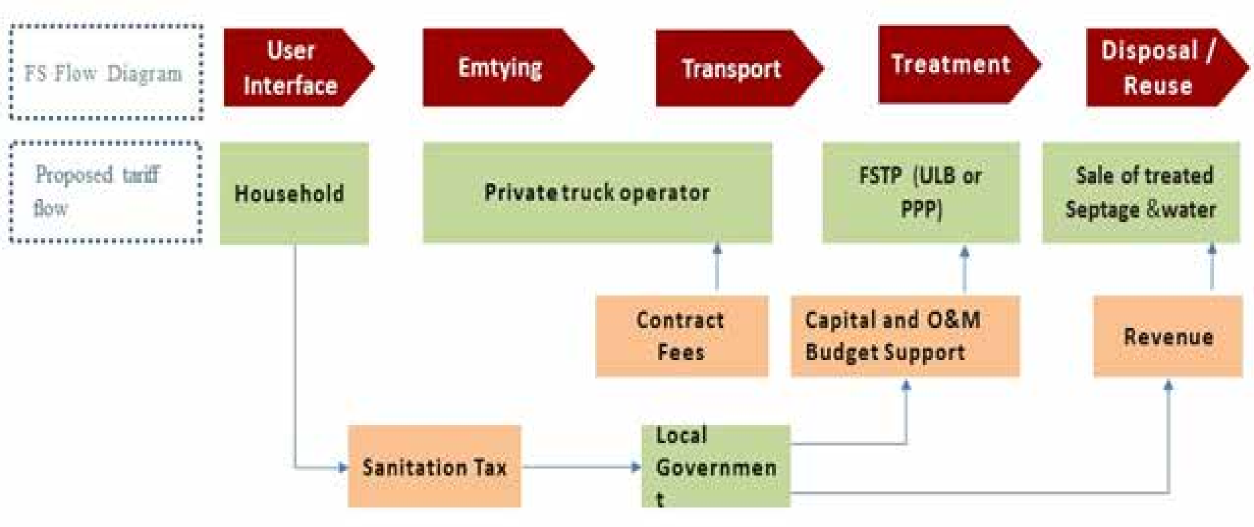
There are various other transactions also involved in the FSSM process like discharge fees, discharge incentive, fines for illegal activities etc. Assessment of willingness to pay by the households is important before levying of such fees or taxes to decide the amount. Sanitation tax can be decided based on the willingness of HH to pay additional property tax to cover the O&M of the FSTP.

4.5 Potential Revenue Structure

Schedule Desludging through Sanitation Tax

Under the proposed tariff flow, the local government levies sanitation tax and pays contract fees to the private government. Capital and O&M of the treatment facility is covered by tax and budget support.

Figure 46: Model for desludging through Sanitation Tax



This model helps to mobilize capex for conveyance from the private sector. Citywide scheduled desludging contracts using annuity payments can be done for a potential revenue structure to recover of O&M of desludging and treatment through Sanitation Tax. This tax is collected by local authority either as a percentage of property tax or by the public utilities as a surcharge on water bills. A private company to be contracted to provide citywide services, and can be performance linked payment – based on number of septic tanks emptied. As no permit is given to another private operator, there can be an assured market. The households are not expected to pay anything at the time of emptying as emptying is provided as a regular service and the tax is charged already to the households.

Case Study: Wai, Maharashtra

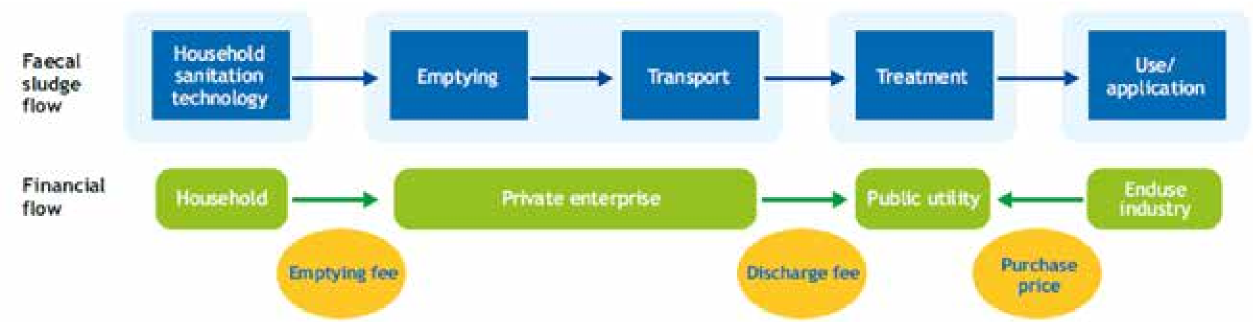
The FSTP at Wai was initiated as a pilot project wherein capital cost was funded by BMGF. The city formulated a scheduled emptying plan wherein all the septic tanks in the city would be emptied once in 3 years and the collected septage will be treated at a dedicated septage treatment facility. To achieve the same, the entire city is divided 3 zones and the city aims to empty the septic tanks of 1 zone per year. Initially, around 2% (~100) septic tanks were cleaned annually in Wai and these services were being provided by two WMC operated truck against a charge. However, Wai is now going to empty 33% i.e. 2000 septic tanks annually. This service is being provided by a private contractor which was selected through a competitive tendering process. A performance-based contract for 3 years has been signed. A sanitation tax that is 10% increase in annual tax is levied on the citizens which amounts to much less than what each family needed to pay for emergency desludging. This tax, along with surplus from property tax collection, funds the O&M of emptying and treatment. Wai Municipal Council opened an independent escrow account for payment of private contractor for emptying service which protected it against payment delay. It is observed that with appropriate awareness, there was a willingness to pay additional taxes. The taxes have been levied for a year and the citizens have paid the taxes. These taxes cover the desludging of septic tanks every three years for the property owner.

4.6 Financial Models

The financial flows and models cannot have a blanket application over different cities. They are usually modified and restructured as per local conditions and requirements. There are multiple stakeholders and financial transactions across the service chain which can have different flows as per the structure and contractual arrangements. Based on financial flows certain models have been identified.

Discrete Collection and Treatment Model

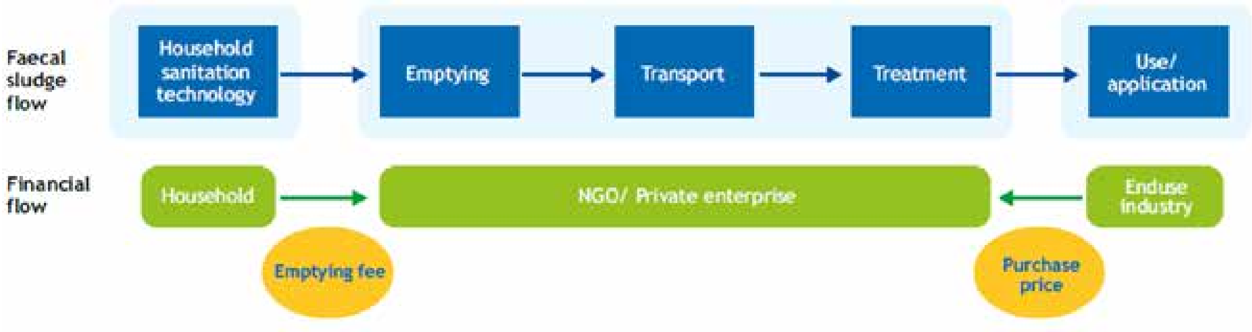
Figure 47: Discrete collection and treatment model



In this type of model, each of the stakeholders is responsible for a single technology in the FSM chain, and consequently, there is financial transaction each time responsibility is handed over (emptying and transport are identified here as a single technology). The household pays a private enterprise (PE) an emptying fee for desludging and transportation and the PE is responsible for the emptying and transportation of the sludge. The PE then pays a discharge fee to the public utility for disposal and treating the sludge. This public utility post-treatment sells the end product. The end use industry pays a purchase price to the public utility for treated FS or sludge-grown products (e.g. fodder). This model is advantageous to the households as they are not fixed to any sanitation tax, free to choose the financially viable option for emptying and can decide the frequency of emptying as per feasibility. This does not help ULB cover the O&M expenses so the private operators have to pay a discharge fee for emptying.

Integrated Model

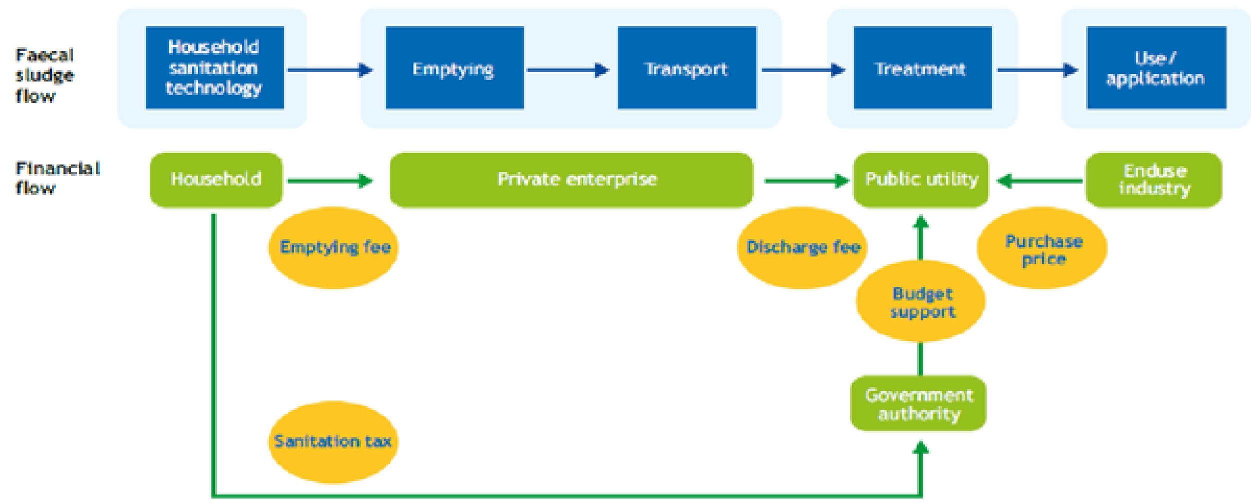
Figure 47: Integrated model



In the integrated model, HH pays the emptying fees for desludging, a single private operator/ NGO is appointed for emptying, transport and treatment facility and the treated products are sold to an end use industry paying a purchase price. The operator responsible for treatment is not subject to the sludge or payment irregularities of the PE responsible for emptying. This model with single source operations for C&T and treatment eliminates the need for a discharge fee between the stakeholder responsible for C&T and the stakeholder responsible for treatment. This type of model improvises the efficiency of operations and optimizes the business model due to single source operations. There is less potential for illegal discharge as the treatment facility is self-run by the operator. This type of model high fees of emptying may be passed on to the HHs.

Parallel Tax and Discharge Fee Model

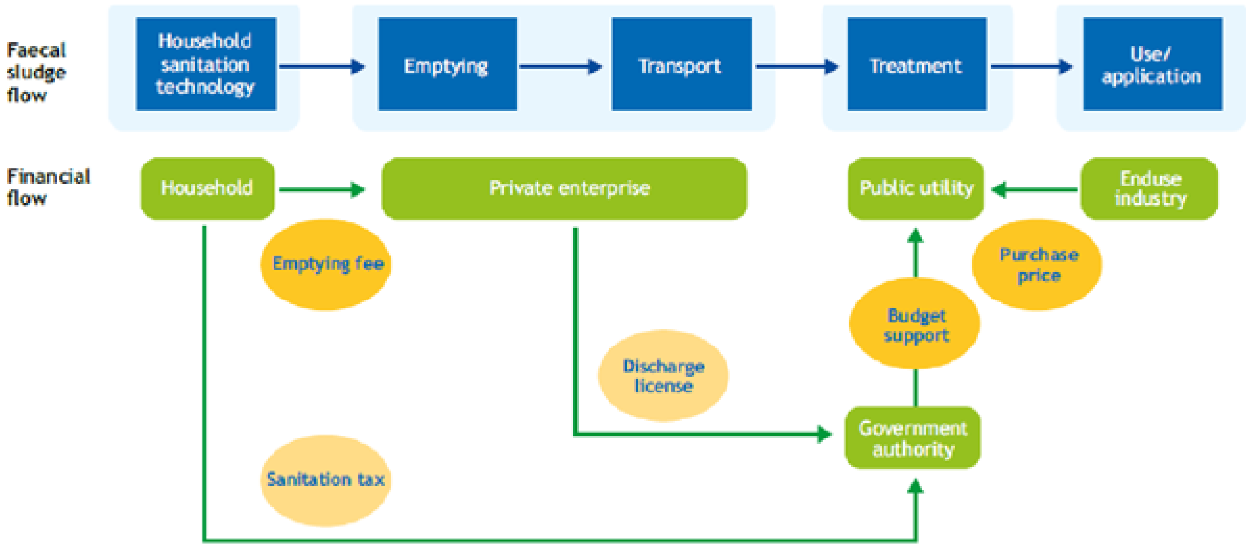
Figure 49: Parallel Tax and Discharge Fee model



In the Parallel Tax and Discharge Fee model, a sanitation tax is paid directly to the government authority by the toilet user through water, sewer, or property taxes. In this case, government authority takes budget support to cover costs of the utility from the tax collected. The utility, therefore, does not need to rely entirely on the discharge fees charged and so the fees could be lowered. The discharge fee must be high enough, such that operator can hold the PEs accountable for what they dump, but not so high that the toilet users are unable to afford the high emptying fees and result into illegal dumping. The financial dependency in this model is on the consistent collection of the sanitation tax. The collection and conveyance may increase in this model. In case if the collection of the fee is low in government authorities and there are fluctuations in the sanitation fees it can significantly affect the ability for the utility to function and make long term O&M decisions. In such cases, the reserves available from the authority may have to be used to buffer the variation.

Dual Licensing and Sanitation Tax Model

Figure 50: Dual Licensing and Sanitation Tax model

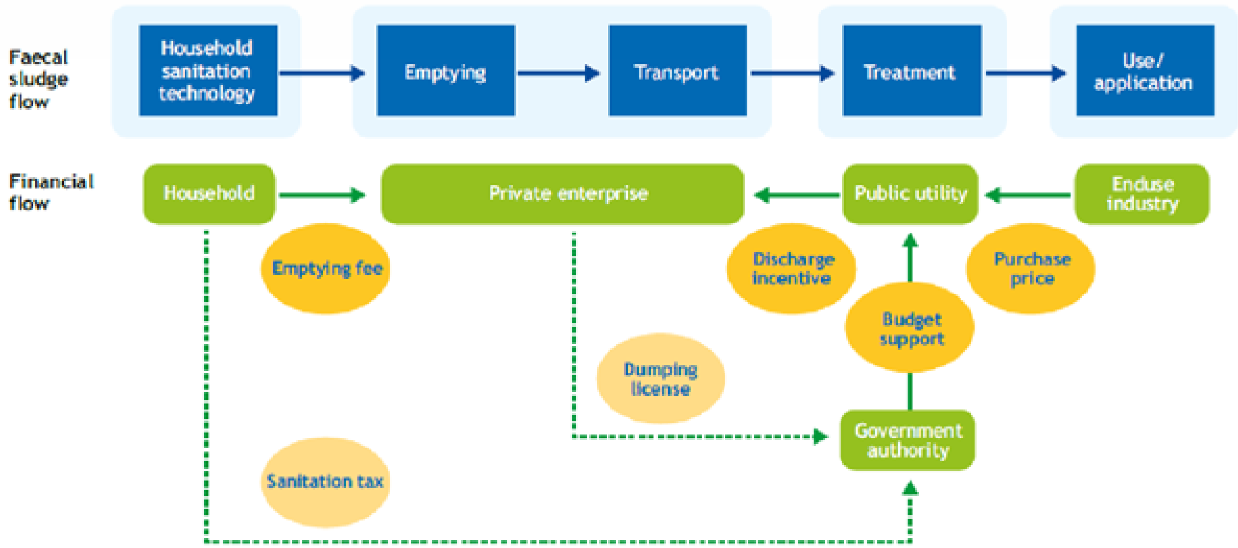


In the dual licensing and sanitation tax model, the private operators have to pay licensing fees for operations which is a onetime discharge fee for discharge license to the ULB. The private entrepreneur who is responsible for C&T is granted unlimited (or semi-limited) access to dump through a discharge license, thus reducing illegal discharge by those C&T operators who may not be able to afford the discharge fee. Having to pay a discharge license, no matter how nominal, ensures that the government has more administrative control over the industry. Data on the number of operators, the revenue that is generated, the distances travelled etc. can be collected and used to advise policy. This optimizes and brings in regulations for operations through licensing. This also gives the operators the benefit of unlimited disposal discharges at the treatment facility decreasing the risk of illegal dumping. The management of too many aspects of the service chain by one entity could prove difficult for a new /other similar business.

Incentivized Discharge Model

This model is built on the theory that C&T stakeholders cannot afford the discharge fees charged by FSTP operators and so dump indiscriminately, causing damage to public and environmental health. Working under this scheme, the C&T operator would only have to recover a portion of the total operating costs from the emptying fee (the other portion would be made up by the discharge incentive). As a result, the collection service would be more affordable for poorer households, more sludge would be collected, less sludge would be discharged to the environment and the community as a whole would benefit. In the incentivized discharge model, the private operators are given dual licensing along with an incentive for discharging at the treatment plant. This incentive generates more revenue and in turn efforts for the private operator to carry out desludging. This model can help reduce emptying fees and also inaccessible and far away septic tanks also become attractive as they receive a monetary incentive in addition to the emptying fees. For this model, significant budget support is required by the treatment facility.

Figure 51: Incentivized Discharge model



4.7 Bundling Contracts

Integrated FSSM plan is based on various activities or contracts which are a part of the service value chain. Performance in one component of the service chain affects the other component. Thus, when contracts are bundled they have tangible benefits over unbundled contracts as they are linked. The advantages of having bundled contracts are there is greater accountability, aligns performance incentives and simplifies contract management. The major disadvantage is it has high non-performance risk as non-performance across one component puts all activities at risk. Also, one single company may not have expertise across all components of the service chain.

4.8 LIFE CYCLE COSTING

Life Cycle Costing is widely accepted that the total economic cost of a given system is best determined by assessing both the capital and operational costs together over the entire life cycle of the system. This approach makes it possible to determine the most cost-effective solution amongst a range of alternatives by considering all cash flows over the lifetime of the system and allows practitioners to identify potential trade-offs between initial capital investment costs and long-term cost savings.

Life Cycle Costing And FSTPs

The application of LCCA to FSTPs is particularly appropriate because of the significant cost variability that exists between different locations. Individual systems may have different CapEx and OpEx profiles depending on location, and therefore, should be assessed on a case by case basis.

There are three types of temporal LCC variations that have to be considered in the analysis of FSTPs:

- Initial capital expenditure (CapEx),
- Recurring costs i.e. Operation and maintenance expenditure (OpEx), and
- One-off replacement costs.

LCC Analysis across FSTPs

Figure 52: Life Cycle Cost

FSTPs	Capacity, KLD	CapEx, in Lakh INR	NPV - O&M in Lakh INR	NPV -LCC in Lakh INR	Total LCC in Lakh INR	LCC / year in Lakh INR	LCC / KLD in Lakh INR
Jabalpur	50	50.23	129.70	179.93	359.86	29.99	7.20
Devanahalli	6	70.90	118.69	189.59	346.67	28.89	57.78
Puri	50	73.90	193.01	266.91	533.83	44.49	10.68
Leh	12	52.20	119.63	171.83	343.66	28.64	28.64
Tenali	20	20.00	98.69	118.69	237.37	19.78	11.87
Phulera	20	239.45	163.39	402.84	805.68	67.14	40.28
Bhubaneshwar	75	167.90	209.52	377.42	754.84	62.90	10.06
Warangal	15	110.00	229.17	339.17	678.34	56.53	45.22

The results of the LCC analysis across the 8 FSTPs are presented in the table above.

- From the LCC analysis of the different technologies, it is evident that the technologies focusing primarily on liquid management are far lesser in the total LCC, when compared to technologies which focuses on both liquid as well as solids management.
- Phulera, Bhubaneswar and Warangal show total LCC, at about 3-4 times that of Jabalpur, Leh and Tenali.

4.9 Group exercise: Calculation for infrastructure requirements for conveyance in a city

In this exercise, participants are divided into groups of two or three depending on the type of participation. For participants with a technical background, this exercise can be done individually.

Basic FSSM infrastructure requirement is calculated in a group exercise of session 3. The answers of the session 3 exercises are taken as input parameters for this group work. Based on these figures, participants are expected to calculate the O&M cost for emptying and conveyance which includes the energy cost, repair and maintenance cost, establishment expenses and overheads. The participants are then similarly expected to calculate the O&M expenses of treatment facilities. On the basis of these O&M values the participants are expected to calculate the Sanitation tax required for a city to cover the O&M expenses. The calculations are broken down with formulae given under each indicator. With such a hands-on exercise, participants understand the expenses involved in O&M of conveyance and treatment systems and the amount of tax required to be levied to cover the expenses.

Step 1: O&M cost for schedule septic tank emptying service

Table 8: O&M calculation for septic tank emptying services

1	Fuel cost for schedule emptying service = (Number of septic tank to be emptied daily*300* Average distance * 2 * Fuel price/ Fuel efficiency) • Assume Fuel efficiency for truck = 5 km per liter • Assume Fuel price = Rs 70 per liter	
2	Repair and maintenance cost = (Number of suction emptier truck requirement* 12 * 2,000) • Assume average repair & maintenance cost = Rs 2,000 per month	
3	Establishment expenses = ((Number of suction emptier truck requirement* 12 * No of manpower* Monthly Salary) • Assume, 2 manpower requirement per truck • Assume, Salary = Rs 10,000 per month	
4	**Sub-total = (1+2+3)**	
5	Overhead + Insurance + other Miscellaneous cost = Sub-total(4)*X% • Assume, other cost as X% of sub-total (4)	
6 –A	**Total O&M cost for schedule septic emptying service = (4+5)**	

Step 2: O& M cost for septage treatment facility

Table 9: O&M calculation for septage treatment facility

1	Energy cost for Septage treatment facilities = (Energy cost per month * 12) **Energy cost** • < 25 cum/day = Rs 5,000 per month • 25-50 cum/day = Rs 10,000 per month • 50-75 cum/day = Rs 15,000 per month • > 75 cum/day = Rs 20,000 per month	
2	Repair and maintenance cost = (Avg. Repair & maintenance cost * 12) • Assume average repair & maintenance cost = Rs 10,000 per month	
3	Establishment expenses = (No. of manpower*Monthly Salary *12) • Assume, 4 manpower requirement (in 2 shifts) • Assume, Salary = Rs 10,000 per month	
4	**Sub-total = (1+2+3)**	
5	Overhead + Insurance + other Miscellaneous cost = (4*X%) • Assume, other cost as X% of sub-total (4)	
6-B	**Total O&M cost for managing Septage treatment facility = (4+5)**	

Step 3: Sanitation Tax Calculation

- Annual O&M Cost= 6-A + 6-B =
- Per property tariff requirement for septage management
  = (Annual O&M cost (A)/ (total properties* collection efficiency)
  - *Considering tax collection efficiency= 70%*
  - *Note: Users may calculate differential tariff structure across property uses; properties with toilet facility v/s properties dependent on community toilet etc.*

5. Further readings and References

- Strande, L., Ronteltap, M., & Brdjanovic, D. (2014). *Faecal Sludge Management: Systems Approach for Implementation and Operations.* London: IWA Publishing
- EAWAG/SANDEC (2008): (Sandec Training Tool 1.0, Module 5). Duebendorf: Swiss Federal Institute of Aquatic Science (EAWAG), Department of Water and Sanitation in Developing Countries (SANDEC)
- Centre for Water And Sanitation, CEPT University (Sept-2017), *Financing FSM – Potential Sources and Approaches*
- National Institute of Urban Affairs/Ecosan Services Foundation/Sanitation Capacity Building Platform (2018) *Integrated Wastewater And Septage Management* (TOT Module) Part 1 – Learning Notes.
- Centre for Water And Sanitation, CEPT University (June-2018), *Stakeholder Workshop on Financing FSSM.*
- Centre for Water And Sanitation, CEPT University (Sept-2017), *Financing FSM – Potential Sources and Approaches*
- Ministry of housing and Urban Affairs, Government of India (Feb -2017), *National Policy on Faecal Sludge and Septage management*
- National Institute Of Urban Affairs /Sanitation Capacity Building Platform (2019) Cost Analysis Of Faecal Sludge Treatment Plants In India, Life Cycle Costing & Contracting Models Of FSTPs

Session

07

Interaction with State and ULB Officials

Session Objective

To discuss learnings in implementation of FSSM with state and ULB officials

2. Session Plan

Activity	Time	Material /Methods
State-specific approach and technology details interaction with State/City Officials	60 min	Presentation followed by Discussion/Q and A

3. Key Learning

To help participants understand the overall process and implementation of FSSM through knowledge sharing and interaction with senior State/City Officials.

4. Learning Notes

Organization of interactive learning session with relevant stakeholders involved in the implementation of FSSM services for learning of the participants through experience sharing

4.1 Interaction with Senior Officials from State/City

- Discussion on the detailed assessment and preparation of FSSM plan for the State/City based on ground conditions.
- Sharing learnings about advocacy and policy level decisions for implementation of FSSM plan pan State/city
- Understanding the viable technology options available and the instrumental decision-making process for finalization of emptying and technology selection.
- Discussion on the efforts for implementation of FSSM plans.
- Discussion about the implementation of FSSM plans on ground and challenges faced in operationalizing FSSM
- Discussion on the scope and involvement of the private sector across the service chain
- Understanding the finances and fund allocation for FSSM planning and implementation
- Discussion on integration of services delivery across different components of the chain
- Share learning about performance and monitoring of FSSM service delivery across various components of the value chain.

4.2 Interaction with Private Sector Stakeholders (Emptying and Technology)

- Understanding the system of schedule/demand based desludging in the city
- Discussion on daily challenges faced in on-site implementation of desludging and the improvisations required to overcome the challenges
- Understanding the process of technology selected and implemented for septage treatment in the State/City

Session

08

Action Plans

1. Session Objective

To discuss learnings in implementation of FSSM with state and ULB officials

2. Session Plan

Exercise followed by a presentation

Activity	Time	Material /Methods
Exercise – Action plan preparation	30 min	Hands on exercise on flip charts in groups and presentation

3. Key Learning

To make participants understand how to formulate action plans for planning and implementation of FSSM activities in a city including all aspects of assessment of the existing situation, source of funding, ULB level resolution/regulations, demand and schedule desludging, site and technology selection and stakeholder participation.

4. Learning Notes

In this exercise, the participants are divided into groups and are expected to prepare an action plan based on their learning of all the sessions over three days. The participants are expected to identify five most important actions to be taken by the city for planning and administration, technology, finance and IEC activities to prepare and implement a FSSM plan in the city. The participants then have to present and discuss their action plans with all participants.

Table 10 Group Exercise for action plan

Group Exercise

	PLANNING AND OVERALL ADMINISTRATION	TECHNOLOGY	FINANCE	IEC ACTIVITIES
1				
2				
3				
4				
5				

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About NIUA

NIUA is a premier national institute for research, capacity building and dissemination of knowledge in the urban sector, including sanitation. Established in 1976, it is the apex research body for the Ministry of Housing and Urban Affairs (MoHUA), Government of India. NIUA is also the strategic partner of the MoHUA in capacity building for providing single window services to the MoHUA/states/ULBs.

About SCBP

The Sanitation Capacity Building Platform (SCBP) is an initiative of the National Institute of Urban Affairs (NIUA) to address urban sanitation challenges in India. SCBP, supported by Bill & Melinda Gates Foundation (BMGF) is an organic and growing collaboration of credible national and international organisations, universities, training centres, resource centres, non-governmental organisations, academia, consultants and experts. SCBP supports national urban sanitation missions, states and ULBs, by developing and sourcing the best capacity building, policy guidance, technological, institutional, financial and behaviour change advise for FSSM. SCBP provides a unique opportunity for:

- Sharing and cross learning among the partner organisations, to pool in their knowledge resources on all aspects of urban sanitation capacity building;
- Developing training modules, learning and advocacy material including key messages and content, assessment reports and collating knowledge products on FSSM. Through its website (scbp.niua.org), SCBP is striving to create a resource centre on learning and advocacy materials, relevant government reports, policy documents and case studies;
- Dissemination of FSSM research, advocacy and outreach to State governments and ULBs.

Its strength is its ability to bring together partners to contribute towards developing state sanitation policy, training of trainers and training content development, technical and social assessments, training programme delivery, research and documentation.

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