सत्यमेव जयते

Ministry of Housing and Urban Affairs
Government of India

FAECAL SLUDGE AND SEPTAGE MANAGEMENT

ORIENTATION MODULE

PART A: PRESENTATION SLIDES

National Institute of Urban Affairs

NFSSM Alliance

ecosan SERVICES FOUNDATION

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Faecal Sludge and Septage Management: Orientation Module (Part A: Presentation Slides)

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CONTENT

The module has been developed with the collaborative effort of NFSSMA partner organisations under Training Module Review Committee (TMRC) anchored by NIUA.

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Ministry of Housing and Urban Affairs
Government of India

FAECAL SLUDGE AND SEPTAGE MANAGEMENT

ORIENTATION MODULE

A CASE BASED ON LESSONS FROM UTTARKHAND

PART A: PRESENTATION SLIDES

Collaborative Effort Under Training Module Review Committee (TMRC)

National Institute of Urban Affairs

NFSSM Alliance

ecosan SERVICES FOUNDATION

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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.

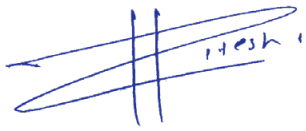
Through a collaborative engagement of the Training Modules Review Committee(TMRC) of NFSSM Alliance, anchored by NIUA, all training content developed so far on septage management, has been strategically revised updated into a 3 set learning Modules on Faecal Sludge and Septage Management :

- **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:

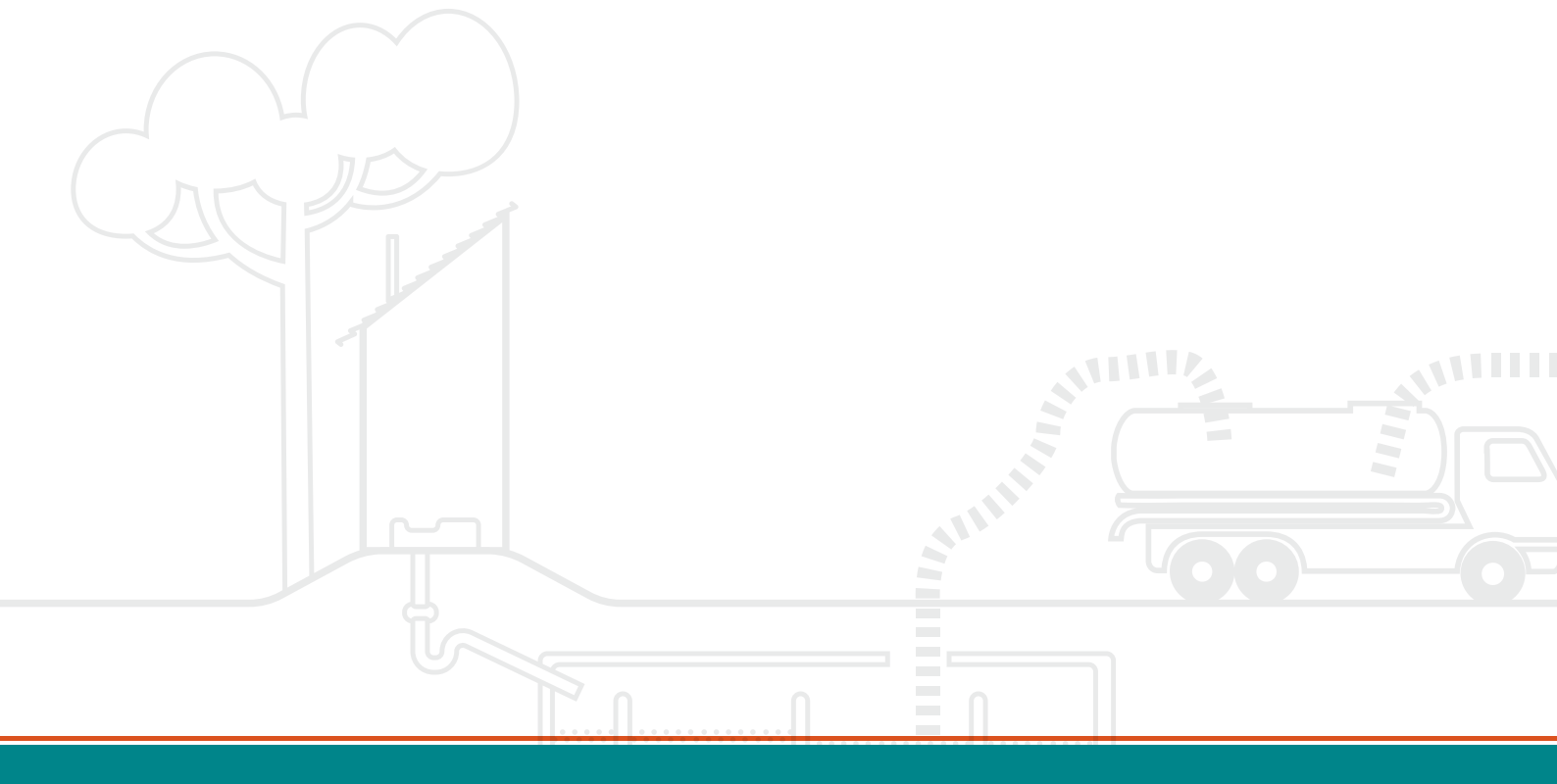
- Identification of priority stakeholders and accordingly training modules for Capacity Building
- Development of a Normative Framework – For Capacity Building at State Level
- Standardization of priority training modules – appropriate standardization of content with flexibility. for customization based 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	Faecal Sludge And Septage Management — Orientation Module for Uttarakhand
Purpose	There are centralized and decentralized / on site systems of treatment of wastewater and septage. While conventional sewerage may be a comprehensive system for sewage collection and transport, it also is a highly resource intensive technology for CapEx and OpEx. Consequently, high capital cost and significant O&M cost of this system inhibits its widespread adoption in all sizes of urban areas. Decentralized FSTP are emerging as solutions to the challenge of addressing safe treatment and disposal of faecal sludge and septage. However, it does not imply that all small towns and cities need FSTP infrastructure. The Handbook attempts to instil a rational perspective for tackling urban sanitation challenge, without being prescriptive or offering single technology solutions. This is compendium of planning process and technologies involved in treatment of faecal sludge and septage considering solid and liquid treatment.
Target Audience	Officials from State and Urban Local Bodies – Executive Officers, Junior and Mid-Level engineers, Sanitary Inspectors, SBM and AMRUT nodal officers, Elecetd Representatives
Learning Objectives	The module aims to convey the following learning: • Understanding the sanitation situation and need of FSSM at Uttarakhand state. • Understanding the different approaches and its applicability under different constraints to tackle these problems which covers the planning process of FSSM and its technical aspects. • Faecal sludge and septage quantification, characterization, emptying and conveyance and treatment solutions and its situation specific selection. • Designing of faecal sludge and septage treatment technologies and their applicability under different contexts. • Assessment and planning both technical and financial for FSSM at the city level.
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 any state depending on the profile of the participants, their areas of interest and time available for the training.
Duration	The module is for one day orientation training. 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

Activity	Material /Methods
9.30-10.00 hours	Introduction of Participants
10.00-10.30 hours	Introduction of participants & expectations
10.30-11.15 hours	Setting the context of FSSM for Uttarakhand State
11.15-11.30 hours	Tea/Coffee Break
11.30 –12.15 hours	FSSM policy and Septage Management Protocol, GoU
12.15 –13.00 hours	Challenges in Sanitation Systems in Uttarakhand
13.00-14.00 hours	Lunch Break
14.00-14.45 hours	Emptying and Conveyance of Faecal Sludge and Septage
14.45-15.45 hours	Treatment of Faecal Sludge and Septage
15.45 -16.00 hours	Tea/Coffee Break
16.00-17.00 hours	Planning and Financial aspects of FSSM
17.00 -17.30 hours	Wrap up - Feedback and closure



Contents

Session

01

Urbanisation and Sanitation

Contents

Setting the context	State perspective	Policy and programs
National perspective Introduction to sanitation- Objectives	Demographics Urban Local Bodies Sanitation status	National FSSM Policy, Septage Management Protocol

Learning objectives

- Understanding urbanization and its impact on sanitation
- Understanding the types of waste and their origin and constituents
- Realizing the sanitation situation in Uttarakhand state
- Introduction to flagship program of GoI to manage sanitation at different scales
- Institutional framework and policies existing in Uttarakhand state pertaining to FSSM

In this session we are trying to understand that it is impossible to match the pace of improving sanitation with the pace of urbanization in India. Haphazard urbanization is putting stress on the existing sanitation infrastructure and hence there is need of solutions which are quicker to deploy and helps in achieving total sanitation step by step. In order to conceptualize these solutions, we need to understand the types of waste, their nature and origin. At the same time, we will try to understand how the programs and schemes launched by central government are helping to take reach to our goals one step at a time. We will discuss the sanitation status in Uttarakhand state – Water supply, access to toilet, dependence on septic tanks and collection of wastewater and sewage. Lastly, we will see the institutional framework for managing water resources in the state of Uttarakhand and focus on the Septage Management Protocol released by Government of Uttarakhand.

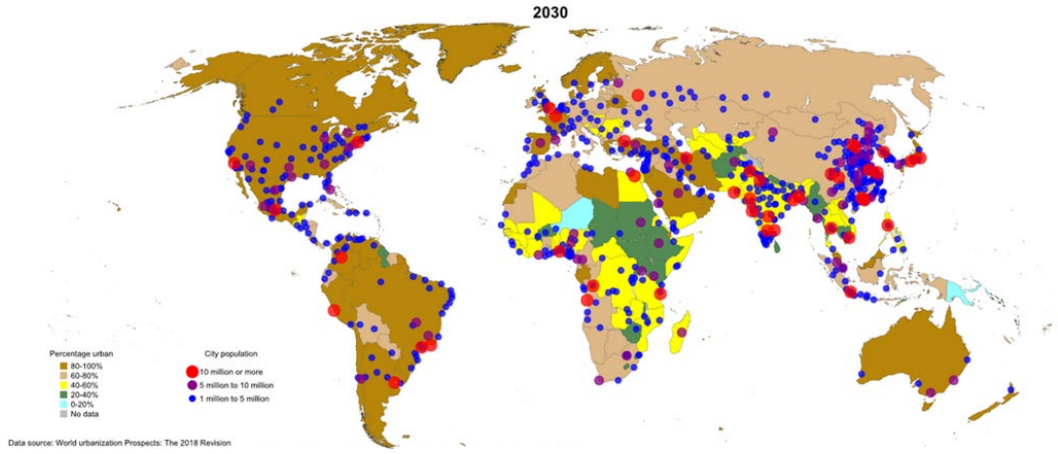
What does the picture depict? Can you pin point certain things and draw inference from the picture?

The person seems to be well to do, yet he is resorting to open defecation in the fields. Lower access to toilet is not the result of poverty but it is the way of life for certain people. Behavioral practices and strong IEC campaigns are required in order to achieve ODF in real sense.

What does the picture depict? What kind of toilet is it? Who is the person in the picture? What is his job? Does he have the right equipment to do his job? Is his health at risk by doing this job? Will you use this toilet? If no, then why?

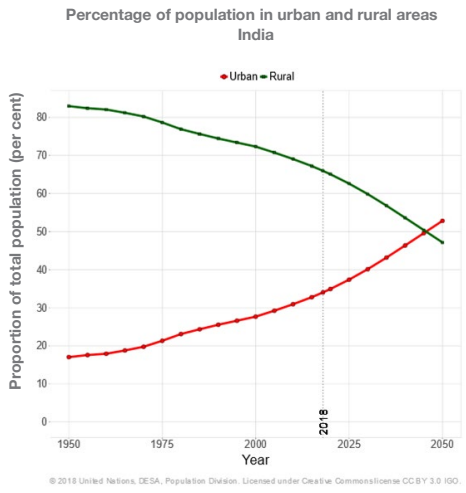
Having access to sanitation infrastructure as the one shown in picture is one thing; however, maintaining it and keeping it in proper working condition helps to achieve the real goal of ODF. Without proper operation and maintenance of the sanitation infrastructure, it is very difficult to reach to the ultimate objective of practicing good sanitation.

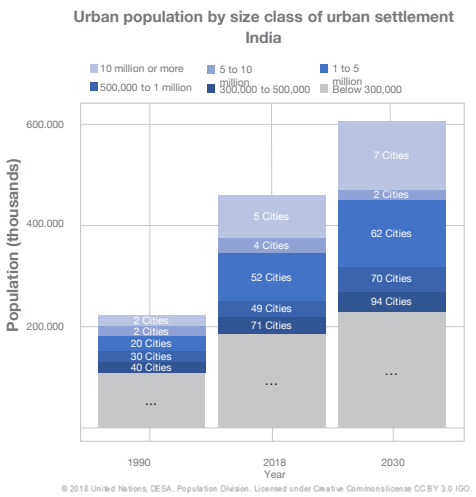
Urbanization prospects



This slide shows the pace at which India has undergone urbanization as compared to other countries in the world. Although, India will have less percentage of population living in the urban centers, it will host to host to many cities having population more than 10 million. The pace at which the urban centers are experiencing population explosion, it is very difficult to provide adequate municipal services such was drinking water, access to toilet and safe management of solid and liquid water. Add to this the population migrating from the rural to urban centers in search of better employment opportunities puts more stress in the infrastructure.

Urbanization in India





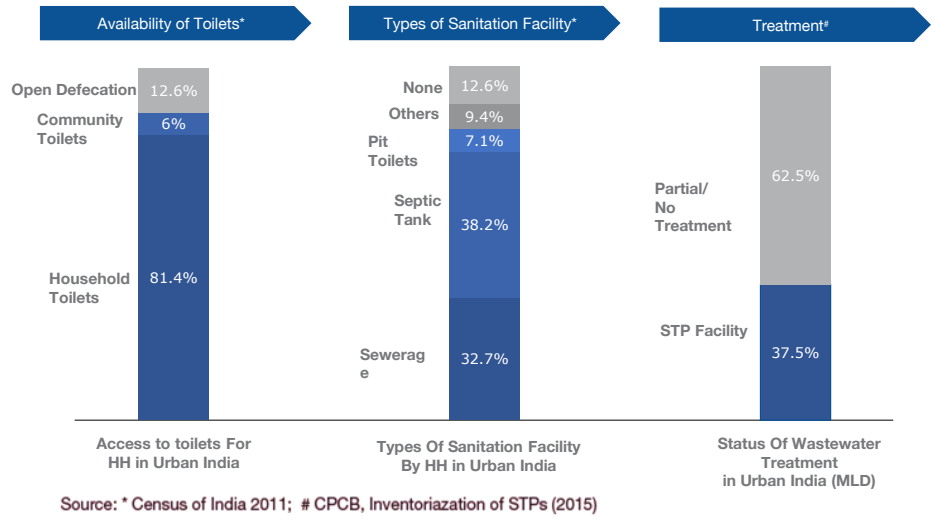
The graph in the left shows that percentage of population residing in the rural areas is decreasing and by 2045 more than 50% of the population in India will be living in urban areas. It is expected that in less than a decade time, India will have seven cities with more than 1 crore population and 62 and 70 cities with population between 10 to 50 lakh and 5 to 10 lakhs respectively.

Sanitation facts INDIA (2011 census)

- **18.6%** urban HHs have **NO TOILETS!**
- **32.7%** of urban HHs have access to **PIPED SEWER!**
- **38.2%** HHs are connected to **SEPTIC TANKS.**
- **6%** of HHs depend on **COMMUNITY TOILET!**

According to the Census of 2011, less than 20% urban households had no access to toilets. However, only 33% households were connected to sewers and 38% were connected to septic tanks. These numbers might seem to be okay, but taking a comprehensive look at the status of sanitation in urban India reveals something different.

Status of Sanitation in Urban India



Source: * Census of India 2011; # CPCB, Inventoriazation of STPs (2015)

The percentage might be deceiving, but when we calculate the absolute numbers, the picture is horrifying:

- 37 million people practice open defecation in urban India.
- 28 million people with individual toilets use insanitary methods of disposal of waste.
- 43,117 MLD of untreated wastewater is discharged in water bodies or on land.

Uttarakhand: Urban growth rate

Census Years	Total Population	Urban Population	Urban Content (%)	Decadal Growth (Urban) (%)
1901	1,979,866	154,424	7.80	—
1911	2,142,258	179,332	8.37	16.13
1921	2,115,984	191,660	9.06	6.87
1931	2,301,019	195,797	8.51	2.16
1941	2,614,540	270,503	10.35	38.15
1951	2,945,929	400,631	13.60	48.00
1961	3,610,938	495,995	13.74	23.80
1971	4,492,724	734,856	16.36	48.16
1981	5,725,972	1,149,136	20.07	56.38
1991	7,113,483	1,634,084	22.97	42.20
2001	8,479,562	2,170,245	25.59	32.81
2011	10,116,752	3,091,169	30.55	42.43

Source: Office of the Registrar General and Census Commissioner, 2013

- Urban development is result of fast expansion of road linkages
- Urban population increase is mainly due to rural – urban migration in search of employment (Tiwari et. al, 2018)
- Migration from Lower Himalayan Region to Terai and Doon Region is significant
- Growth in tourism industry is providing employment opportunities to locals in urban centres

It is observed and documented that urban development in Uttarkhand is quite significant because of expansion of road network and linkages of settlements. The urban population has increased mainly due to population migration from rural parts to urban centres in search of employment. It has been seen that migration is significant from lower Himlayan region to Terai and Doon region. Tourism is scaling up in Uttarakhand every year and this is improving the employment opportunities in the urban centres.

Need for a Paradigm Shift

PAST
TRADITIONAL APPROACHES

- Master planning/ investment only for **centralized systems**
- Financed by **central government/loans**
- **Wealthy/business districts** prioritized
- **Limited coverage**
- **Sustainability challenges** for O&M
- **Resource recovery not considered**
- No **performance management**
- **On-site, small network not considered**

PRESENT
NSS/FSSM APPROACHES

- **Often standalone pilots**, not mainstream
- **NGO / pilot financed**
- FSM value chain/faecal sludge treatment plants
- **Poor communities** targeted but often missed
- Business models often **unable to scale**
- Limited **professional capacity**

FUTURE

CWIS focuses on promoting public service approaches to ensuring everyone in an urban area is served **by safe, equitable, and financially viable sanitation service systems.** This means systems are designed to **reach the poor and to ensure human waste is safely managed** along the whole sanitation service chain

Source: https://adb.eventsair.com/online-adb-sanitation-dialogue-2021/resources

The slide showcases a trend in the changing of sanitation approach moving from traditional/ conventional to NSS and CWIS. In the past 8 years NSS has gained a huge momentum but the problem is the scale and being pilot projects run by NGOs. To tackle the gap, CWIS is promoted. Being a public service approach, it helps in establishing safe, equitable and financial viable sanitation services. Thus ensuring marginalized and vulnerable group can also benefit with sanitation services.

Principles of Citywide Inclusive Sanitation (CWIS)

To achieve the following outcomes for sustainable changes in sanitation management:

Source: https://adb.eventsair.com/online-adb-sanitation-dialogue-2021/resources

There are seven Principles of CWIS which advocate:

1. Everyone should get the benefit including poor
2. In the Planning stage gender & social equity needs to be considered. They need to be empowered, involved in decision making for what type of system they want to have
3. When we talk about safely managed we need to look and take into consideration each and every component of the value chain. It also includes the safety of the sanitation workers
4. Inclusive mandate to authorities to act
5. Strong mechanism with regard to the system to be established. Ranging from hardware should it be sewered or non-sewered based on the local area need.
6. Systems implemented should be backed with strong business models thus establishing the sustainability needs.
7. Political will is very essential and at the same time resources (fund etc) need to be built under it.

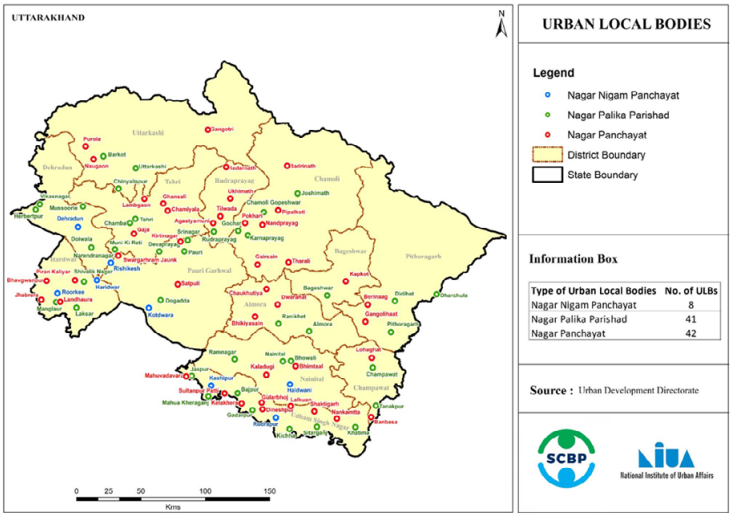
CWIS Framework: Promoting a public service approach

Source: https://az659834.vo.msecnd.net/eventsairseasiaprod/production-adb-public/f08330cb31114d17ab6dba7474566f9f
Schrecongost, A., et al. (2020). Citywide inclusive sanitation: a public service approach for reaching the urban sanitation SDGs. *Frontiers in Environmental Science*, *8*, 19.

To achieve the CWIS outcomes (equality, safety and sustainability) which are inline with the SDG goal 6 (directly) and also caters to SDG11, 5 and 3, we need to have the institutional system in place.

The core outcomes of a system are valid for everyone in an urban area, not just those in sewered areas. However they will vary by country/city. Thus to achieve these outcomes, system must demonstrate functions of a public service delivery system for sanitation, relevant across diverse city contexts – who will be the response authority(ies) for executing mandate for inclusive urban service delivery. The legal authorities must be accountable for performance, planning and managing resources with transparency and accountability. For e.g. how will the funds be allocated from centre to state. Also consideration of range of technologies and business models catering to the service needs for all.

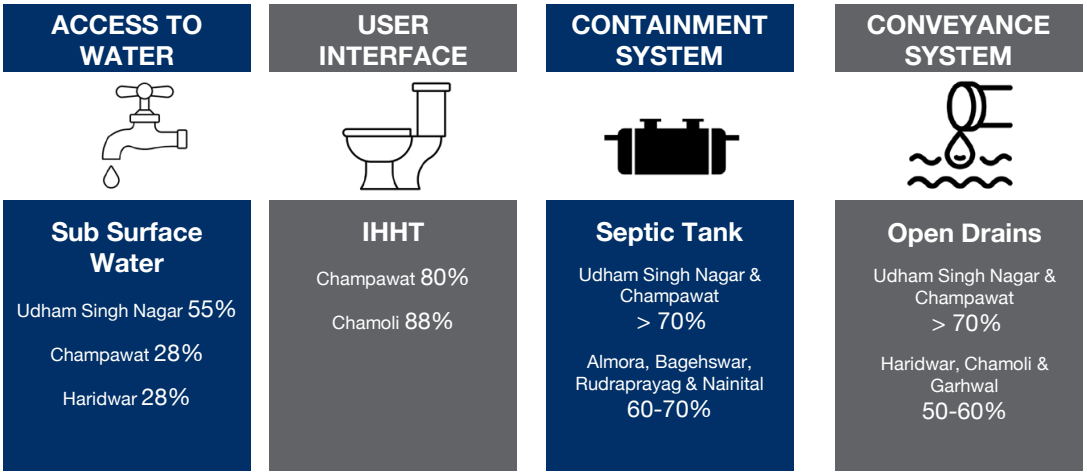
Urbanization



- Maximum no. of ULBs are situated in the Terai and Doon region of Uttarakhand
- Udham Singh Nagar District has largest population inflow because of industrialisation and agriculture
- Dehradun is the winter capital has largest population
- Gairsain is the summer capital
- Haridwar District has largest floating population

As a result of urban expansion, there is increase in 14 ULBs- 2 Nagar Nigams, 10 Nagar Palika Parishads, 2 Nagar Panchayats. Maximum number of ULBs increase is observed in the Terai and Doon region. Udham Singh Nagar has experienced large inflow of population because of industrialisation and agriculture. Dehradun is capital of the Uttarakhand State and hence has all the headquarters of the administrative departments and other parastatal departments. Dehradun district has got second largest population increase followed by Haridwar which experience large number of floating population on annual basis due to its religious importance.

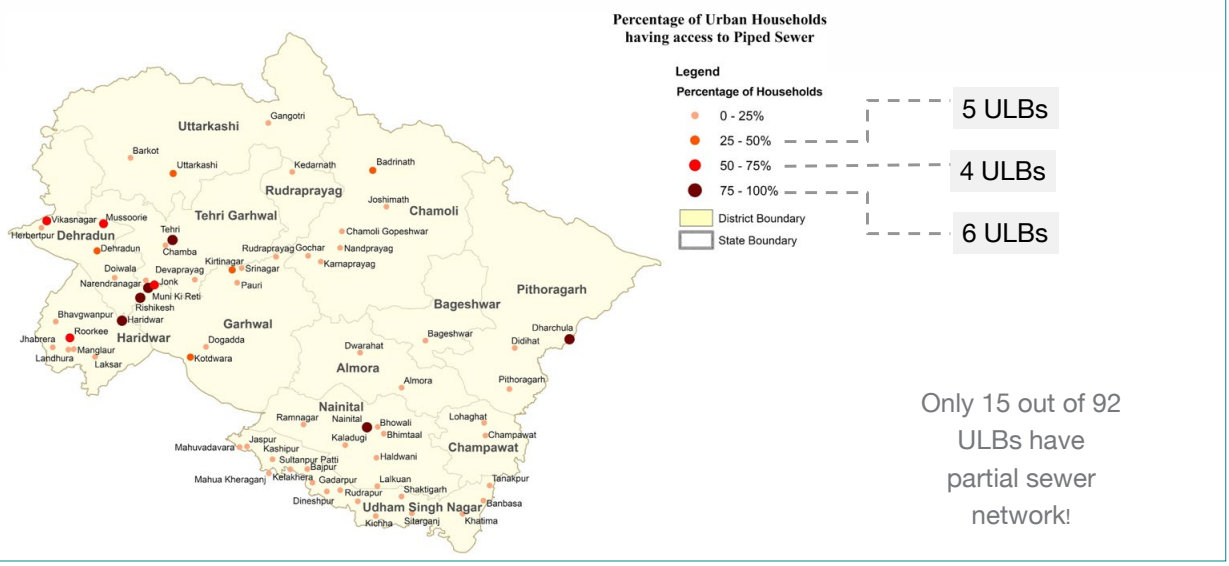
Sanitation Status



Management of water resources consist of water supply, water use, collection – conveyance of wastewater and treatment of it. If at any stage mismanagement happens, it results not only into waste of resource but also potential of contamination of other water resources. Uttarakhand has good access to water. Mostly the water supply is through taps, however, 2011 census suggests that 55% of the households in Udham Singh Nagar depend on ground water for their fresh water needs. Access to toilet is also quite good, which means black water is generated from these flush toilets. Most of the ULBs do not have sewerage systems and hence the toilets are connected to septic tanks. In Udham Singh Nagar and Champawat, more than 70% households are connected to septic tanks. The effluent from the septic tank and grey water from the households in then discharged into the network of open and closed drains. In Udham Singh Nagar and Champawat, more than 70% households are connected to open drains.

Thus it can be observed that mismanagement of liquid waste in district such as Udham Singh Nagar will have much higher negative impact on the environment and water resources.

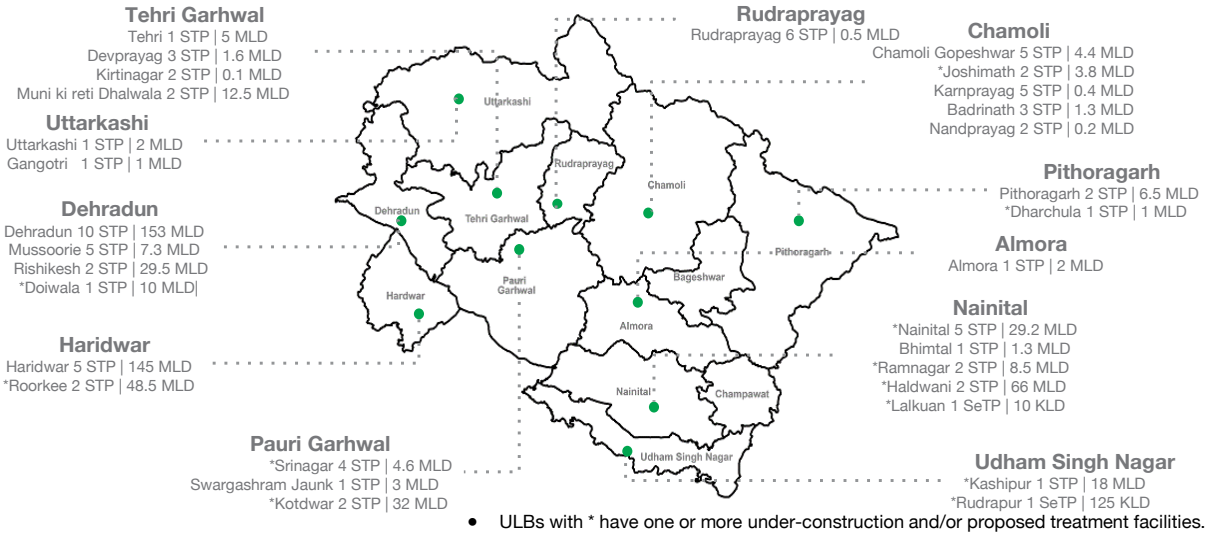
Sewerage System



Out of 92 ULBs, only 15 have sewerage system for collection and conveyance of wastewater. None of ULB has 100% coverage of sewerage system. The development of sewerage schemes is slow as the implementation of it is quite complicated and challenging in undulating terrain. The implementation of the sewerage schemes in undulating terrain in cost intensive.

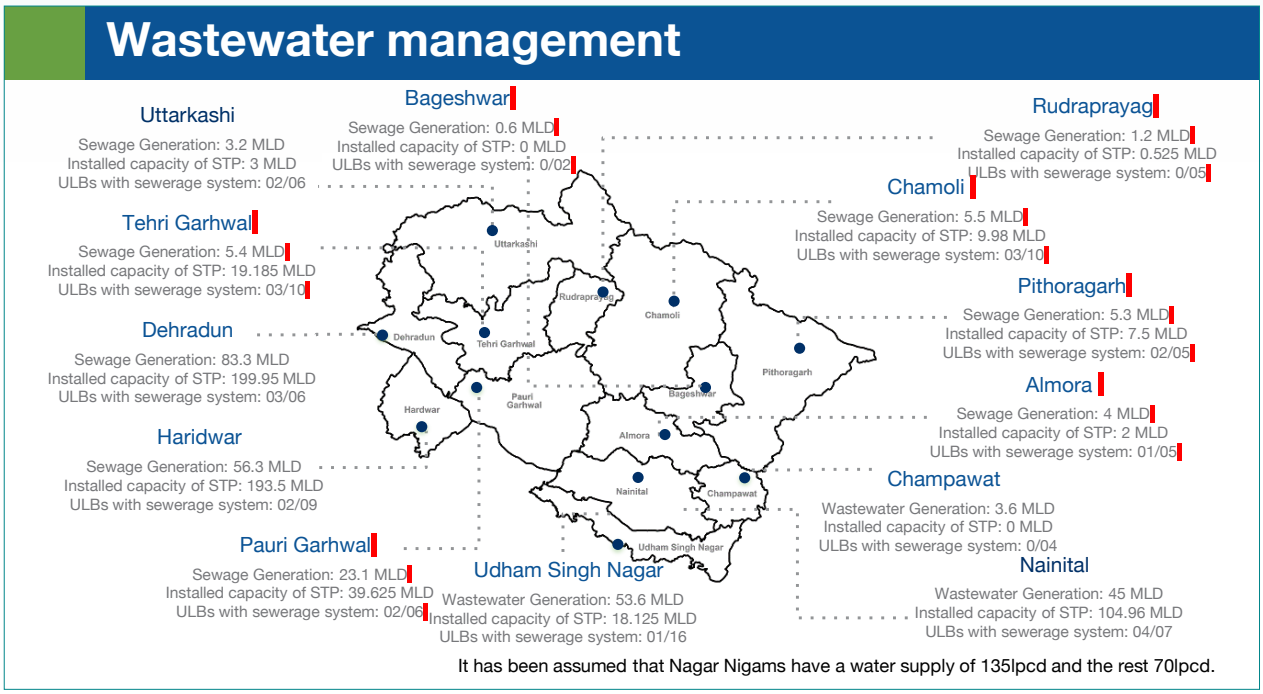
There are also cases where 100% connection to the existing sewerage system could not be achieved due to reasons such: (1) septic tank/toilet is located in such a way that it cannot be connected to the sewerage, (2) households are not ready to pay the charges levied for connection.

Treatment plants (as of May 2021)



- ULBs with * have one or more under-construction and/or proposed treatment facilities.
- In addition, some CETPs and decentralised STPs also treat domestic wastewater
- Many STPs in small towns are I&D plants and they don't have a sewerage network.

As of May 2021, there are 82 sewage treatment plants in Uttarakhand with a accumulative capacity of upto 598 MLD. Close to 61 STPs are completely operational and the rest are either under construction, commissioning or rehabilitation under AMRUT/Namami Gange Scheme.



A quick glance at the liquid waste management across Uttarakhand state shows that there is absolutely no management of liquid waste happening in districts such as Udham Singh Nagar and Champawat. There are no functional sewerage schemes and STPs which are collecting and treating the wastewater. Thus, the drains that carry the wastewater by gravity to the nearest surface water body act as non point source of pollution.

In the districts of Nainital, Uttarkashi and Haridwar there are sewerage schemes to collect and convey the wastewater, however the sewage treatment plant capacities are not adequate to treat it. Result of which now the outfall of the sewerage becomes point source of pollution to the water body. This is much more harmful as the it affects the health of the river.

In Dehradun, the STP design capacity is far more than the sewage generation. Thus there is a huge potential to co treat the septage at the STP if it is done scientifically with understanding of characterisation of septage.

Sanitation

Definition
Safe management of human excreta and wastewater

Objective
To reduce faecal – oral disease transmission

Components

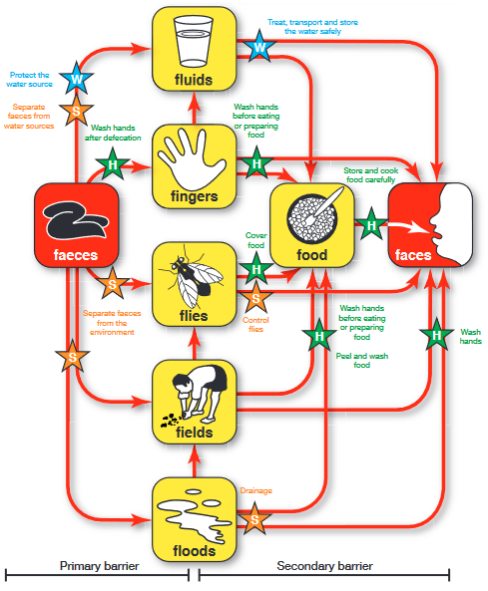
Hardware
Toilets, Sewers, STPs

Software
IEC campaigns,
Behaviour change

Basic definition of Sanitation is safe management of human excreta and wastewater. To safely manage these, one needs hardware components such as toilets, drainage network and treatment plants and software components such as strong IEC and behavior change campaigns. It is only through such campaigns that people realize the importance of the infrastructure such as toilet and practice proper sanitation practices. The overall objective of management of human excreta and wastewater is to reduce or better eliminate faecal – oral disease transmission. This transmission path is clearly depicted in F Diagram.

F Diagram

- Shows pathway from faeces to faces.
- Depicts movement of pathogens from faecal matter to the new host.
- **Primary barrier** essentially stops the spread of pathogens from faeces.
  - Consists of providing access to toilet and developing hygiene habits.
- **Secondary barrier** essentially stops the transmission of pathogens to the food.
  - Consists of combination of access to safe water, food and hygiene habits



The F Diagram as shown in picture shows, how the disease is transmitted from one person to another. To stop this transmission, one needs to set up barriers as shown in the picture. The

primary barrier is a toilet and safe containment system which restricts the vectors from getting in contact with the faecal matter. The secondary barriers are personal WASH habits. Maintaining personal health and hygiene ensures that even if vectors do come in contact with faecal matter or cross contamination happens, the same is not transmitted to food that we eat. Such F Diagrams are quite useful while conducted the IEC campaigns to spread awareness of building, using and maintaining a toilet.

Types of waste

Black water

- Origin- Water closets
- Constituents- urine, faeces, flushing water, anal cleansing water and material

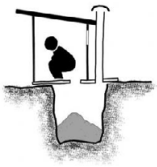
Grey water

- Origin- Bathrooms and domestic kitchen
- Constituents- rinsing water, surfactants, suspended solids

Sewage is a mixture of black and grey water

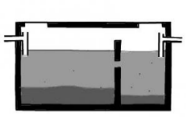
Liquid waste originating from domestic household can be classified depending on its point of origin as shown in the slide. Black water is termed as the flushing water coming from the toilet which may contain urine, faeces, flushing water, anal cleansing water and/or material. Grey water originates from bathrooms and domestic kitchen which mostly consists of rinsing water with surfactants and solids. Sewage or wastewater is mixture of black and grey water.

Types of waste



Faecal sludge

- Origin- pit latrines, poorly designed soak pits, defunct leach pits
- Constituents- urine, excreta, anal cleansing water/material



Septage

- Origin- onsite containment systems (septic tanks)
- Constituents- digested sludge, water, scum

Faecal sludge is the human waste such as excreta, urine and anal cleansing water/material contained in the pit of the pit latrine or a poorly designed soak pits, septic tank. Septage is the content of the onsite containment system such as septic tanks which is desludged after a period of two to three years. It is mixture of the scum, liquid and digested sludge settled in the tank.

What is faecal sludge & septage?

- All liquid and semi-liquid contents of pits and vaults accumulating in on-site sanitations installations
- High Total Suspended Solids (TSS) and Total Dissolved Solids (TDS) than wastewater

Faecal sludge and septage differs from sewage because of the percentage of solids present in it. Faecal sludge and Septage has considerably high TSS and TDS, thereby by having very high BOD and COD as compared to sewage. Faecal sludge is termed as the sludge which has not undergone much digestion in the containment system such as pits or heavily used community and public toilets. The CT/PT whose septic tank needs to emptied at higher frequency, then it had more undigested solids and substantially higher suspended solids which needs stabilization. Hence faecal sludge is yellowish in color and needs higher degree of treatment.

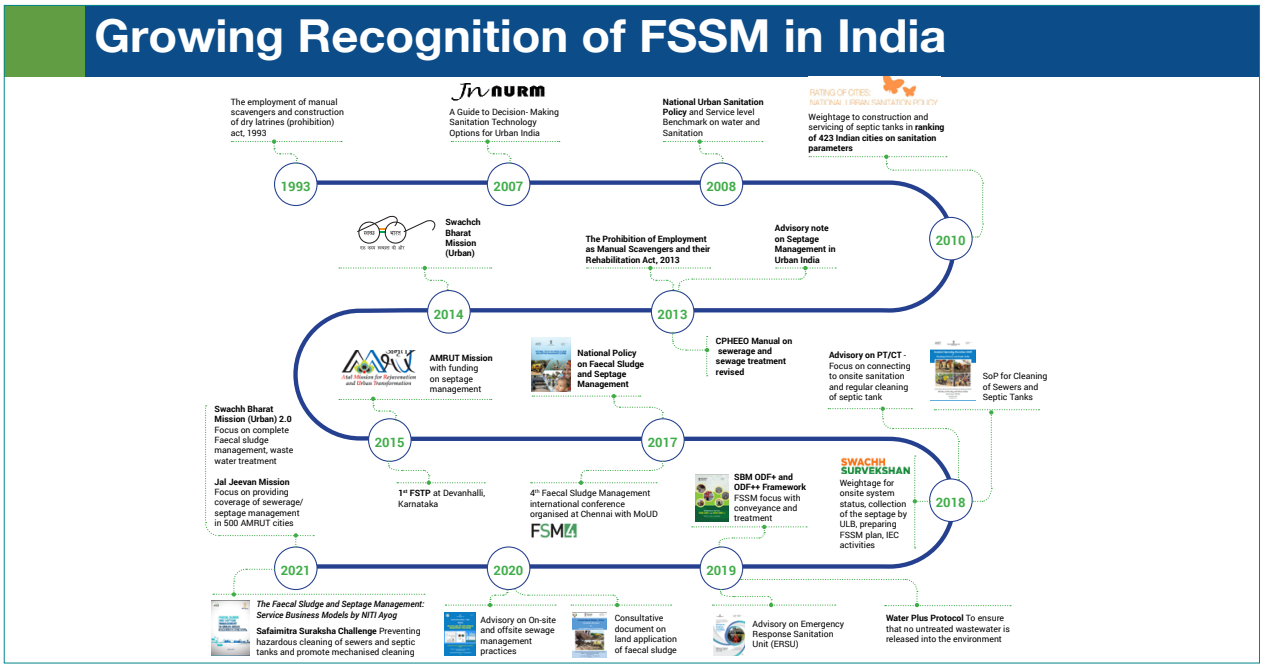
Faecal sludge and Septage

EAWAG Sandec Training Tool: Faecal Sludge Management

- Faecal sludge- fresh and yellowish, higher BOD, needs higher degree of treatment
- Septage- well digested and blackish, lower BOD, needs lesser degree of

Pictures show the faecal sludge on the left and septage on the right. You can see the difference in the color by naked eye.

3. Policy and programs



FSSM is fast gaining traction in India. In 2007, under JNNURM, a guide to decision making sanitation technology options for urban India was launched under which onsite sanitation systems were recognised. In 2010, under the National Urban Policy, rating of 423 Indian cities was done on various sanitation parameters. In 2013, 'The Prohibition of Employment as Manual Scavengers and their Rehabilitation Act' came which focussed on safety protocols of sanitation workers. Also, the CPHEEO guidelines were revised from sewerage and sewerage treatment to sludge treatment and septage management and an advisory note on septage management was launched. In 2014, sanitation gained momentum with the launch of Swachch Bharat Mission and Amrut Mission with funding on septage management by the government. In 2015, the first FSTP was set up in Devanhalli, Karnataka. In 2017, National Policy of Faecal Sludge and Septage Management was launched. In 2018, under the Swachch Sarvekshan, weightage for onsite system status, collection of septage by ULBs, preparation of FSSM plans and IEC activities were considered. In 2019, MOHUA launched the SBM ODF+ and ODF++ framework with a focus on conveyance and treatment. An advisory on on-site and off-site sewage management was launched in 2020 thriving the FSSM momentum continuously.

Manual scavenging act

The Employment of Manual Scavengers and Construction of Dry Latrines (Prohibition) Act - June 5th, 1993

- Manual cleaning, carrying, disposing- handling in any manner
- Human excreta in insanitary latrine or in an open drain or pits, railways tracks

The Prohibition of Employment as Manual Scavengers and their Rehabilitation Act - September 18th, 2013

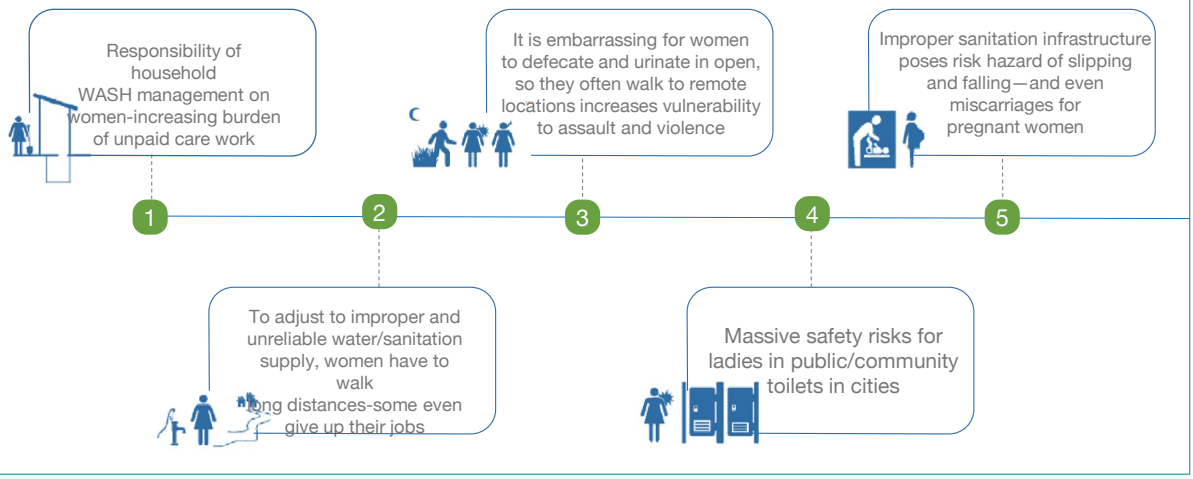
- Septic tanks, gutters and sewers

Manual scavenging act was drafted and launched in 1993, in order to prohibit manual cleaning, carrying and disposing of human excreta by a person. The act specifically mentioned that human intervention is needed to clear excreta in case of insanitary latrines (dry latrines), open drains or pits and railway tracks as the railway coaches did not have containment unit for its toilets. However, this act got amended in 2013 which now stated that even cleaning of septic tanks, gutters and sewers which involves direct contact of a person with the waste is not allowed. Thus, intending to put a complete end to the manual scavenging involved across the sanitation system.

Gender challenges

Different Groups experience Sanitation differently

Impact of inadequate sanitation on women and girls in disproportionately high



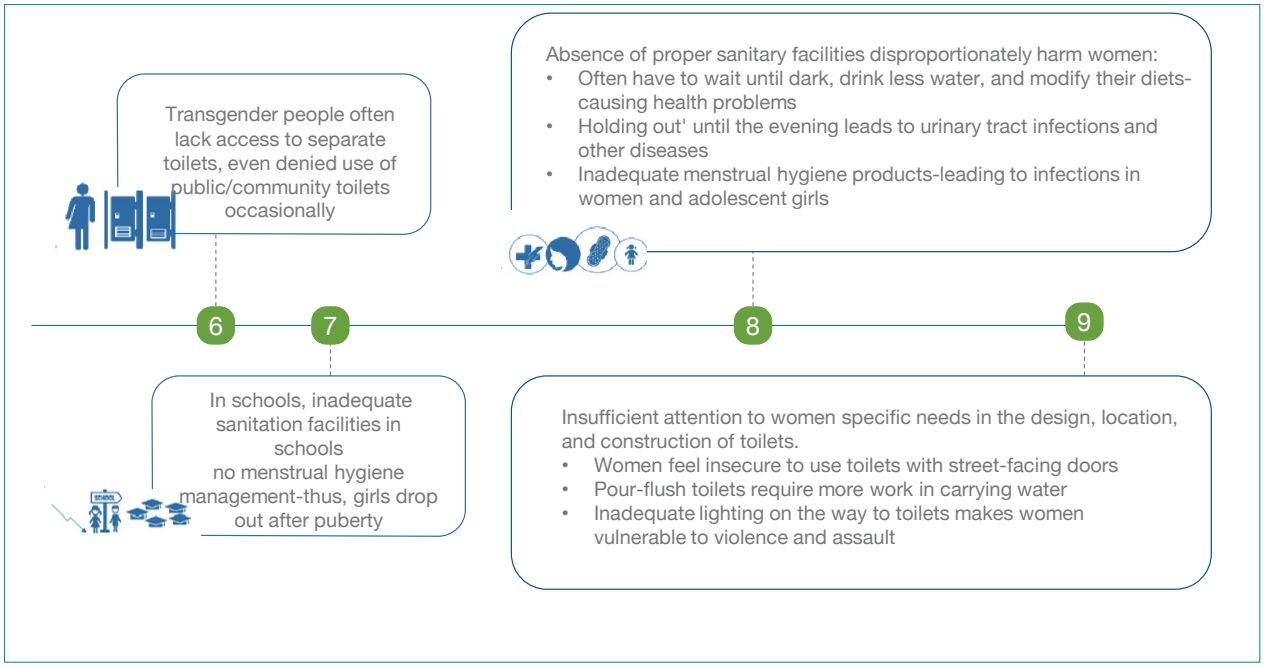
Source: ASCI, Hyderabad

Challenges

- Responsibility of household WASH management on women – increasing burden of unpaid care work
- To adjust to improper and unreliable water / sanitation supply, women have to walk long distances – some even give up their jobs
- It is embarrassing for women to defecate and urinate in open, so they often walk to remote

locations – increases vulnerability to assault and violence

- Massive safety risks for ladies in public / community toilets in cities
- Improper sanitation infrastructure poses risk hazard of slipping and falling – and even miscarriages for pregnant women
- Transgender people offer lack access to separate toilets, even denied use of public / community toilets occasionally
- In schools, inadequate sanitation facilities in schools, no menstrual hygiene management – thus, girls drop out after puberty
- Absence of proper sanitary facilities disproportionally harm women
- Insufficient attention to women-specific needs in the design, location and construction of toilets



Source: ASCI, Hyderabad

Social Entrepreneurship in FSSM - The case of Odisha

Social Entrepreneurship in FSSM

Best Practices: Under Odisha National Urban Livelihoods Mission engagement of women SHGs in the O&M of community toilets

- Berhampur city - Engaged **26 Self Help Groups (SHGs)** for O&M of **36 community toilets**.
- SHGs also engaged in motivating households for **mechanised cleaning of septic tanks** for which they are given incentives based on every desludging service.
- Balasore, Bhadrak, Bhubaneswar and Cuttack adopted similar concept.

Source: EY, Odisha

- Mainstreaming vulnerable populations through livelihood opportunities within the sanitation sector is crucial for their empowerment and progress. Among the successful social entrepreneurial activities undertaken under the Odisha National Urban Livelihoods Mission are engagement of women SHGs in the O&M of community toilets.
- Berhampur has taken a lead by engaging 26 Self Help Groups (SHGs) engaged in the O&M of 36 community toilets. SHGs in Berhampur are also engaged in motivating households for mechanised cleaning of septic tanks for which they are given incentives based on every desludging service. Other towns such as Balasore, Bhadrak, Bhubaneswar and Cuttack have adopted similar interventions.

Open defecation free

ODF (2014)

- At any point of the day, not a single person is found defecating in the open

ODF+ (2019)

- All CTs and PTs are functional and well maintained

ODF++ (2019)

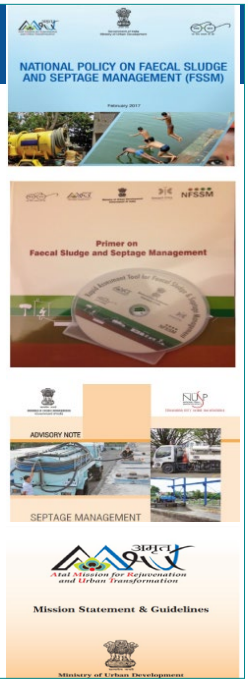
- Faecal sludge/septage and sewage is safely managed and treated, with no discharging and/or dumping of untreated faecal sludge/septage and sewage in drains, water bodies or open areas

Subsequent to the introduction of Manual Scavenging Act, Government of India in 2014 took up a huge task of eliminating open defecation in India. In terms of percentage, the number might be misleading, but back in 2014 the absolute number of persons practicing open defecation was huge. Swachh Bharat Mission was launched and one of its focus in was making urban and rural habitation open defecation free (ODF). To do this the policy specifically mentioned that all the households should have access to toilets in the form of Individual Household Toilet (IHHL) or a Community Toilet (CT). It also mentioned that all the insanitary latrines- toilet having single pits or which are directly connected to drains should be converted into sanitary toilets by linking them to twin pits (soak pit) or a septic tank.

Creating infrastructure in the form of toilet and containment system is one part, however soon the government realized that maintenance of the infrastructure is also equally important if one needs to realize the ultimate of becoming of sustaining ODF status. This was termed as ODF +. At the same time, it was also realized that without the management of the waste originating from the households and containment units the objective of sanitation cannot be ensured. Hence ODF ++ was concept was brought forward, which said that faecal sludge, septage and sewage should also be safely managed at the local government level.

Recognition to FSSM

- National policy on FSSM by MoHUA, GoI
  - Leveraging FSSM to achieve 100% access to safe sanitation
  - Achieving integrated citywide sanitation, Sanitary and safe disposal, Awareness generation and behaviour change
- National declaration on Septage Management by MoHUA, GoI
- One of the major thrust areas under AMRUT
  - Focus on sanitation services delivery to the citizens, Incentives for achievement of reforms, States to prepare their own FSSM policy
  - Financial allocations under AMRUT for FSSM related projects
- Primer on FSSM under NFSSM Alliance
- Septage Management Advisory of GoI provides guidelines, standards and resources for preparing plans

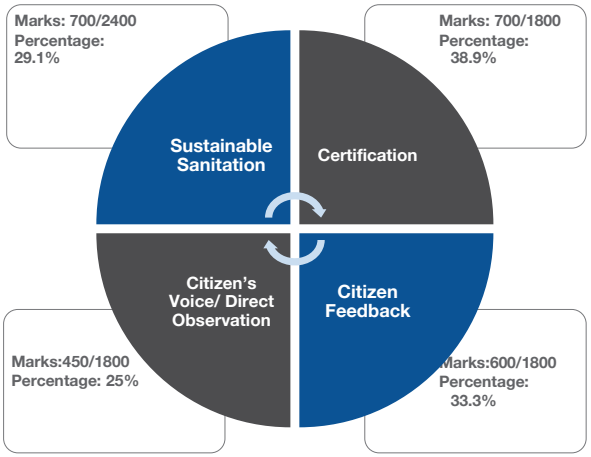


In 2016 FSSM got a formal recognition in different forms. Along with the National Policy on FSSM, government provided plenty of guidelines, standards and resources in the form of primer and other publications. FSSM was also propagated under AMRUT. Since one of the focus of AMRUT was sanitation services delivery, it was soon realized that cities under AMRUT will not be able to go for sewerage and STPs due to local conditions and hence financial allocations towards FSSM were allowed once the state prepared their FSSM policy and strategy.

Swachh Survekshan 2021

Capacity Building ULB officials and training of Sanitary Inspectors
Safe management of FSS or Wastewater through sewered or non sewered approach

Cleaner neighborhood, gender specific initiatives, health, livelihood, air pollution, industry, start-ups, citizen engagement in governance or any other impact



Certification for ODF
Certification for ODF+
Certification for ODF++
Certification for Water Plus

Awareness about Swachh Survekshan and City's last rank

Sustainable Sanitation under Service Level Progress – 700/2400 Marks (29.16%)

The Government of India also validated that work done under the flagship program of Swachh Bharat Mission and AMRUT through Swachh Survekshan. Swachh Survekshan also included parameters pertaining to FSSM as shown in the diagram above.

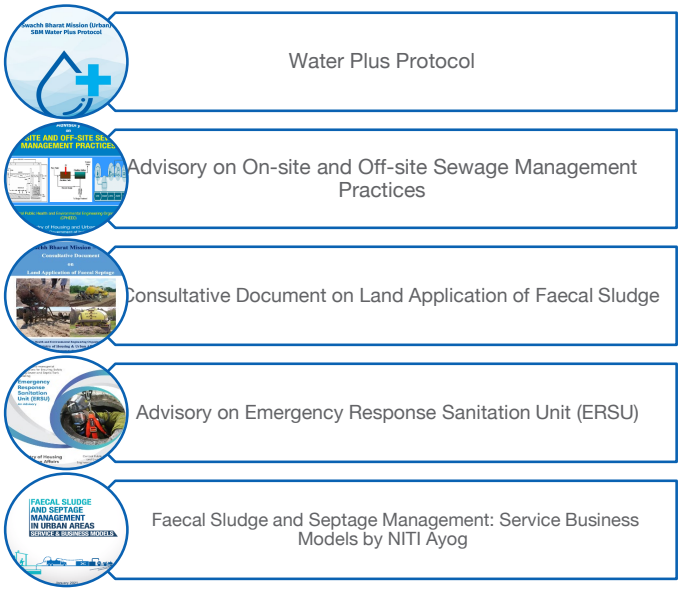
Swachh Bharat Mission (Urban) 2.0

Components	Expected Outcomes
Sanitation (IHHL, CT, PT, Urinals)	3.7 lakh additional toilets (for unserved HHs and migrant population) All cities ODF+
Wastewater Treatment (Desludging Services, I&D of Drains, STP / FSTP)	Wastewater Treatment and Faecal Sludge Management (for towns < 1 lakh population) All Cities ODF++ and 50% cities Water+
Solid Waste Management (Waste Processing Plants, Mechanised Sweeping Equipments)	Preparation of City Sanitation Plan and DPR
Information, Education and Communication (IEC)	Campaigns, Awareness Generation
Capacity Building (CB)	Training, Workshops, E-Learning Modules, Advisories, Model Tender Documents, DPR Preparation, Technologies for SWM and WWM etc. Training of Sanitation Workers in SWM and WWM

Jal Jeevan Mission (Urban)

- To achieve functional tap connections in all urban households (4378 ULBs)
- 100% Sewerage and Septage to be treated in 500 Cities
- Water secured cities through circular economy of water - 20% of water demand to be met with reused water by development of institutional mechanism
- Focus on water source conservation – Urban Water Management plan – Rejuvenation of lake and wells
- Peyjal Survekshan Competition
- 10% cost through PPP in Million Plus Cities and engagement of startups

Advisory and Guidelines



This is the latest advisory issued in 2020 by the CPHEEO, which emphasizes on integrated planning of sanitation in a city, comprising of on-site and off-site sewage management systems. In addition to this advisory, the Water Plus Protocol was issued by the government which stated that a city/ward/circle/zone can be declared Water Plus provided all wastewater released form HH, commercial establishments etc. is treated to a satisfactory level (as per CPHEEO norms) before releasing the treated wastewater into the environment.

4. Uttarakhand State Perspective

Uttarakhand

Uttarakhand
November 9th, 2000
Carved out of Uttar Pradesh

Division – 2
Districts – 13
9 located in hilly region
&
4 in plain region

Before November 9th, 2000, the state of Uttarakhand was part of Uttar Pradesh. Currently Uttarakhand is divided into two divisions that is Garhwal division and Kumaon division. Out of the 13 districts of Uttarakhand, 9 of them are located in the hilly region where as 4 i.e. Dehradun,

Haridwar, Udham Singh Nagar and Nainital are located in the plain region.

Uttarakhand

86% of the Uttarakhand State consist of mountainous region

Geographical Zones

Terai

Doons

Lesser Himalayas

Greater Himalayas

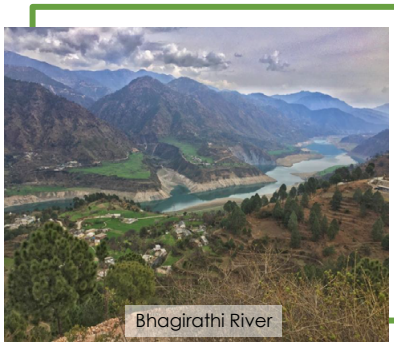
Trans Himalayas

The climate, soil, groundwater and features such as vegetation and biodiversity significantly change from Trans to Terai region

It should be noted that 86% of Uttarakhand consists of mountain with varying altitude. There are five geographical zones – Terai, Doons, Lesser Himlayas, Greater Himalayas and Trans Himalayas. The climate and hydrogeology are significantly different in these five geographical zones. The climatic conditions not only affect the population distribution and development in the state but also needs to be considered by selecting appropriate technology for faecal sludge and septage treatment.

Natural resources: Surface water

Sourced from: Water for Welfare, Uttarakhand



23 Major Rivers

12 Major Lakes

11 Major Dams

11 Major Glaciers

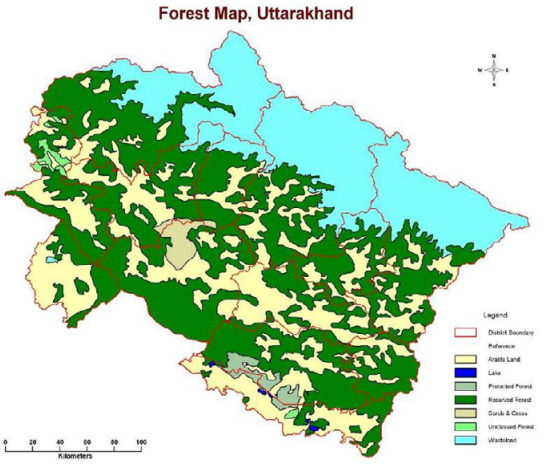
The state of Uttarakhand is quite rich in surface water. There are 11 major lakes, 23 major rivers and 12 major lakes. There are 11 major dams located on these rivers. As the map shows, there are plenty of tributaries of these rivers, which leads to numerous water sheds. Protection of these surface water bodies along with preservation of its water quality is a great responsibility

of the state. The liquid waste which is not managed well finds it way to these surface water body polluting it. The suspended solids in the septage and faecal sludge are the major contributor to the pollution to the river. These organic solids when mixed with surface water body utilizes dissolved oxygen from the water for its stabilisation thus degrading the water quality.

Natural resources: Forest

Land use types	Area (in '000 ha)	Percent
Total geographic area	5,348	
Forests	3,800	63.42
Not available for land cultivation	450	7.51
Permanent pastures and other grazing lands	192	3.20
Land under misc. tree crops and groves	389	6.49
Culturable wasteland	317	5.29
Fallow land	143	2.39
Net area sown	701	11.70

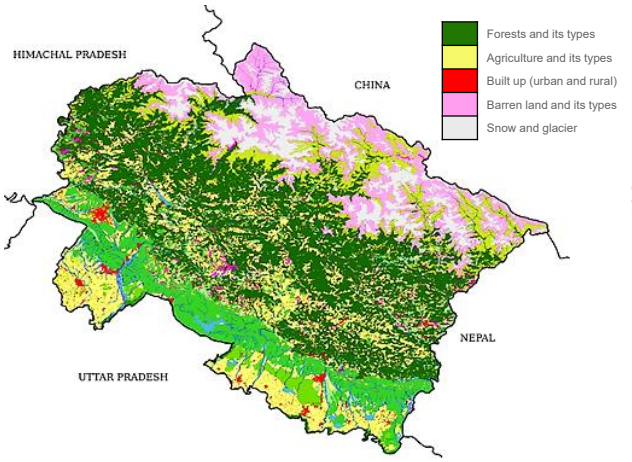
Sourced from: Uttarakhand Forest, Government of Uttarakhand



Author: Malavika Chauhan

Up to 65% of the geographical area is under forest in Uttarakhand state. Except the pastures, land under crops and groves and sown area the other types of land are not in direct contact with the humans or animals. So, up to 15% of the land is wasteland or infertile. This piece of land can be used for scientific land disposal of septage. This will not only increase the fertility but also improve the characteristics of the soil. There by helping to increase the green cover and prevent soil erosion.

Landuse pattern



60-70% Forest

20-30% Agriculture

4-8% Barren

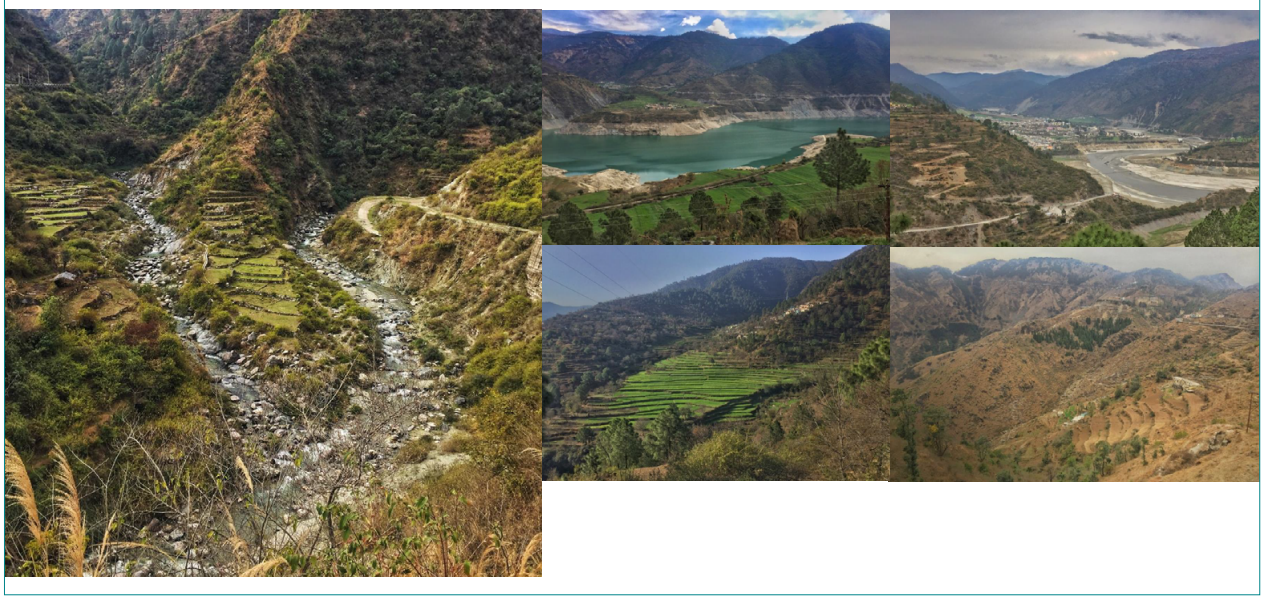
4-8% Snow

< 1% Built Up

Sourced from: Bhuvan, National Remote Sensing Centre

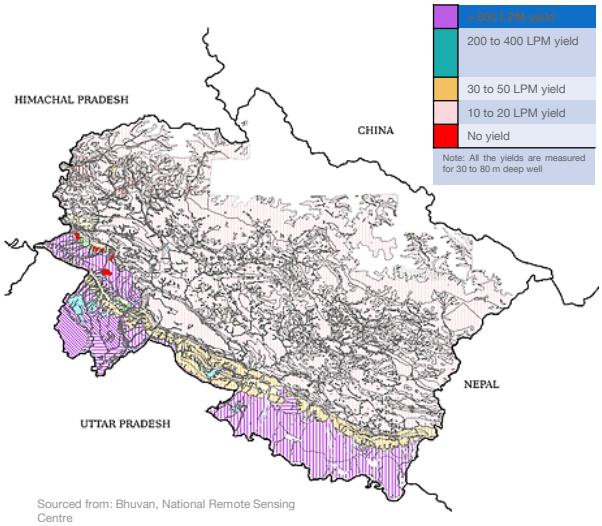
The landuse pattern affirms the fact the forest cover in Uttarakhand state is quite high. It can also be observed that forests are mostly located in the lesser and greater Himalayas. Agriculture is mostly practicing in the Terai region and plateau regions in lesser Himalayas. The built-up area in the state is less than 1%, most of which can be mostly observed in Nagar Nigams located in Udham Singh Nagar, Haridwar and Dehradun districts.

Land use



Groundwater

- High groundwater table in Udham Singh Nagar, Haridwar District
- Population distribution and industrialization
- Challenge for implementation of infrastructure project- gravity sewerage scheme

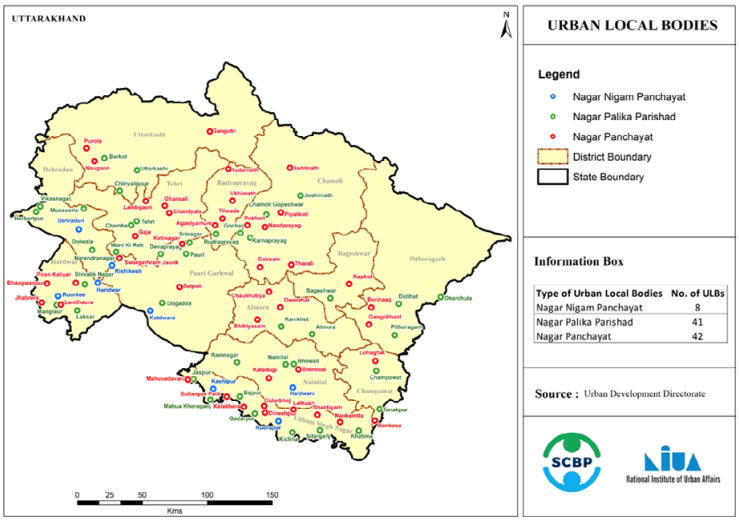


Sourced from: Bhuvan, National Remote Sensing Centre

The groundwater availability also significantly across the geography. The map shows that the groundwater yield as high as 800 lpm at 30 m depth in Udham Singh Nagar. The yield decreases significantly as one goes towards north. Although, having high groundwater availability is advantageous for agriculture and industries; it adds to the challenges during implementation of gravity sewerage schemes.

Mismanagement of onsite containment units, wastewater and dependence on surface drains for conveyance of wastewater leads to contamination of the groundwater. Groundwater is main source of drinking water in district such as Udham Singh Nagar.

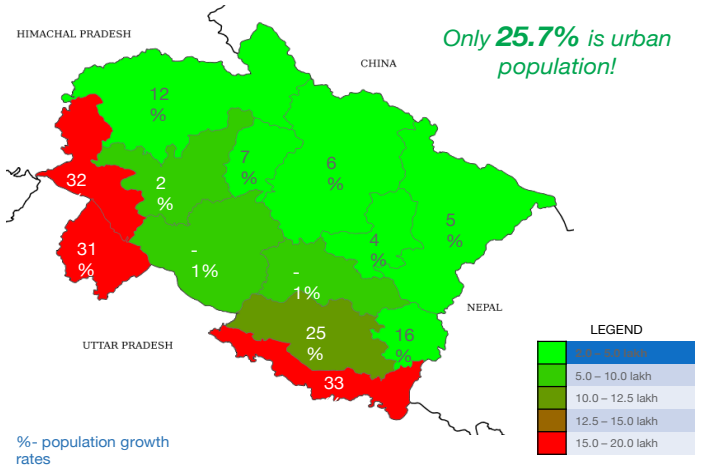
Urban Local Bodies



District	NN	NPP	NP	Total
Almora	0	2	3	6
Bageshwar	0	1	1	2
Chamoli	0	4	6	10
Champawat	0	2	2	4
Dehradun	2	4	0	6
Haridwar	2	3	4	8
Nainital	1	3	3	7
Pauri Garhwal	1	3	2	6
Pithoragarh	0	3	2	5
Rudraprayag	0	1	4	5
Tehri Garhwal	0	5	5	10
Udham Singh Nagar	2	7	7	16
Uttarkashi	0	3	3	6
TOTAL	**8**	**41**	**42**	**91**

As per census of 2011, Uttarakhand had 78 ULBs. There were 6 Nagar Nigams, 31 Nagar Palika Parishads and 41 Nagar Panchayats. Highest number of ULBs were in Udham Singh Nagar.

Population distribution



Population Census 2011

1,01,20,000

District	Population	Density
Uttarkashi	3,30,086	41
Chamoli	3,91,605	49
Pithoragarh	4,83,439	68
Bageshwar	2,59,898	116
Rudraprayag	2,42,285	122
Pauri Garhwal	6,87,271	129
Champawat	2,59,648	147
Tehri Garhwal	6,18,931	170
Almora	6,22,506	198
Nainital	9,54,605	225
Dehradun	16,96,694	549
Udham Singh Nagar	16,48,902	649
Haridwar	18,90,422	801

Wikipedia, List of districts of Uttarakhand

The total population of the state according to the 2011 census was 10.12 million. It is primarily a rural state with almost 70% of the population residing in 15761 villages. Since the population density is far less and the wastewater management is also poor, there is no clear difference between the small towns and villages based on the population and available wet infrastructure. The population growth (more than 30%) has been maximum in the districts located in Terai and Doon region. Champawat and Kashi have second highest population growth of average 14%.

Districts such as Pauri Garhwal and Almora have negative population growth, which suggest that they have population migration from these districts has been maximum in the last decade.

The populations distribution is very uneven in the state. The districts in the plain regions have more than higher residing population (mostly urban). The lesser Himalayas have relatively less population and that too it is present in pockets. The population density varies from 40 persons per sq km (Uttarkashi, Chamoli) to 850 persons per sq km (Haridwar District).

AMRUT & NMCG

AMRUT

Dehradun
Haridwar
Roorkee
Haldwani - Kathgodam
Nainital
Kashipur
Rudrapur

Namami Gange

Haridwar
Rishikesh
Ranipur
Joshimath
Gopeshwar
Karnaprayag
Rudraprayag
Badrinath
Srinagar
Devprayag
Uttarkashi

The map shows the AMRUT and Namami Gange Towns in Uttarakhand. Relatively more work has been done under AMRUT in cities such as Haridwar, Dehradun and Roorkee. Under Namami Gange, there are in total 11 ULBs. The major work which is being carried out in these cities in interception and drainage (I&D) of wastewater and construction of sewage treatment plants for the wastewater collected through I&D works.

Flagship program

Total Schemes	46	Total Schemes	20
Ongoing Schemes	42	Ongoing Schemes	20
Completed Schemes	4	Completed Schemes	0
Sanctioned Cost (Lakh INR)	40180.32	Sanctioned Cost (Lakh INR)	63094.62
Budget Released (Lakh INR)	13357.37	Budget Released (Lakh INR)	25316.15
Expenditure (Lakh INR)	12344.37	Expenditure (Lakh INR)	19586.88
Utilization	31%	Utilization	31%

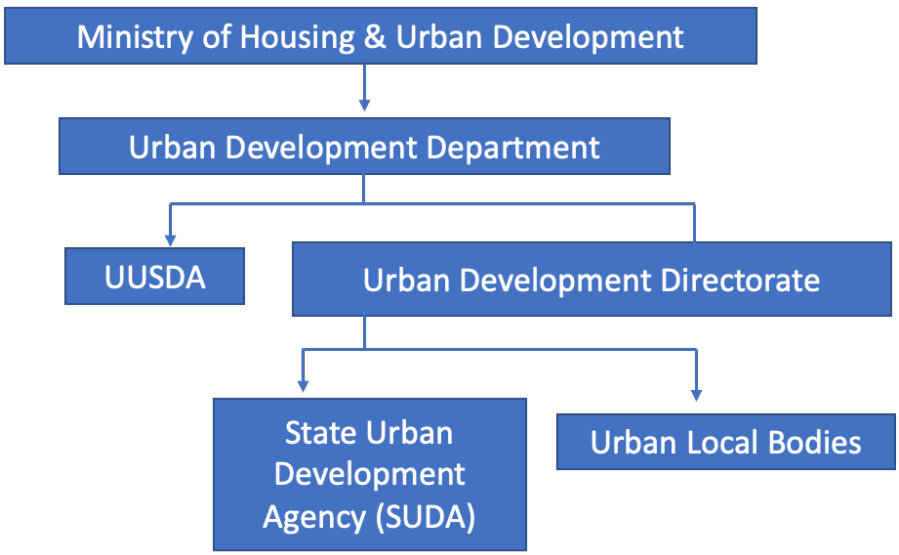
Source: www.peyjalmis.uk.gov.in, April, 2019

The slide details out the progress made by Uttarakhand State under the Flagship program of Government of India- AMRUT and Namami Gange. These schemes under AMRUT are related to water supply, sewerage and STP development, whereas in case of Namami Gange, most of the schemes are related to interception and drainage work and STP rehabilitation.

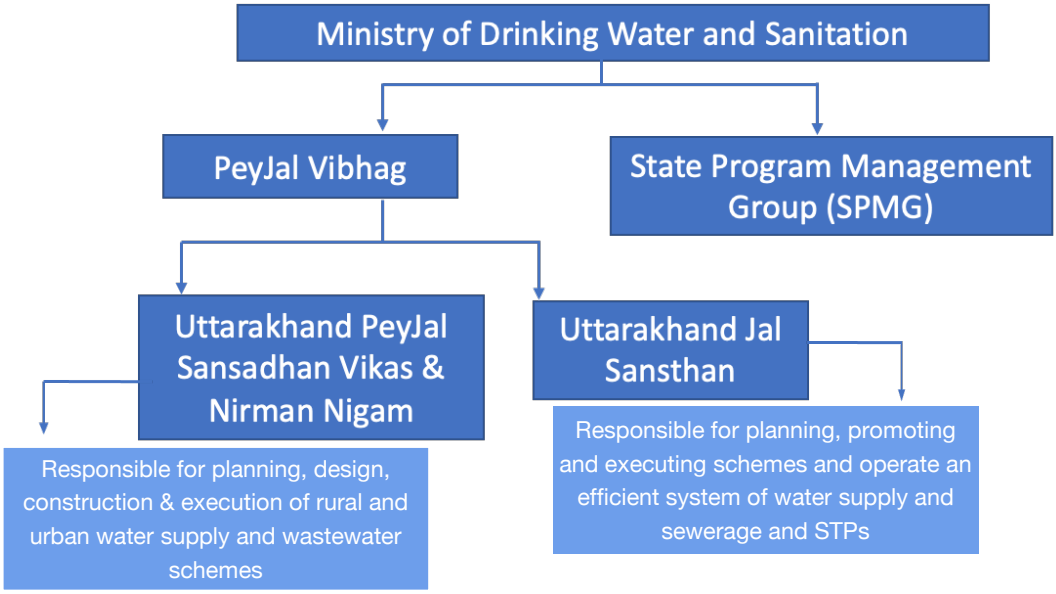
As on April 2019, only 4 out of proposed 46 projects have been completed. Although more than 90% of the total released budget was utilised, this amounts to only 31% of the sanctioned cost.

Under Namami Gange, none of the 20 proposed schemes have been completed. The utilisation of 78% of the released budget was done which also amounts to only 31% of the sanctioned cost.

GoU Institutional framework



GoU Institutional framework



Government of Uttarakhand has different kinds of departments at state level which are responsible for developing various infrastructure for improving the lives of people in Uttarakhand. However, pertaining to water and wastewater there are mainly three departments- Urban Development Directorate (UDD), Pey Jal Nigam (PJN) and Jal Sansthan (JS). The UDD spearheads the programs such as AMRUT, SBM at state level. The PJN is responsible for planning and execution of projects related to water and wastewater management. The JS is responsible for O&M of the water and wastewater management scheme. They are also responsible for collecting user charges to meet the O&M expenses.

GoU: Septage Management Protocol

GoU launched "Protocol for Septage Management" in May, 2017

Content of the protocol

- Basic concept of septage management- management of septic tank, its effluent and its content i.e. septage
- Definition
- Purpose and scope- five specific objectives
- Elements of the protocol- four elements catering to infrastructure and management

The GoU launched Protocol for Septage Management in May 2017. Although the protocol is structured and detailed well, there is a requirement of policy and guidelines for FSSM, based on which the parastatal bodies and ULBs will operationalise FSSM in the ULBs. The protocol contains the basic concept of septage management, followed by definition of FSSM specific terminologies such as faecal sludge, septage, septic tank, black water etc. The purpose and scope of the protocol

is clearly conveyed through five objective statement. In total the protocol contains four elements catering to infrastructure and management.

Purpose and scope of the protocol

- To provide regulatory framework
- To prescribe the actions to be taken by the owners of the premises and septage transporters
- To provide appropriate inspection and enforcement mechanisms
- To ensure cost recovery on sustainable basis
- To facilitate participation of private and non-government sector

- To provide regulatory framework for construction and routine maintenance of onsite sanitation systems, transportation, treatment and safe disposal of septage
- To prescribe the actions to be taken by the owners of the premises connected to onsite sanitation system and septage transporters to ensure compliance with their obligations
- To provide appropriate inspection and enforcement mechanisms
- To ensure cost recovery on sustainable basis for proper septage management
- To facilitate participation of private and non-government sector in septage management

Monitoring committee

To monitor the activities pertaining to septage management at district level Committee constitutes of:

1. District magistrate
2. Chairman
3. Executive officer
4. State Pollution Control Board
5. Pey Jal Nigam
6. Jal Sansthan
7. Health Department
8. Town & Country Planning Department

Monitoring committee is to be appointed at a district level and will consist of members representing various stakeholder organizations in FSSM- administrative department, elected representatives, parastatal bodies and monitoring departments. The main responsibility of the monitoring committee will be to guide the ULBs to form SMCs carry out the tasks as per the protocol.

Septage management cell

- To ensure that appropriate septage management happens at local level
- Power to impose penalty to individual, government or private entrepreneur if they fail to follow the protocol
- Separate cell structure has been instructed for the NN, NPP and NP
- District Magistrate is replaced by head of the ULB

The septage management cell (SMC) has to play key role in operationalising FSSM. They have the power to penalise in case the protocol is not followed. There is a separate structure suggested for NN, NPP and NPs. However, the only change which is made with respect to members is that district magistrate has been replaced by the head of the ULB. Detailed responsibilities of the SMC are articulate in the Septage Management Protocol of GoU.

Summary

- Uttarakhand state has good access to water and toilets which generates high quantum of wastewater
- Dependency on the onsite systems such as septic tank and network of open drains for sullage creates health hazard and risk
- Access to sanitation by planning and implementation of sewered sanitation system is difficult to achieve in state of Uttarakhand
- Faecal sludge and septage has a different characteristics and required a separate service chain and management

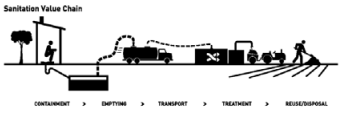
- Uttarakhand state has a good access to water and toilets which leads to generation of high quantum of wastewater. The wastewater thus generated needs to be managed well. Mismanagement of the wastewater at various levels poses threat of contamination of water resources such as surface water and ground water.
- Due to insufficient sewerage network, the dependency on the onsite containment units such as septic tanks is quite high. Moreover, most of the ULBs relies on network of open drains along the road to discharge the grey water and septic tank effluent. The undulating terrain takes advantage of gravity and transfers the wastewater to the lowest point which is usually a stream or a river. Thus, creating a bigger health hazard to population staying on the downstream of the river.
- Planning and implementation of centralised sewerage scheme and STPs is not only time consuming but also expensive solution for complete management of liquid waste. Since such projects takes years to implement, the ULBs should adopt FSSM approach for reducing the pollution footprint.
- Faecal sludge and septage has different characteristics as compared to sewage and hence requires different management scheme. The sanitation service chain in case of such non sewered sanitation is different and practically involves much more stakeholders as compared to sewered solutions.

Session

02

Challenges in Sanitation System

Contents



Group discussion on sanitation service chain

Sanitation Systems Components of sanitation systems Sanitation Service Chain

Challenges and issues in operationalising FSSM in Uttarakhand State

Learning Objectives

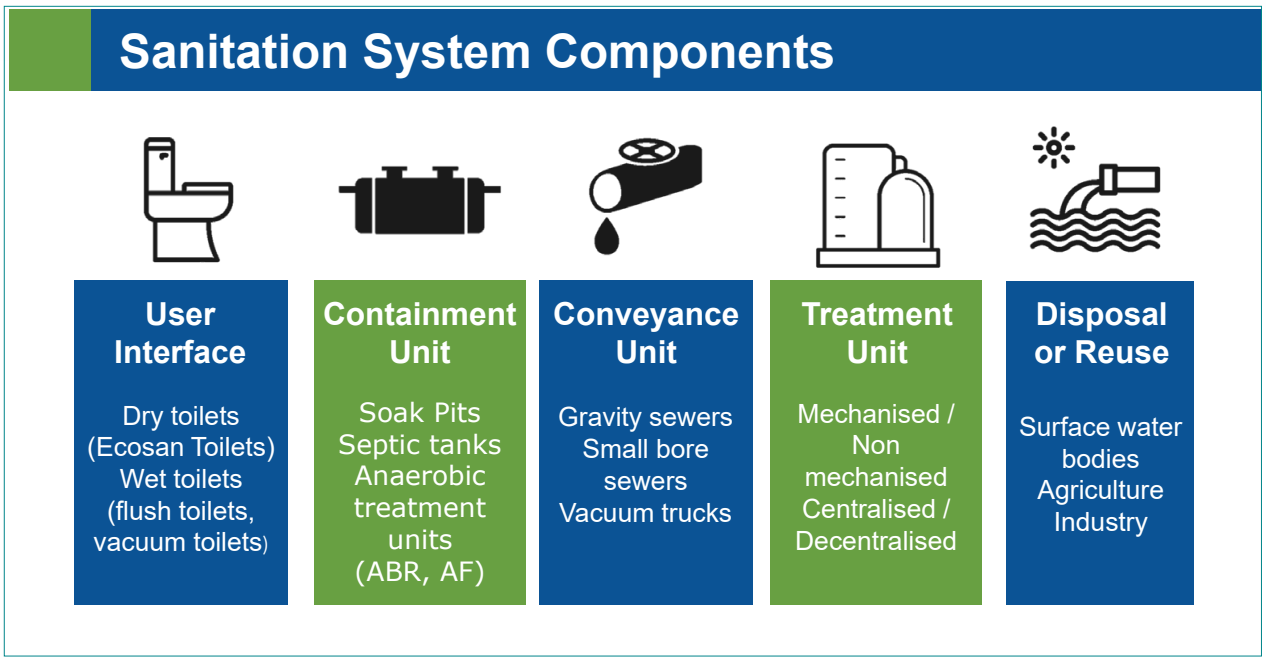
- To introduce to the participants the basics of sanitation systems and its types
- To introduce to the participants sanitation service chain in FSSM
- To realise the current state of sanitation service chain in the ULBs of Uttarakhand state.
- To realise and challenges and issues in non sewered and sewered sanitation systems in Uttarakhand state

In this session we will introduce the participants to the concept of sanitation systems. This will enable them to look at complete process of liquid waste management- from generation to disposal. We are also introducing the participants to the types if sanitation systems, thereby familiarizing them with the most prevalent type of sanitation system found in India. The session continues to focus on one aspect of the non sewered sanitation i.e. Faecal Sludge and Septage Management. Here we will introduce all the processes involved in the management of faecal sludge and septage.

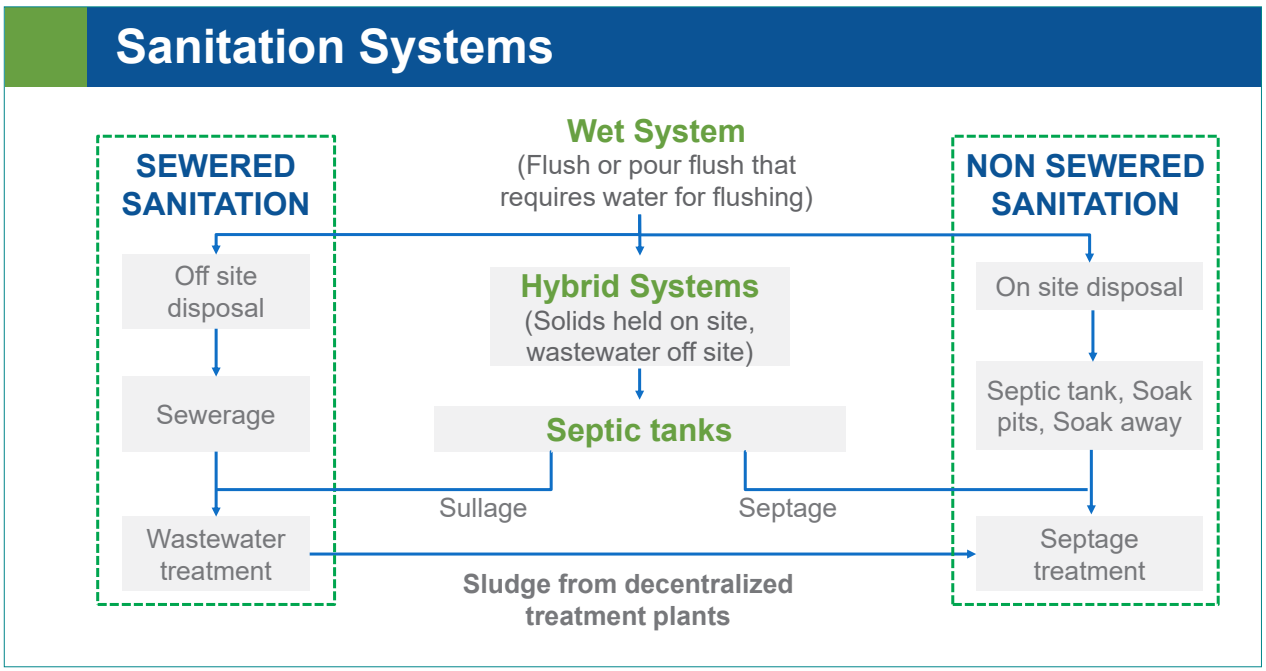
We will have a short group exercise, where we will try to understand and document the problems faced in the sanitation systems in the state of Uttarakhand by the ULBs and parastatal agencies involved in liquid waste management.

Finally, we will discuss the current situation and challenges faced in sewers and non sewered sanitation systems in Uttarakhand State.

1. Sanitation Systems



A sanitation system consists of five different components as shown in the slide- User Interface, Containment Unit, Conveyance Unit, Treatment Unit and Disposal or Reuse. A sanitation system can be formed using three or more components. The options available under each component is listed in the boxes on the slide. We will be looking into different sanitation systems which will make the picture clearer as to how each component connects with other.

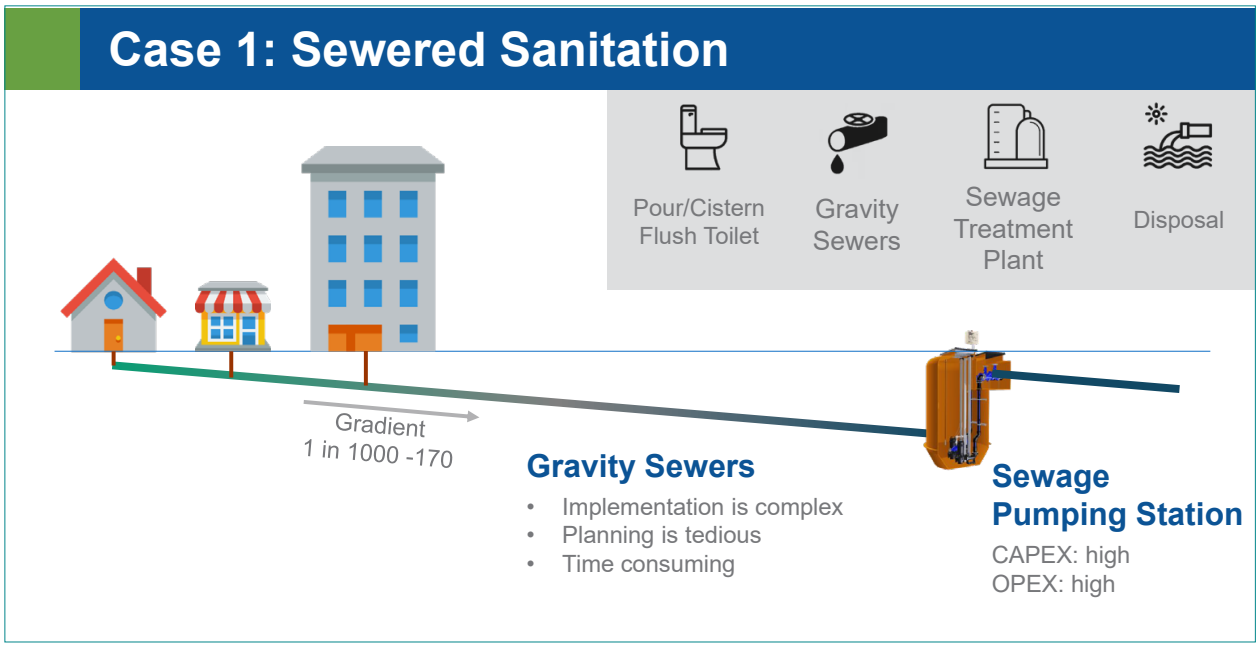


In the urban centres of the developing countries, due to availability of the water, use of flush toilets and the myth that wet systems are the easiest to operate and maintain, water borne systems are used. Water is used to transport the waste from one point to another. These systems are called wet systems. The wet systems can be classified into two types depending on where the

treatment of waste is done. In case of “Off Site” disposal, the liquid and solids are carried away from the point of generation using sewerage network. The sewerage network brings the waste from all the households to one point where a wastewater treatment plant is set up. This type of system is called as sewered sanitation.

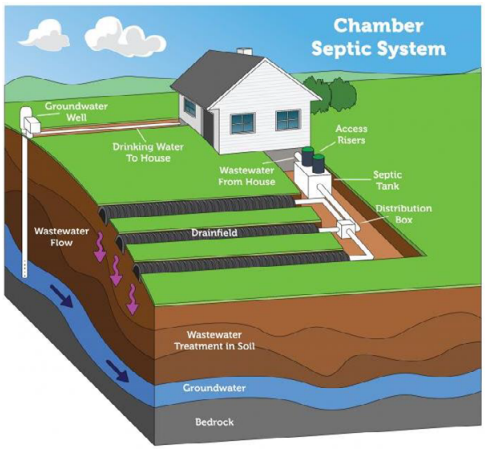
In case of “On Site” disposal, the solids are stored in the containment unit and the liquid effluent is disposed off into the ground using soak pits or soak away. After a duration of few years, the contained solids are emptied and transported for further treatment. Since this conveyance of solids is done by mechanised equipment such as vacuum trucks, this type of sanitation system is called as non sewered sanitation.

However, in India, we have developed a hybrid system where in the solids are contained in the septic tank at the household level and the sullage is disposed off into the drains outside the houses. The network of drains thus collects the sullage from all the households and by gravity brings it to the surface water body such as rivers, lakes and ponds. The septage from the septic tank is emptied after few years and transported by vacuum trucks for either treatment or direct disposal. Since a network of drains is involved for conveyance of the sullage, these systems cannot be classified as completely sewered or non sewered sanitation system.



The sewered sanitation system starts with a flush toilet which uses water to flush the excreta mixed with urine and anal cleansing water. Thus, the black water originating from the toilets is mixed with the grey water originating from the bathrooms and domestic kitchens and forms sewage. The sewage is collected using gravity sewer systems as shown in the picture. Sewage pumping station is an integrated component of the gravity sewers which pumps the sewage up to certain level to again use the gravity flow. The sewerage system brings all the sewage to the sewage treatment plant where it gets treated as per the standards and is then disposed or reused.

Case 2: Non-sewered Sanitation



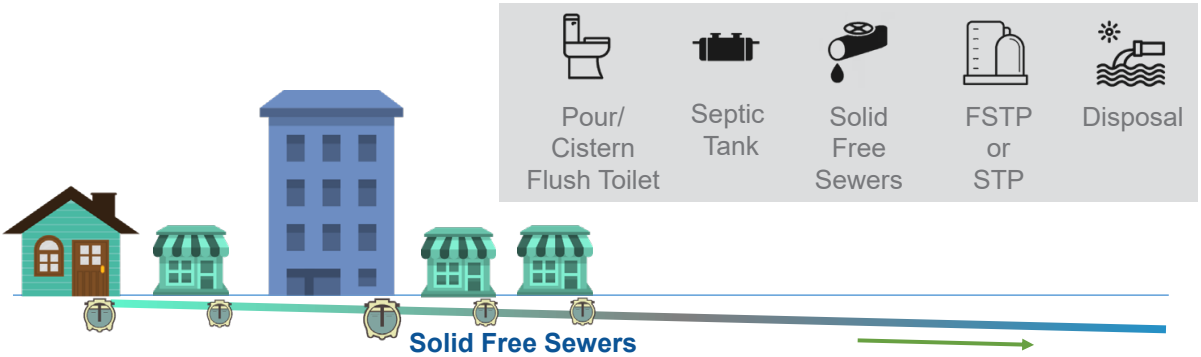
Pour / cistern flush toilet

Septic tank

Drain / Leach Field, Soakaway zone

The non sewered sanitation system starts with a flush toilet which bring the black water to the septic tank. Inside the septic tank, the solids get sedimented and the liquid comes out. This septic tank effluent mixes with the grey water is then sent to the drain field or soak away zone. The solids contained in the septic tank undergo digestion over a period of time. Usually it is recommended to desludge the septic tank once in 2-3 years. This helps to maintain the efficiency of the septic tank to remove the solids from black water, increases the life of the soak away zone and reduced the odour problem if any. The desludging is done using vacuum trucks.

Case 3: Hybrid Systems



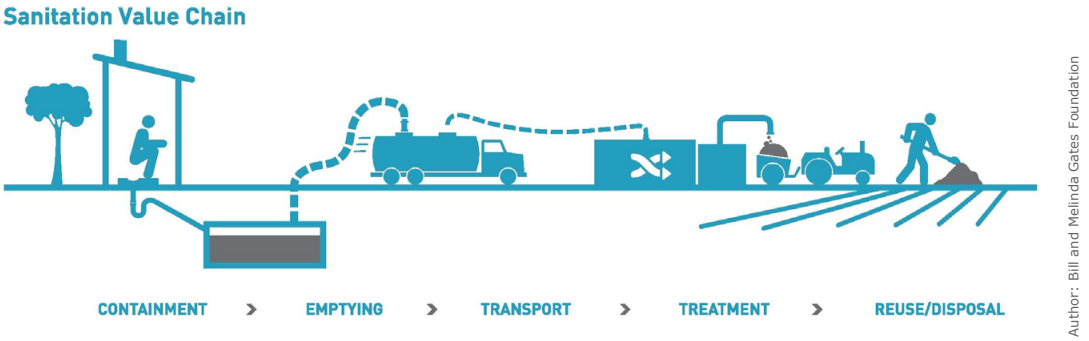
Solid Free Sewers

- Planning and execution is relatively easy.
- More properties per unit distance
- Less water for cleansing pipes
- Less O&M

Smaller Gradient
Covers more spatial area w/o requiring pumping station

In hybrid systems the liquid effluent after the containment system is collected using network of open/closed drains. Ideally a solid free sewer is suitable in such cases. This brings all the wastewater i.e. sullage to a point where a treatment plant can be set up for treatment of sullage. However, still the septage from the septic tank needs to be desludged and conveyed using vacuum trucks. There are plenty of advantages of solids free sewers over gravity sewers discussed earlier under sewered sanitation system.

Sanitation Service Chain



Management of sanitation services includes,building of appropriate containment, conveyance of human excreta, treatment and its safe disposal

Non sewered sanitation systems and hybrid sanitation systems have one thing in common and i.e. desludging of containment unit and conveyance of faecal sludge and septage to the treatment plant. The figure in the slide represents a sanitation service chain which is the most important part of non sewered sanitation and hybrid sanitation systems. The five components of this service chain are- containment unit, emptying, transport, treatment and reuse/disposal. The management of these five components is important for managing the sludge produced from human waste. The services such as construction of septic tank, desludging of septic tanks is usually provided by private companies of contractors. Treatment of septage needs to be provided by the ULB but is usually operated and maintained by private company and the reuse or safe disposal of end product i.e. bio solids can be practiced in agriculture/industries. Hence, one can observe that most part of this sanitation chain is services by private companies.

2. Group Discussions

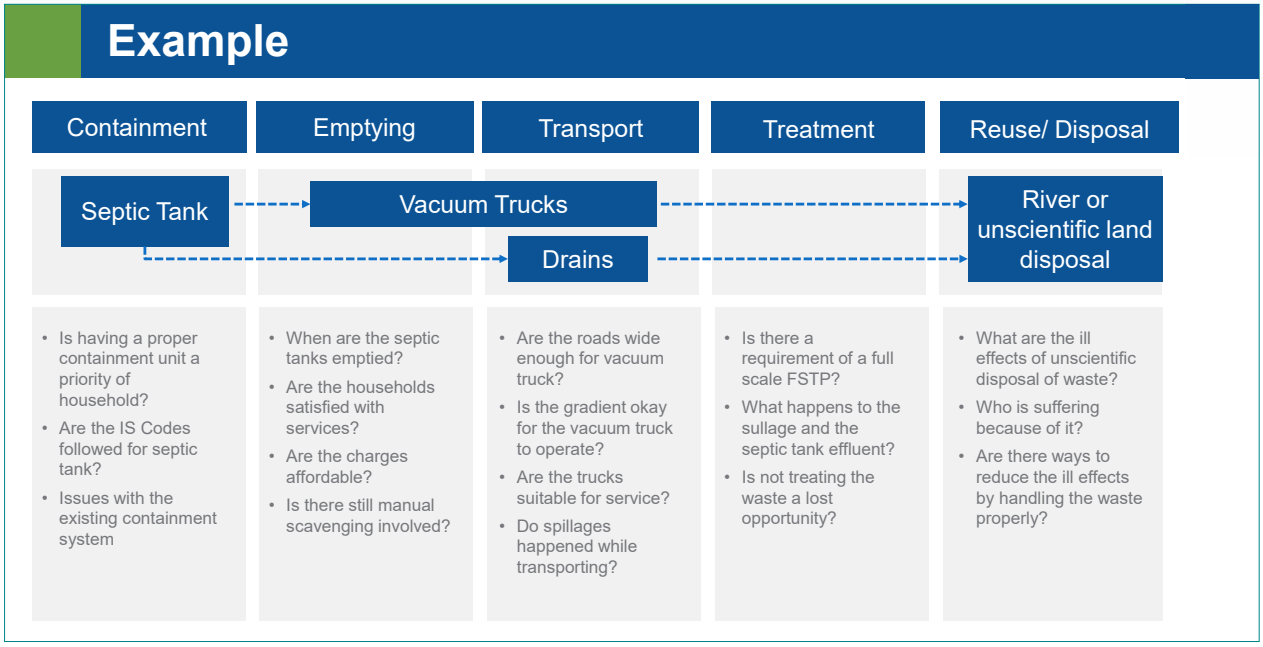
Group Discussion Pointers

- Identify the sanitation service chain in your city
- Plot the service chain on a flip chart
- Discuss each component of the service chain in detail

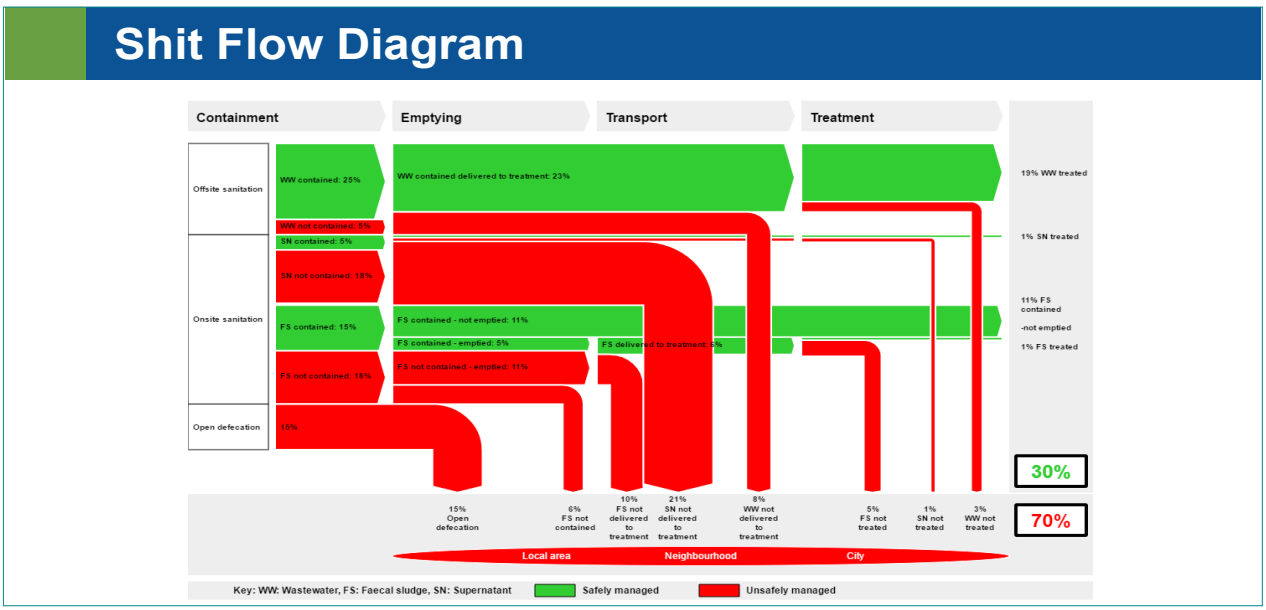
Containment	Emptying	Transport	Treatment	Reuse/ Disposal

What is the current situation in you city

What are the challenges & issues faced in each component of the service chain in your city?



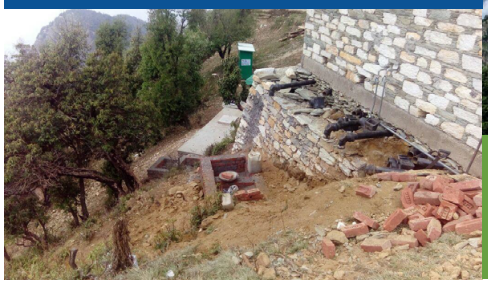
3. Challenges Faced



The figure shows Shit Flow Diagram for the state of Uttarakhand. The figure has to be read from left to right. On the extreme left, we can see that 30% of the households are connected to off-site sanitation system, whereas 55% of the households are connected to onsite sanitation system remaining 15% are practicing open defecation. The SFD shows how and where the mismanagement is happening because of which the arrow turns red and goes down to the bottom of the SFD. At the bottom of the SFD we can see, that due to mismanagement of sanitation systems at various stages can lead to health risks at different scale. Open defecation creates the health risks at local level, whereas mismanagement of emptying and transport causes health risk at neighbourhood or community/ward level. Mismanagement at the treatment causes health risk at the city scale. In this case the untreated wastewater is disposed off into the surface water body such as s river, the health risk is now transferred to city located at downstream of the river. Thus, it can be seen that according to the 2011 census, only 30% of the liquid waste is safely managed whereas 70% is disposed of into the environment.

Containment Unit

Undulating terrain puts land constraints for construction of septic tank



Septic tanks on sloping ground are difficult to construct and access for vacuum trucks

Land constraints are always a challenge for toilets and containment units. However, in case of undulating terrains as shown in picture, it is clear that the complexity increases multi folds. It's not only about construction of containment unit but also access to these units for desludging. The containment units need to be desludged, no matter which sanitation system is adopted (non sewered or hybrid sanitation system).

Containment Unit

- Lack of awareness about standard designs
- Good workmanship
- 2-3 chambered septic tanks are built
- Standard designs are not followed while construction
- Constraints- cost and clients' requirement

During structured interviews with one of the stakeholders in the sanitation service chain, it was revealed that the masons and contractors are not aware about the standard designs of septic tanks as stated by IS Codes. However, after interaction it could be sensed that the masons and contractors do have understanding about the process happening in the septic tanks (ex. The contractors were able to distinguish between the two – three chambered septic tank and its advantage over a single chambered holding tank. However, the contractor said most of the times the cost of construction and clients' requirement puts a constraint on actual construction of the septic tanks.

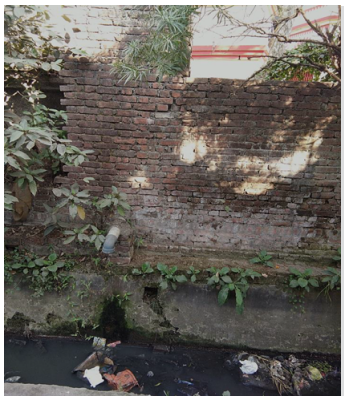
Vacuum trucks

- ULBs lack mechanical equipment for septic tank desludging
- Less private operators providing septic tank desludging services
- Response time of ULB services and cost of desludging services of private operators

In Uttarakhand, it was observed that most of the ULBs do not own vacuum trucks for providing service of desludging of septic tanks to the households. After interacting with few ULB officials, it was understood that there is no clear distinction between the institutional roles and responsibilities when it comes to liquid waste management. Most of the officials were of the opinion that sewerage is handled by Pey Jal Nigam and Jal Sansthan, septage management will also come under their responsibility.

It was observed that very few of the cities had private operators giving desludging services to the households. As the desludging of the septic tank is not practiced quite often, private enterprises do see it as viable business. Response time and cost of desludging was identified as one of the major concerns of the households when it comes to desludging of septic tanks.

Drainage network



- Few cities have gravity sewers
- Coverage of gravity sewers is not good at city level
- Open / closed drains prevalent in ULBs
- Carry sullage and septic tank effluent

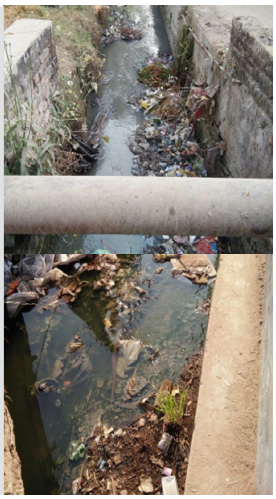
Partially developed hybrid sanitation systems have been adopted in the state. There are no piped sewers systems (solid free sewers) for collection of sullage (septic tank effluent and grey water). Most of the ULBs rely on network of open and closed drains as shown in the figures above. The outfall of these drains is a low-lying surface water body in the form of lake or a river. Thus, avoiding desludging of septic tank results in transfer of organic solids to these drains. Not only it gives rise to odour problems throughout the city, these organic solids eventually reach the river and pollute the river ecology.

The same drains also act as storm water drains during monsoon season, thus all the waste (solid waste as well as sludge and grit accumulated over a period of time) gets washed into the river.

In most of the ULBs, the drains are unlined. This leads to seepage of sullage into the ground. In districts such as Udham Singh Nagar where the ground water table is very high, this can lead to ground water contamination. Since in Udham Singh Nagar, most of the urban population rely on ground water to meet their water demand, this can lead to serious health risk.

Conveyance

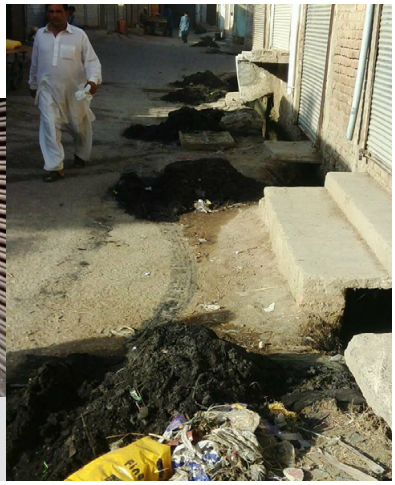
Mismanagement of solid waste resulting in issues and challenges of functioning of drains



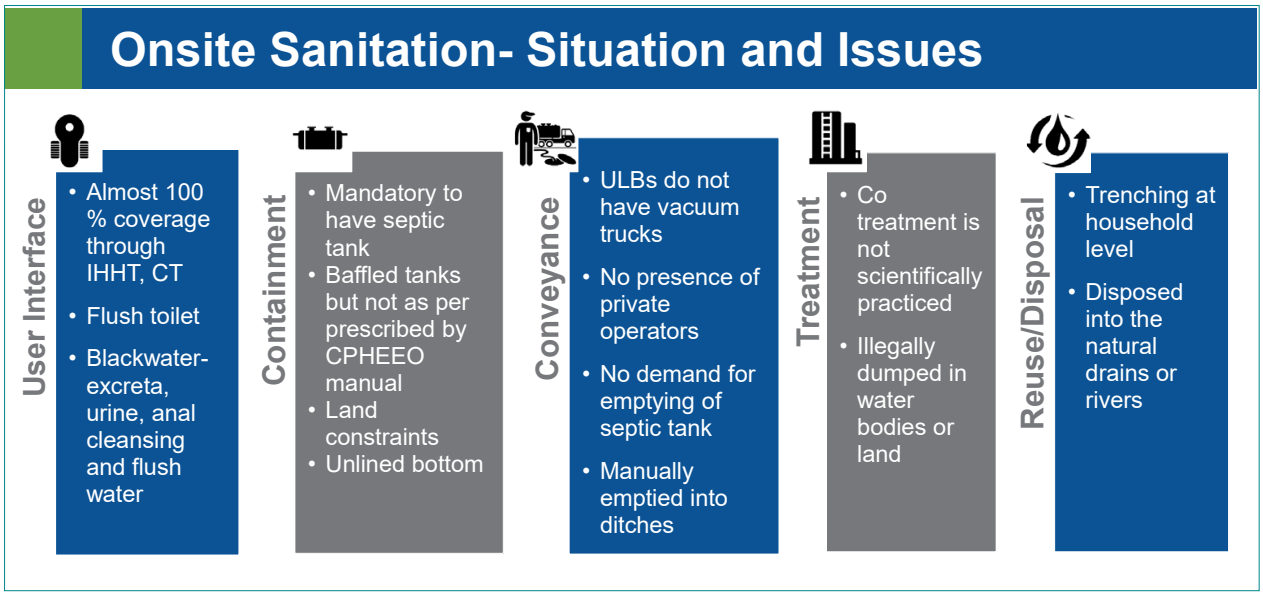
In absence of the gravity sewers, the management of the liquid waste is done by open closed drains as shown in the figure. Improper solid waste management hampers the functioning of the drains. As shown in the picture, the solid waste dumped in the drains, blocks the free passage and leads to stagnation of the wastewater. Making the condition non hygienic for the residents. Cleaning of such drains before the monsoon is necessary becomes an additional work for the ULB officials.

Conveyance

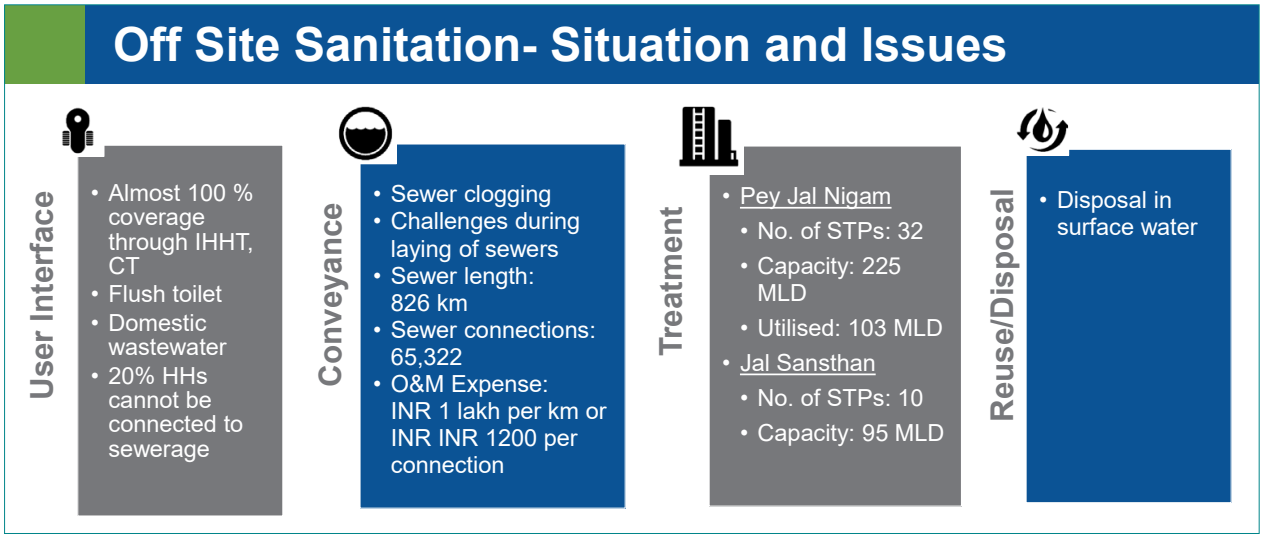
Accumulation of silt in drains and sewers



Because of the unlined and uncovered nature of the drains, lot of silt and solid waste gets accumulated in the drains. During monsoon season, the surface runoff brings all the dirt and sand from the paved areas into the drains where is settles down. Accumulation of silt causes blockages during dry weather and creates challenges for operation of the sewers and STPs in the interception and drainage works.



The slide compiles the current situation and issues faced in onsite sanitation in the ULBs in Uttarakhand. Most of the houses have IHHT and are using flush toilets. These flush toilets generate black water which then goes to septic tank. Most of the septic tank are not built as per the IS Codes and have unlined bottom. This possess a health risk of ground water contamination at the local level. The conveyance of the sullage is done using the network of open and closed drains. Most of the ULBs do not have vacuum trucks to provide the service of desludging to the households. As demand desludging is taking place, most of the time, the faecal sludge and septage is disposed off indiscriminately onto the land or into the water body. Very few cities provide provision for co treatment of septage. In some cities, manual scavenging is also practiced to service the septic tanks in absence of vacuum trucks. In those cases, the disposal is done at the households' level into a pit. This practice is much more hazardous as seepage of the liquid into the nearby bore well can lead to contamination of the ground water.



In case of off-site sanitation system, it is observed that in ULBs where sewerage system is already developed, connection of the households is a problem. It is reported that a minimum of 20% of the households cannot be connected to the difference in the level of the sewer and outfall of the septic tank or toilet. Laying of gravity sewers is a challenge in mountainous region. Maintaining the velocity of the sewage inside the pipes possess a great challenge for which drop manholes need to be constructed. These manholes chambers are quite costly to construct and maintain later on. The statistical data shows that cost of operation and maintenance of sewerage is quite

high. For treatment of wastewater, there are in all 10 STPs operational and functioning under the custody of Jal Sansthan and around 32 are under Pey Jal Nigam. The STPs under Pey Jal Nigam are at various stages such as planning, DPR, construction and commissioning. Disposal of treated wastewater in most of the cases is happening in rivers or streams.

Summary

- ODF sustainability is closely linked in the management of human excreta through FSSM
- Achieving total sanitation with sewered systems is time consuming and expensive in state of Uttarakhand
- Challenges and issues faced in sanitation in the ULBs Uttarakhand differ with respect to geography
- The need of degree of FSSM varies across the state and hence the FSSM approach will also need to be changed

ODF sustainability is dependent on management of human waste through FSSM. Having proper FSSM ensures that faecal oral transmission of disease-causing vectors is completely eliminated.

Achieving 100% sanitation in urban centres through sewered sanitation system demands huge funds and skilled human resources for construction and O&M. Under normal conditions, implementation of sewerage projects takes close to 5 years which is a very long-time span for urban centres having population growth of more than 30%.

Challenges and issues faced in operating the sanitation systems varies with respect to geography and demography. Hence, there is a need of a strategy for scaling of FSSM in the state such as Uttarakhand.

The need of degree of management in FSSM varies across state and hence technologies or appropriate approaches need to be adopted for the same.

Session

03

Technology Options in FSSM

Content

Technology options for Emptying & Conveyance

Case Studies in FSM

Technology options for Containment Units

Technology options for FSS Treatment

Learning objectives

- To introduce technology options for containment units
- To introduce demand and scheduled desludging
- To introduce technology options for emptying and conveyance of faecal sludge and septage
- To introduce faecal sludge and septage treatment/disposal options

In this session we are introducing the participants to the to various technological options for various stages of FSSM Service chain – Containment unit, Desludging equipment and conveyance, Treatment and disposal.

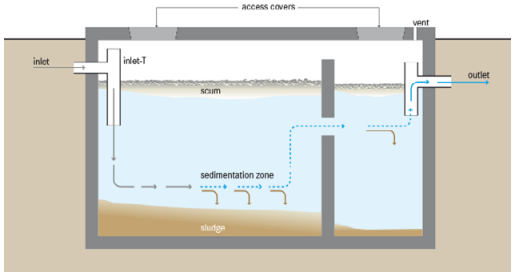
1. Options for Containment Units

Septic tank

SEPTIC TANK

- Sedimentation process
- Settled sludge is stabilized by anaerobic digestion
- *BOD*: 30 to 50%; *TSS*: 40 to 60 %; *E. coli*: 1 log units
  HRT: about 1 day

Containment systems such as septic tanks need to be desludged in 2 – 3 years. This ensures that the effluent of the septic tank is free from settleable solids.



Source: TILLEY et al. (2014)

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

Note 1: The capacities are recommended on the assumption that discharge from only WC will be treated in the septic tank

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

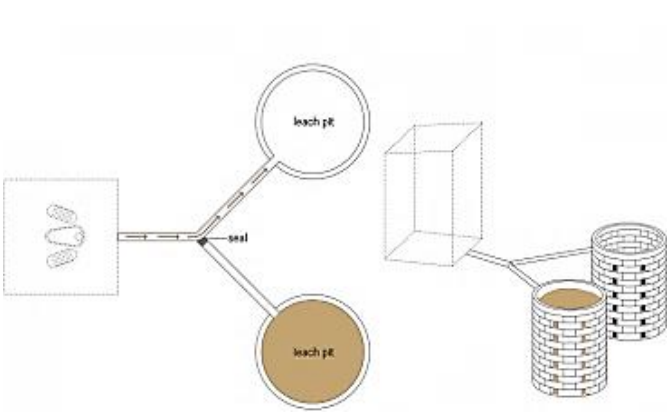
Note 3: The sizes of septic tank are based on certain assumption on peak discharges, as estimated in IS: 2470 (part 1) and while choosing the size of septic tank exact calculations shall be made.

Source: CPHEEO, 1993

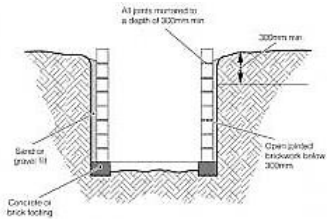
The most common type of containment unit in urban case is a septic tank. IS 2470 (part 1) gives details of standard sizes of septic tanks and other design criteria for India. The main function of the septic tank is to arrest the solids from the black water. The main process which takes place in the first chamber is sedimentation which takes place due to different in the specific gravity of the solids and liquid. The liquid moves in to the second chamber where further settlement occurs and the liquid exists the septic tank. The settled solids undergo natural digestion process because of the anaerobic bacteria present in the faecal matter and inoculant. Since the solids are retained in the tank for more than 2 years, the digestion of the organic solids is nearly complete and inert sludge remains at the bottom of the tank.

Over a period of time, the solids start occupying more volume of the tank, reducing the hydraulic retention time of the septic tank. This results in inefficient sedimentation; thus, the solids are not arrested in the septic tank and flow out with the water. Large part of the solids is organic in nature and hence when they enter the water body, their aerobic digestion takes up oxygen from the water (there by reducing the dissolved oxygen). Hence it is important that the septic tank should be desludged at a right frequency as per the design.

Soak pit



Source: Tilley et al. 2014



Source: D. Friedman

Soak pit is the common type of containment system in rural cases as they are more affordable and easier to operate and maintain as compared to septic tank. A properly built soak pit/leach pit does the function of solid liquid separation. The solids are retained in the honey comb ring structure whereas the liquid seeps out from the openings and percolates into the ground. Usually the soak pits are meant to be used in pairs and hence are also known as twin pits. When one pit is full, the other pit is made operational and time if given for the solids in the first pit to undergo digestion naturally. The intended end product from the pit is humus i.e. bio solids which are rich with organic matter and nutrients.

It should be noted that twin (soak) pits should be avoided in case of a low lying area and places where high ground water table is present. If the pits are situated in low lying area, then during monsoon the surface run off can potentially enter the pit and disrupt the biological process of digestion. This can lead to odour and prolongs the digestion process. When the twin pits are located in region with high ground water table, there is potential of biological and microbial contamination of ground water.

Soak away

- Soak away / Drain field are installed after the septic tank.
- So water free from settleable solids enters the drain field and percolates into the ground.
- Should not be practiced in high groundwater table or high rainfall area.

Source: Civil Planet

Source: Department of Tourism, GoU

In order to have a non sewered sanitation system, the containment unit should follow with an appropriate liquid drainage unit such as a soak away or drain field. The soak away is improved version of a soak pit. The liquid effluent from the septic tank is connected to the centre of the soak away. Here, is there are any solids, they are retained and the liquid gets uniformly distributed in the soak away. The soak away zone consists of permeable material such as brick bats, charcoal, gravel or even coarse sand. The function of this zone is hosting the micro-organisms which can treat the water to some extent while is passes through it and exits from the honey com b wall.

Drain field

Source: Musser Septic Systems

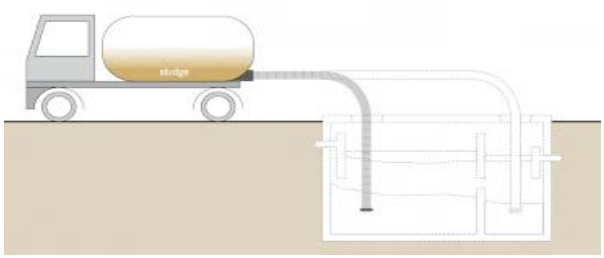
Drain fields are extended and improved version of soak away. Drain fields are not common in India; however, in developed countries such drain fields are used for houses which cannot be connected to sewerage system and where solid free sewers cannot be implemented. The liquid effluent from the septic tank enters the tubes which are located approximately 1-2 feet below the ground. Thus, the liquid is evenly spread across the land (lawn or garden in most of the cases) which eliminates direct contact with water. The water passes through the layers of soil and gets

naturally treated by the micro-organisms present in the soil. Although drain fields are costly, the efficiency and life of drain fields is much more than the soak away and hence is the preferred options in developed countries.

2. Options for Emptying and Conveyance

Emptying and Transport - Vacuum Truck

Vacuum Truck	1000 L, 2000 L, 3000 L, 4000 L, 6000 L, 8000 L, 9000 L
Price range	10 Lakhs and above



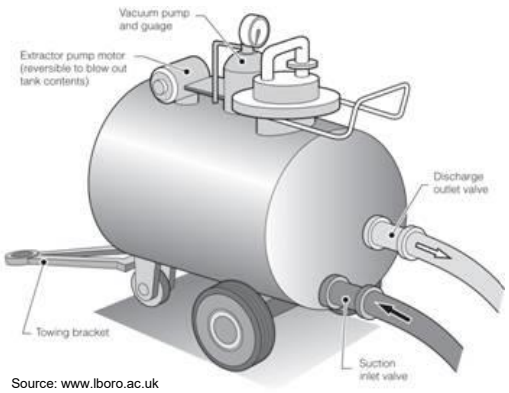
Source: Tilley et al. 2014

Source: KAMAVIDA

Source: KAMAVIDA

Vacuum truck is a most sophisticated equipment which is widely used for desludging of containment systems such as septic tanks. The vacuum trucks come in different sizes and types. As shown in picture trailer mounted tank fitted with vacuum pump is the most basic form of equipment. In this case, the trailer can be tugged with tractor and the vacuum pump is operated using diesel run motor. An improved version is a truck mounted tank fitted with the vacuum pump. In this case there is possibility that the vacuum pump can be coupled with the drive train of the truck, thus eliminating the need of separate diesel run motor. Now-a-days, vacuum trucks fitted with jetting equipment is also available for cleaning sewerage network and manholes.

Emptying and Transport- Vacutug



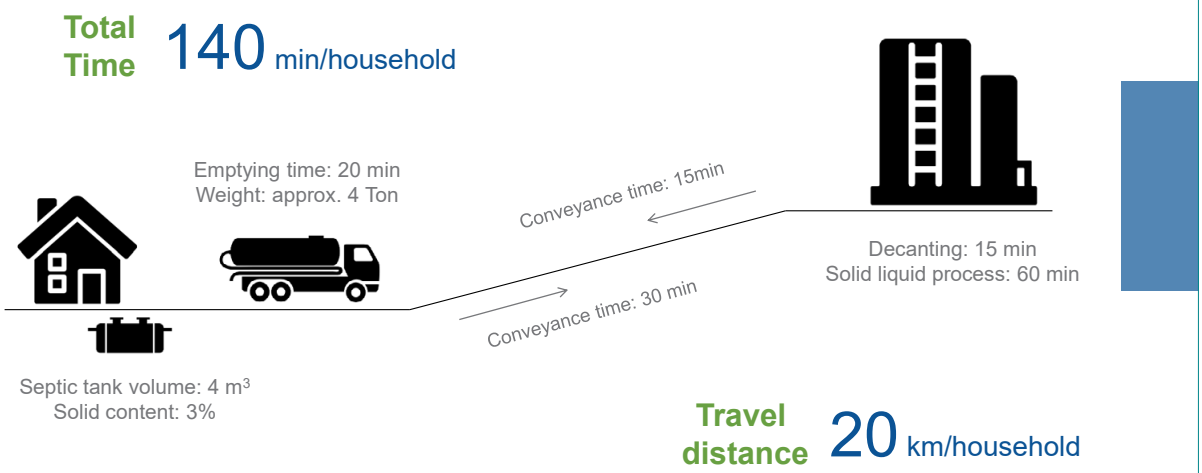
Source: www.lboro.ac.uk

Source: Bangladesh Practices and UN-HABITAT, 2006

Vacutug is a smaller version of the trailer mounted type of vacuum truck. The need of such a smaller size desludging equipment arises from the fact that not all the containment units are easy to access. Especially in the unorganized settlements such as urban slums, the access roads are small and a vacuum truck cannot be driven to the household. Hence, vacutug is used to empty the content of the septic tank in batches and empty it into the bigger truck. The tugs can be as small

as 300 kl. The most important thing which making a vacutug is to keep in mind that it should be easy enough to pull it by persons or vehicle.

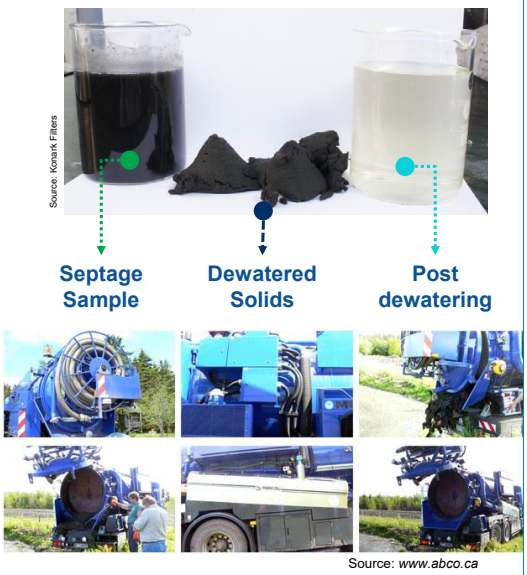
Emptying and conveyance service



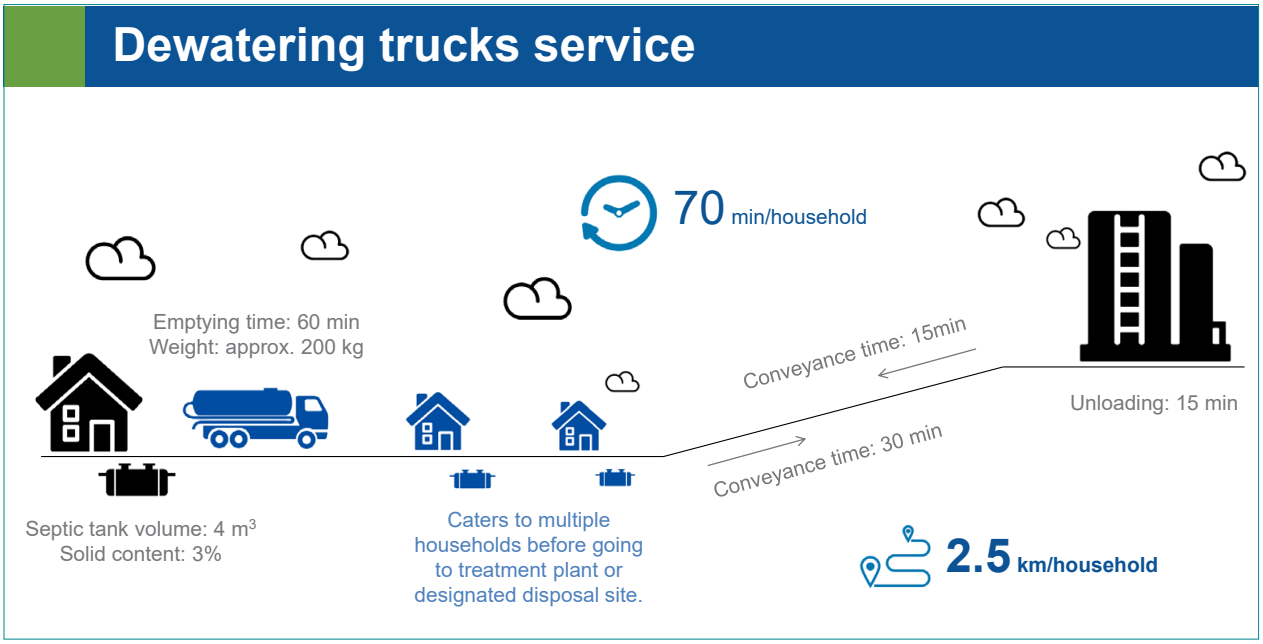
The slide shows time and distance travelled per household while providing the desludging services. Usually the truck of 4kL takes up to 20 min to fill up and weighs more than 4 ton. This trucks then drives close to 10 km to the treatment plant, where decanting of the truck takes another 15 min. The first stage of the treatment that is solid liquid separation takes close to 60 min. After decanting the trucks comes to service another home and thus total time and distance travelled taken to service one household is close to 2 hours and 20 km respectively. If only, the solid liquid separation was possible during the desludging stage, one will need to transfer only the solids in the form of slurry to the treatment plant. Potentially, the truck can provide service to multiple households before it has to go to the treatment plant for disposing the solids.

Emptying and Transport- Dewatering truck

- The dewatered solids can be collected and transported to the STP/ SeTP for further drying.
- Provides onsite dewatering of the septage, reducing the volume to be transported.
- The filtered water is put back into the septic tank or drains.
- The filtered water is free from suspended solids.



Dewatering truck is a vacuum truck which desludges the septic tank and simultaneously separates the solids from the septage. The filtered water can be put back into the septic tank as its characteristics are much better than the septic tank effluent. The separated solids now have significantly less volume and weight less. Thus, it not gives an opportunity to service more households but also improves the fuel efficiency of the truck.



In this slide we can see, that from each household now the dewatering truck will collect only the solids which will weigh significantly less than conventional truck hauling solids and liquid together to the treatment plant. The dewatering truck in this case can cater to at least 8 households, before it is completely filled with solids. Once filled, the truck will have to go to the treatment plant where is can empty the solids (slurry) for further processing. The time saved per households is close to 70 min and average distance travelled per household is 2.5 km per household. Thus, the desludging practices can be optimised using such dewatering trucks.

In case of Uttarakhand, where the population is density is medium and population growth rate is also moderate, equipment such as dewatering trucks will suffice. In some cases, the need of FSTP can also be completely eliminated as the truck can also cater to nearby smaller ULBs.

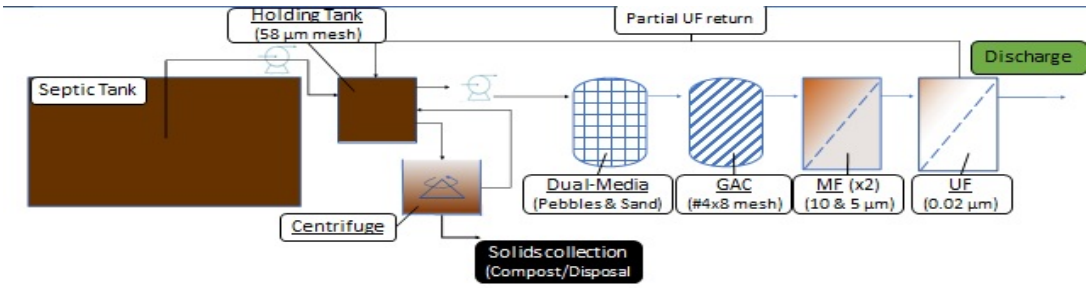
Mobile Treatment Unit

Mobile Faecal Sludge Treatment Unit- WASH Institute

Source: WASH Institute

The Mobile Treatment Unit is improved version of the dewatering unit as it treats the liquid effluent too. The solids are stored on the truck. The treated liquid is discharged on the land.

Mobile treatment unit



Models

3000 L/h – INR 13 lakhs | 6000 L/h – INR 15 lakhs

Source: Wash Institute

The septage is pumped into a holding tank using a centrifugal pump. The centrifuge is used to separate the solids from the liquid and the liquid is sent further for treatment. The liquid treatment starts with a sand filter followed by granular activated charcoal filter. Membrane filtration is then used to clarify the water to the discharge standards. Currently the truck is available in two capacities i.e. 3 KL per hour and 6 KL per hour costing INR 13 lakh and 15 lakhs respectively.

Demand desludging

- Customers call the service provider directly to request for service
- Service may be performed by public or private operator

Advantage	Disadvantages
Provides the households more control over their facility as they determine when to request for service	• Containment may be full before the request for service • Lump sum payment at the time of service • More expensive as the process is time consuming • Limited opportunities for optimisation of the service • No guarantee of income/month for the operators

Desludging of containment units such as septic tanks if a critical and should be practiced at a regular frequency. However, currently in India ULBs are practicing demand desludging. The provision of desludging services upon request by the household is called demand or "on demand" desludging. The household can opt for calling a private operator or the ULB for availing this service. Demand desludging has more disadvantages as compared to advantages.

Disadvantages:

- Usually the households call for the service only when there is an emergency such as back flow from the septic tank or stinking odour from the toilets. This essentially means that the containment system is full (more than a year ago or so) well before the service has been called for. Thus, increasing the pollution load on the water bodies where the sullage is disposed.
- The charges for the desludging service are fixed by the private operator based on the ground conditions. These charges can be usually high depending on how worse the situation is. In case of ULBs, the charges are usually fixed and quite affordable but the service is not prompt and hence households do not opt for this option.
- The process of desludging is time consuming as the scum on the top has hardened and needs to be loosened and broken-down using jetting machine. Once the scum is broken down, the contents of the septic tank are mixed well using jetting machine or rods and vacuumed out of the septic tank into the truck. However, the solid content is such cases are quite high and hence the vacuum pump cannot work in optimal range of vacuum and is inefficient.
- Since the call for service can come from any part of the town and households located at varying distances from the treatment/disposal point, there is not scope for optimisation of service making it more expensive.
- Since there is guarantee of income per month for the operators, this discourages the private enterprises from entering into this business. Moreover, the existing operators might tend to charge more in absence of proper regulations.

Scheduled desludging

- Regular and periodic emptying service provided to the household
- Zone by zone desludging
- Financial management with ULB

Challenges

- Requires a strong IEC and BCC
- Difficult to be practiced in ULBs with low tax collection efficiency
- Different sludge accumulation rates and FS storage capacities makes estimation of “optimal frequency” difficult

Advantages

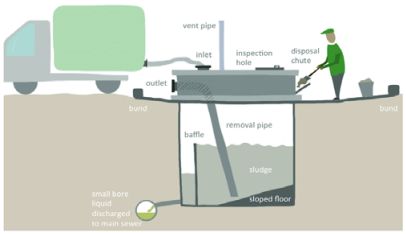
- Avoids emergency
- situation- preventive measure
- Cost effective through program efficiency
- More affordable as the payments are spread out over time
- Ensure the performance efficiency of septic tank

Scheduled desludging is a concept where the containment units are emptied at a fixed frequency decided by the ULB. The households need to be informed in advance regarding the service time. Financial management are to be done by ULB. The advantage of practicing scheduled desludging is that it helps the septic tank to perform consistently. Since the scum is still soft, the desludging process is quite easy and requires less time. The cost of desludging can be brought down by optimising the route. Since the cost of desludging reduces, it becomes more affordable to the households.

Although, there are advantages, scheduled desludging does face some challenges. Operationalising scheduled desludging requires a strong IEC campaign. If the desludging charges are to be recovered in the form of tax, then the ULB should focus of increasing and maintaining the tax collection efficiency. In this case, ICT can be used for improving the performance. Since the sizes of the tank and sludge accumulation rates can differ, the optimal frequency of the desludging cannot be gauged easily.

Transfer station

Permanent Storage Type Station



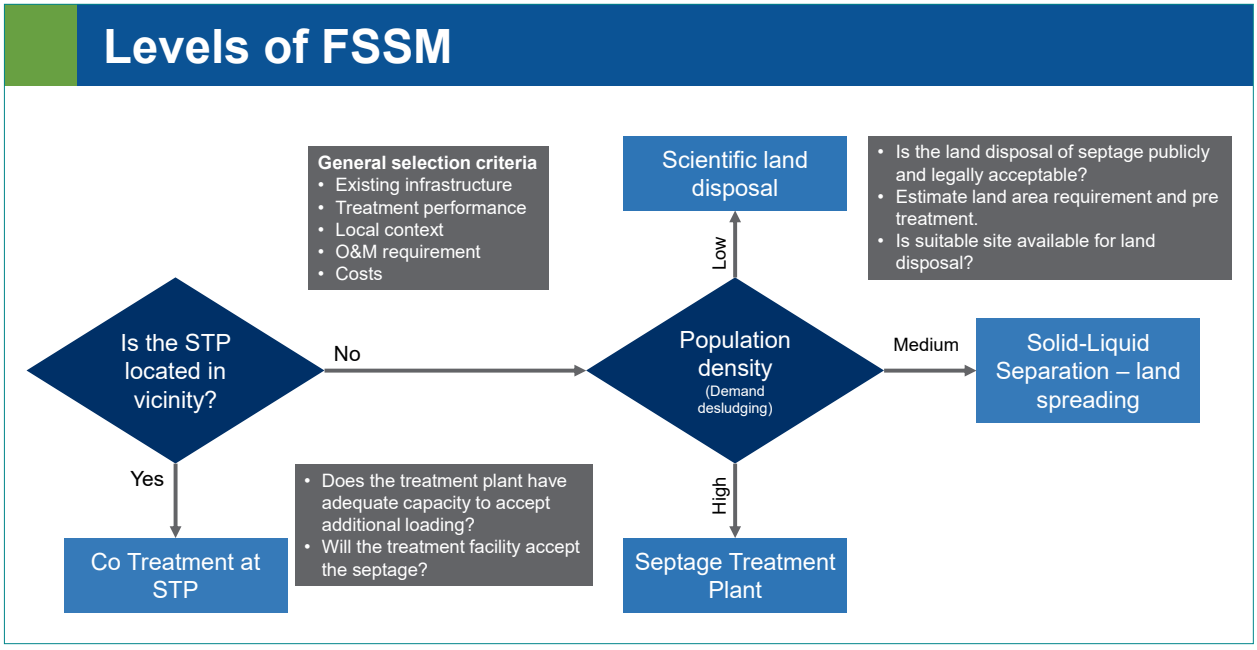
Source: Pierre Mukheibir, 2015

Top of an underground holding tank, showing a chain to lock the lid, a vent pipe and a wall to prevent overflowing excreta travelling onto the road' Source: Boot, 2008

Sludge and septage emptied from on-site sanitation systems need to be transferred to (semi-) centralised infrastructures for further treatment. Transfer stations or underground holding tanks act as intermediate dumping points for faecal sludge and septage when it cannot be easily transported to a (Semi-) Centralized Treatment facility. A vacuum truck is required to empty transfer stations when they are full. Sewer discharge stations are similar to transfer stations, but instead of simply being a holding tank, the stations are directly connected to the sewer transporting the sludge to a (semi-) centralised treatment facility. Transfer stations reduce transport distance, may encourage more community-level emptying solutions and prevent illegal dumping. The moderate capital costs may be offset with access permits and the construction and maintenance can create local income. However, expert design and construction supervision are necessary.

Further reading: http://www.sswm.info/category/implementation-tools/wastewater-collection/hardware/sewers/transfer-stations

3. Options for Treatment



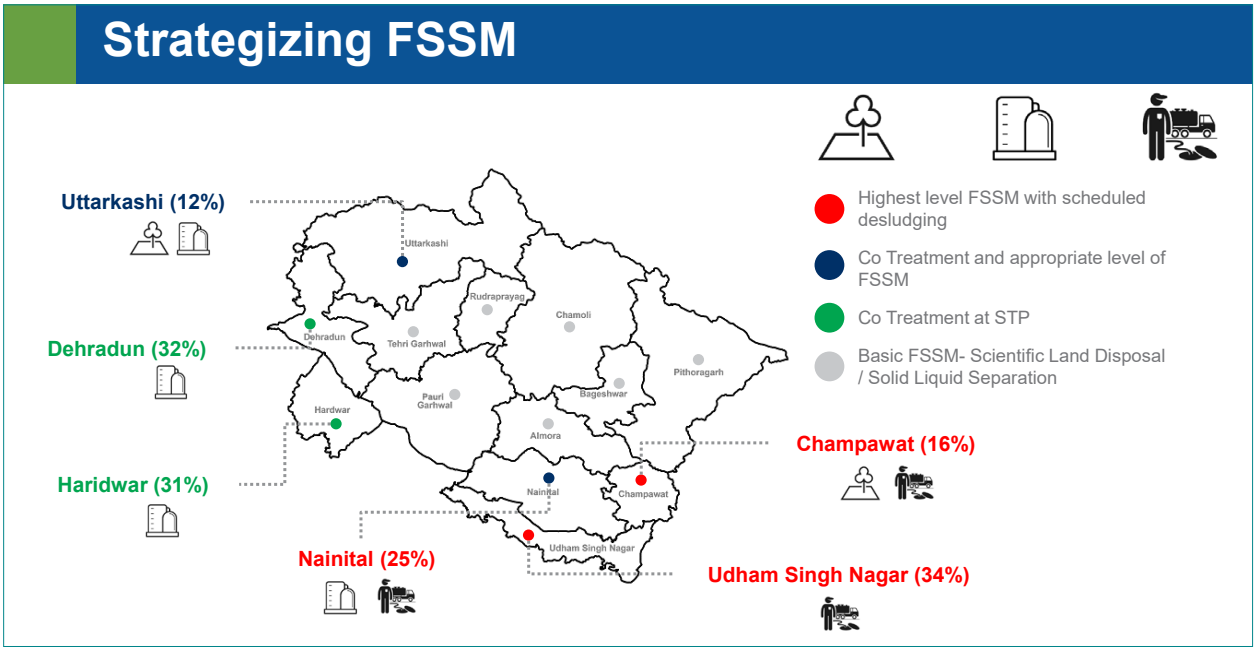
As discussed, earlier FSSM consists of different stages. Emptying & conveyance coupled with treatment of faecal sludge and septage are the most important part. However, in state like Uttarakhand, it is not easy to set up a faecal sludge and septage treatment plant in all the ULBs individual or in clustered. The economic viability of such projects cannot be guaranteed across the state as the cost of construction in mountainous region is quite high and the quantum of septage coming to the plant is not small and inconsistent.

The slide presents decision making chart. 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.

- 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.

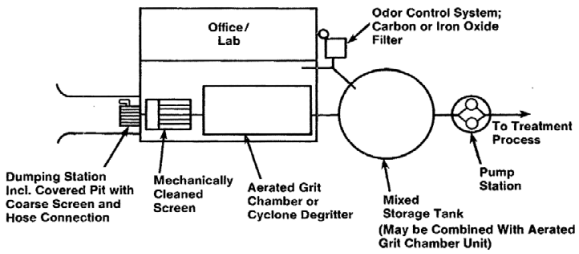
- In ULBs where population density is high and demand for desludging is moderate, it is recommended to have faecal sludge and septage treatment plant. In this case, not only the solids, but the liquid also will have to be treated as per the discharge norms.



According to the decision tree discussed earlier, a basic strategy has been presented for practicing FSSM in Uttarakhand State. Udham Singh Nagar which has experienced highest population growth and ground water table in Uttarakhand state should practice highest level of FSSM with scheduled desludging if possible. Only then it will be possible to protect and water resources and avoid health risk. Dehradun and Haridwar have sewered sanitation systems and hence can practice co treatment. Nainital district attracts lot of tourist due to presence of beautiful lakes. Although sewered sanitation system is set up in Nainital city, highest level of FSSM should be practiced in other parts of the district along with co treatment. Champawat district is also experiencing considerable population growth; hence, moderate level of FSSM should be practiced here. In Uttarkashi the population density is very low, however inflow of tourist is quite high because of its religious importance. Sewered sanitation system has been set up and hence along with co treatment of septage, basic level of FSSM should be practiced in other parts of the district. In all the other districts, since the population growth rate as well the population density is low, basic level of FSSM i.e. scientific land disposal or solid liquid separation can be practiced.

Co treatment at STPs

Permanent receiving stations



US EPA Handbook on Technology Transfer: Septage Treatment & Disposal

Components of Septage receiving station

- Dumping stations
- Screens
- Grit removal
- Equalization tank
- Odor control unit

Objective

To pretreat the septage and safely transfer it to the STP or the sewer network

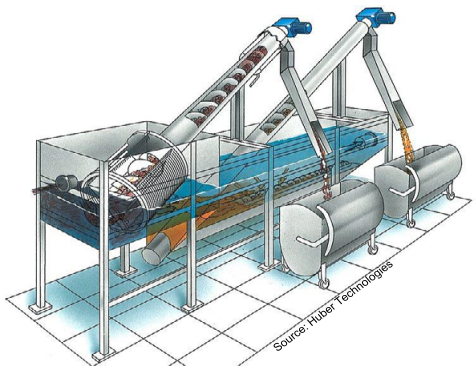
Septage receiving stations are constructed at / near the STP or at pumping station. The function of the station is to pre-treat the septage and transfer the septage to the STP. Components of Septage Receiving Station- Dumping station, Screening, Grit removal, Equalisation tank and Odour control unit. It ensures that the components of the STP do not encounter shock loading in terms of TSS and BOD, COD.

Such receiving stations can accommodate multiple dumping stations, thus multiple trucks are empty the septage simultaneously.

Co treatment at STPs

Mechanized receiving stations

- Mechanical septage receiving stations provide screening, grit removal
- Washes and compresses the screenings for easy transfer or disposal
- Washes the grit and makes it safe further handling or disposal
- Compact and easy to install
- Smaller foot print



In case where space is constraint, mechanised receiving station can be opted for. The mechanized receiving station only needs a platform where the equipment (as shown in the slide) is mounted. The equipment comes in plug and play type. The electrical connection is required and the outlet of the station needs to be connected to appropriate liquid treatment stream. The screening and grit is segregated and washed before dumping it in the bins. Washing of screening and grit helps to keep odour in control and makes it easy for handling and transporting. Since, the inlet to this station is through 4-inch quick release connector, there is no possibility of spillage. Complete receiving station is made from stainless steel and covered thus there is very little scope for corrosion or odour during its operation.

Co treatment in STP

Limiting factor

- Organic & hydraulic loading

Application

- At the Manhole Chamber before the inlet of STP
- At the inlet of Screens of the STP
- At the Sludge Management Process of the STP

Source: ESF/Dhawal Patil

Source: ESF/Dhawal Patil

Source: Faecal Sludge Management- Systems Approach for Implementation and Operation

Co treatment of septage in STP is the most preferred option since, the septage can be treated with minimal investment and at the same time optimise the operational efficiency at the STP. However, through feasibility of co treatment should be checked before practicing co treatment. Limiting factors can be organic loading to the biological treatment and hydraulic loading to the physical treatment processes. Application of pre-treated septage can be done at manhole chamber before the inlet of the STP, inlet of the screens of the STP or directly to the sludge management process.

Land disposal

Suitable for low population density ULBs practicing demand desludging

Surface application	Subsurface incorporation	Deep row entrenchment
	 Source: R. Maguire, Virginia Tech	 Source: OWSSB, Odisha Government Deep Row Entrenchment
Ridge and furrow irrigation method for applying septage to land	Use of special equipment for incorporating septage in the top layer of the soil safely	Special equipment will be required for excavating deep trench.

Scientific land disposal refers to various types of safe land disposal options for septage. The types are classified based on depth at which septage is applied to the land.

- Surface application refers to ridge and furrow method where the septage can be applied. Such furrows can be made between the rows of trees. The solids are arrested in the furrows whereas the liquid is soaked up by the soil around the trees. The liquid containing nutrients improves the biomass generation of the trees. However, appropriate selection of land and tree is essential in order to avoid any adverse effect. It should be noted that the area where surface disposal is to be practices should be restricted, so that animal and humans do not come in direct contact with the septage without knowledge.
- Subsurface incorporation refers to application of the septage just below the surface. This is achieved using specialised equipment as shown in the picture. The machine opens up the land and applies fixed amount of septage before topping off the septage with the excavated soil. This is a better way or land application since, it eliminates possibility of odour and direct contact with septage. However, specialised equipment needs to be used for practicing this method.
- Deep row entrenchment refers to the method where septage is fed to an excavated pit. It is discussed in detail in the next slide.

Deep row entrenchment

Deep trenches, filled with sludge and covered with soil.

Advantages
Simple, low cost, limited O&M, no visible or odour nuisance.

Limiting factor
Land and groundwater table, legislation.

Source: S. Vishwanath, Biome Environmental Trust

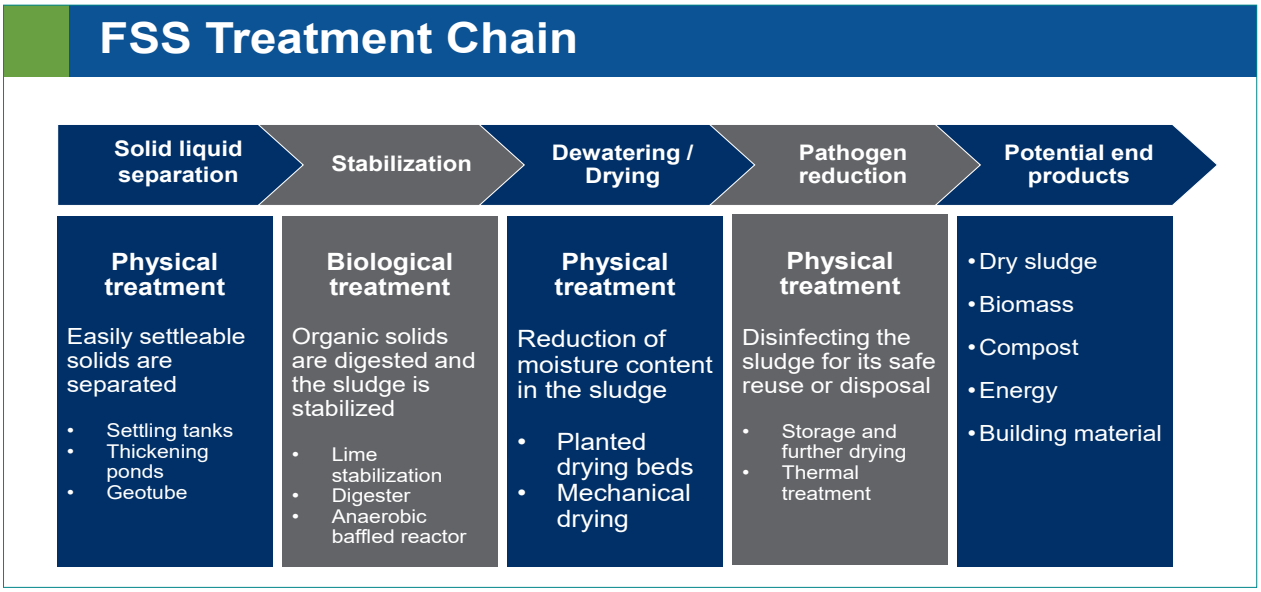
Source: Faecal Sludge Management- *Systems Approach for Implementation* and Operation

Deep row entrenchment (DRE) refers to the method where septage is fed to a excavated pit. Once the pit is fed with septage, the liquid seeps into the surrounding soil and the solids are arrested in the pit. Once the pit is full it is topped off with the excavated earth so that the solids can be stabilized. Once stabilized the content of the pit are converted into terra preta, which can be safely used in agriculture to improve the characteristic of the soil.

DRE is very simple and low on operational expenditure. It does not create any visible of olfactory nuisance. ULBs usually have heavy machinery for earth excavation readily available with them and hence, no specialised equipment is required to start practicing DRE.

DRE cannot be practiced in low lying areas and region where ground water table is high.

4. Faecal Sludge and Septage Treatment Chain



- For understanding the faecal sludge and septage treatment, first we need to understand the stages and processes involved in faecal sludge and septage treatment. Preliminary treatment of screening of solid waste is used for all the technologies as a precautionary measure. In case of septage, the digested solids are easily settleable solids and contribute to COD & BOD of the septage.
- Solid liquid separation physical process is necessary to separate the easily settleable solids from the suspension. Removing the easily settleable solids reduced the COD & BOD. Solid liquid separation can be achieved using treatment units such as settling thickening tank and geo tubes.
- In case of faecal sludge, the solids are not stabilized and hence they are not easy to separate using sedimentation process or dewatering as the bound water content is quite high as compared to the septage. Hence, faecal sludge needs to be stabilized first. This is a biological process and organic solids are digested. This process reduces the BOD and stabilizes the solids. The digested solids can then be sent for dewatering.
- Dewatering/ drying is a physical process where the water content of the solids is further reduced by sludge drying beds (planted/unplanted) or mechanical equipment. The function of this stage is to reduce the moisture content of the sludge so that it can handled easily. In case of planted drying beds, stabilization also occurs since sludge undergoes mineralization over period of months.
- Pathogen reduction is the important stage as this renders the bio solids suitable for reuse or safe to disposal. Disinfection of solids can be achieved by simply storing it over a period of weeks or thermal treatment which includes applying heat to further dry the solids. Incineration and pyrolysis are also options to make the solids bio safe. Incineration and pyrolysis also reduced the volume of solids significantly, hence in cases where disposal of solids is a challenge, these processes become economically viable.
- Drying and pathogen reduction can also be achieved by using the dewatered bio solids for co composting. If done properly, the temperature of the pile (mixture of organic waste and dewatered sludge) rises beyond 65^0 C for adequate duration. Exposure to temperature above 60^0 C leads to pathogen removal. Also moisture of the mixture reduces as the composting process completes achieving adequate moisture content for compost.

- Depending on what treatment units are chosen, end products are obtained. In most cases, bio solids in the form of dry solids/biomass are obtained. If the bio solids are used for co composting, then organic compost is obtained as end product. If digester is used for stabilisation of faecal sludge, energy can be obtained in the form of methane gas. Methane gas a good calorific value and can be used as cooking fuel or fuel for running generators to generate electricity. In case of incineration and pyrolysis energy is obtained in the form of heat. This heat can be used for various purposes such disinfection or running a steam engine to generate electricity. Fly ash from incineration can be used for making fly ash bricks. Pyrolysis produced bio char which is alternative to coal or can also be used as soil additive for improving its characteristics.

FSS treatment chains

Solid Liquid Separation	Geobags	Settling thickening tank	Settling thickening tank	Settling thickening tank
Stabilization		Lime stabilization		
Dewatering/ Drying	Sun Drying	Planted/ Unplanted drying beds	Mechanical dewatering	Mechanical dewatering/ drying
Pathogen reduction	Storage	Drying / Co composting		Incineration

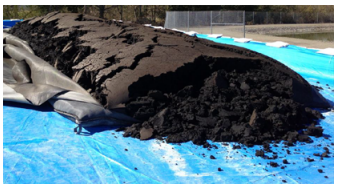
The slides show four different treatment chains (vertical) suitable in case of Uttarakhand state. The first treatment chain is the most simple and low on CAPEX and OPEX. The second is non mechanized treatment consisting of settling thickening tank, lime stabilization (optional), drying beds (planted/unplanted), co composting. The third and fourth treatment chain is mostly mechanical (settling thickening is optional although preferred for efficient dewatering using mechanical equipment). The CAPEX and OPEX of these treatment chains are on higher side, however, they are quite compact when compared to sludge drying beds.

Solid liquid separation

Geo tubes can be used for solid liquid separation. The tubes are one time use only and hence once cut open, needs to be washed and reused for protecting surface from soil erosion or slope stabilization is landslide prone area.

Geotube

Source: Fibertex Geotubes



Source: VIRIDIS Engineering Sdn Bhd

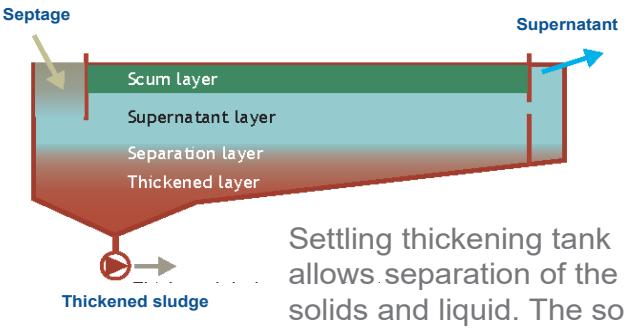
Geotubes are made from a specialised woven fabric made out of polypropylene material. The fabric has pores of fixed size. When the septage is pumped into the geo tube, the solids bigger than the size of the pores is retained inside and the liquid bleeds out of the tube. The free water leaves the geo tube immediately, however, the bound water takes seeps out of the tube over a period of day. Once the tube is filled and the seepage stops, the bags are cut open for sun drying of solids as shown in the picture above.

The Geotubes cannot be reused for solid liquid separation and hence needs to be washed before repurposing or disposing. The fabric can later be used for protecting surface from soil erosion or slope stabilisation in land slide prone area.

Solid liquid separation

Settling thickening tank

The settleable solids can contribute to up to 90% to the TSS, BOD and COD of the septage



Source: Faecal Sludge Management- Systems Approach for Implementation and Operation

Settling thickening tank allows separation of the solids and liquid. The solids need to be further treated before disposal

Settling thickening tank is another option to achieve solid liquid separation. The picture on the left shows the separation of solids and liquid in an Imhoff cone. The separation processes take few hours, however for thickening the sludge layer takes few days. The solid content of the septage usually is around 1%. The thickened sludge from the settling thickening tank can achieve solid content up to 12% if designed and operated well. The reduction of the solid content in the liquid effluent reduced the COD, thus bringing the COD to BOD ratio closer to 2 (domestic sewage has COD to BOD ratio of 2). Thus, the liquid effluent from the settling thickening can be treated with wastewater treatment technologies. The thickened sludge from the tank is sent for dewatering.

Dewatering/Drying

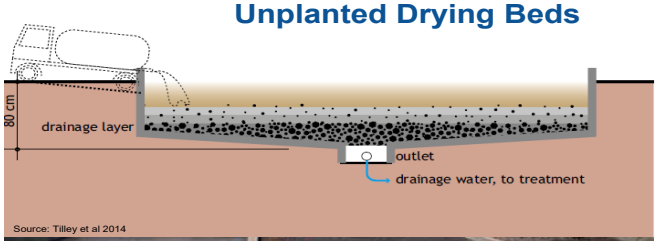
Shallow filters with sand and gravels with under drain to collect filtrate.

Application
Climatic factor and types of sludge

Advantages
Low cost and ease of operation

Limitation
Large footprint and odour potential

Unplanted Drying Beds



Source: Tilley et al 2014

Source: Faecal Sludge Management- Systems Approach for Implementation and Operation

Unplanted drying beds are shallow filters with filter bed made out of combination of gravels and sand. The beds have under drain to collect the filtrate which is collected in filtrate sump by gravity. The free water in the sludge drains out of the filter bed and the bound water is removed from the sludge by evaporation. The design of the sludge drying bed is based on the evaporation rate which is determined by the average temperature and humidity. The operational cycle of unplanted sludge drying beds ranges into weeks depending upon the local conditions. The sludge drying beds have relatively low CAPEX and since they are easy to operate and low on OPEX. The biggest limitation of drying beds is their area requirement is quite high and if not operated properly the odour can be a nuisance.

Dewatering/Drying

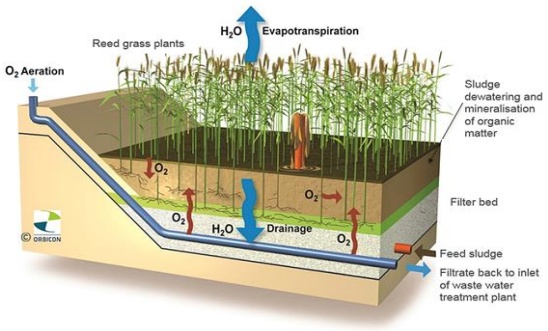
Planted Drying Beds

Unplanted drying bed with emergent macrophyte

Application:
Climatic factor

Advantages
Low cost and ease of operation

Limitation:
Large footprint and odour potential

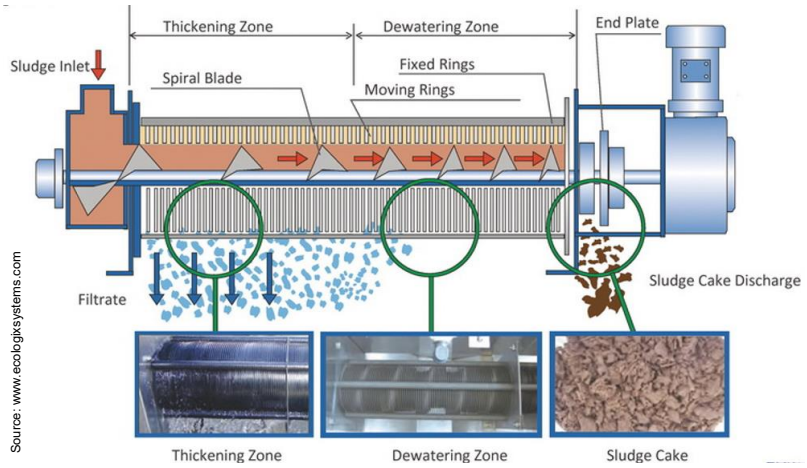


Planted drying beds are similar to the unplanted drying beds having macrophyte such as cattail, typha etc. In this case the bound water is removed by evapotranspiration. The difference between the planted drying bed and unplanted drying bed is the way they are operated and stabilization of sludge. Unlike unplanted drying beds, the operational cycle of planted drying beds is in months. Each bed is used for months before it is made non-operational. Since the sludge stays in the beds for a long time, mineralisation of the sludge also occurs. The nutrients are taken up by the plants leaving behind mineralised solids behind.

In most of the cases the planted drying beds are made dysfunctional, however there are cases where the filter media has been removed, washed and reinstalled. The application criteria, advantages and limitations are similar to unplanted drying beds.

Mechanical Dewatering/Drying

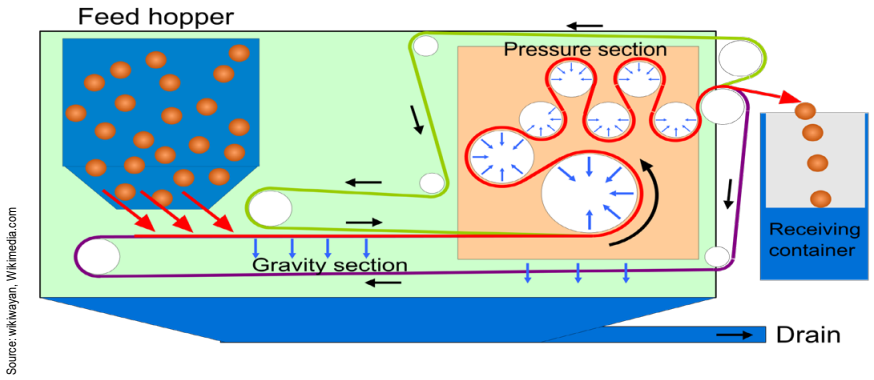
Screw Press



A screw press consists of a rotating screw placed in a perforated cylinder. The sludge is loaded at one end and the dewatered solids is discharged at the other end. A screw press has two zones, first is the thickening zone where free water drains out and the next is dewatering zone. Here the sludge is it is compacted 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. Although the screw press can operate for varying solid content, it is recommended to operate it at a consistent solid loading rate. This can be achieved by conditioning the sludge using polymer before it enters the screw press. This increases the CAPEX of the system as now it needs polymer making and dosing equipment. Although this increase in the cost is quite small, the operational expenditure increases as a good quality polymer can be quite expensive. Alternative is to have a settling thickening tank, which thickens the sludge to adequate consistency. Typically, a solid content up to 25% can be achieved using screw press. The dewatered solids now only contain mostly bound water which can only be removed using evaporation.

Mechanical Dewatering/Drying

Belt Press



As the name suggest, a belt press consist of belts which squeeze out the water from 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:

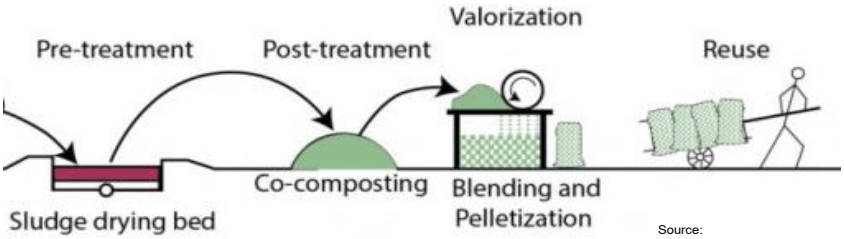
- A gravity drainage zone where the flocculated sludge is deposited and conveyed on a porous and mobile belt;

- 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.

Co composting

- C:N Ratio = 20-30:1, Oxygen concentration: 40-60%, Particle diameter < 5 cm
- **Advantages:**
  Thermophilic condition- Pathogen inactivation
- **Limiting factors:**
  Technical and managerial skills

Source: www.iwmi.cgiar.com

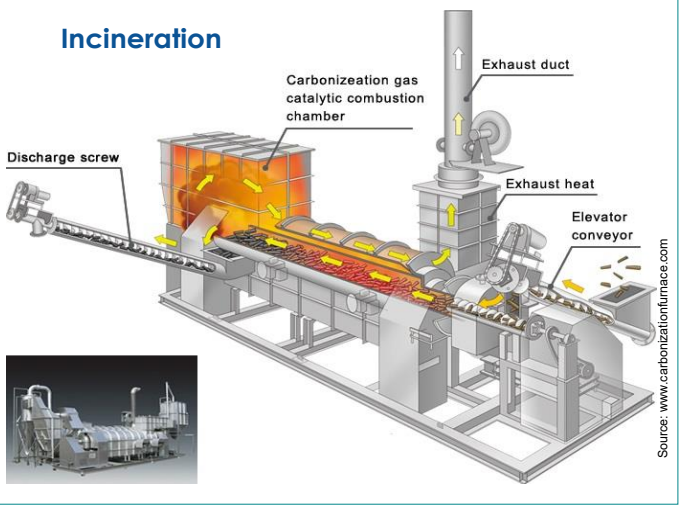


Source: www.wateratleeds.com

Co composting can be performed on the dewatered sludge. Sludge is rich in nitrogen and if mixed with organic solid waste to achieve C:N ratio of 30 then aerobic composting can be done. Thermophilic condition is required for pathogen inactivation and hence care needs to be taken to achieve optimum temperature and maintain oxygen concentration between 40% - 60%. The advantage of the co composting is that it performs drying and pathogen reduction simultaneously and generates a end product with higher value in the market. Limiting factors to practice co composting can be technical and managerial skills along with area required to manage the piles.

Sludge Drying - Heat Treatment

- Dewatered sludge is dropped onto the conveyor belt
- The sludge is furthered dried using the exhaust heat
- The dried solids go for dry pyrolysis or incineration
- The by product such as biochar or fly ash is taken out from the combustion chamber
- Exhaust gases to meet discharge standards



Source: www.carbonizationfurnace.com

The dewatered sludge is dried using the hot air from the combustion chamber. The dried solids then fall into the combustion chamber. This chamber can be operated as an incinerator or pyrolizer. The operating temperature and supply of oxygen determines of the combustion process. The solids are first converted in to carbon (commonly known as bio char) at a lower temperature

(4000 C – 6000 C) and further the bio char burns to produce more heat and higher temperature up to 8000 C – 9000 C.

There is complete elimination of pathogen from the solids and significant volume reduction is also achieved. The advantage of such system is it is very compact and gives quite consistent results. The end product such as bio char has good calorific value and can be used in furnaces. However, economic viability needs to be checked. Disadvantages are the high CAPEX, need of electricity to for treatment and requirement of skilled persons makes it costly and difficult to operate.

Selecting context-appropriate technical options

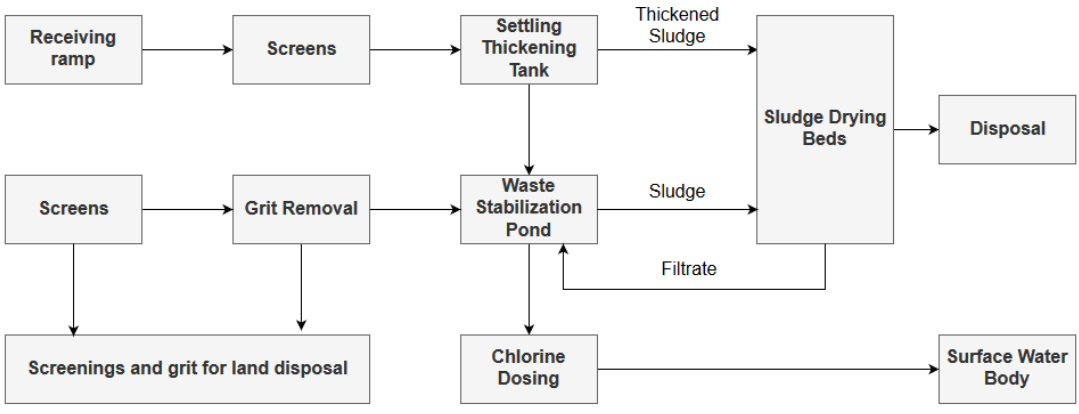
Treatment Performance	Local Context	O & M requirements	Costs
• Effluent & sludge quality according to national standards	• Characteristics of sludge (dewaterability, concentration, degree of digestion, spreadability) • Quantity & frequency of sludge discharged at the FSTP • Climate • Land availability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

Source: Faecal Sludge Management- Systems Approach for Implementation and Operation

Appropriate selection of technology for faecal sludge and septage treatment is key to bring down the overall cost of FSSM. Selection of technology is dependent on various factors which are listed above in the slide. However, this list if not extensive and once must investigate all possible factors before arriving at a decision. Usually technologies with lower CAPEX are preferred; however, it is wise to check other factors which can result into significantly higher OPEX affecting the sustainability of FSSM.

5. Case Studies

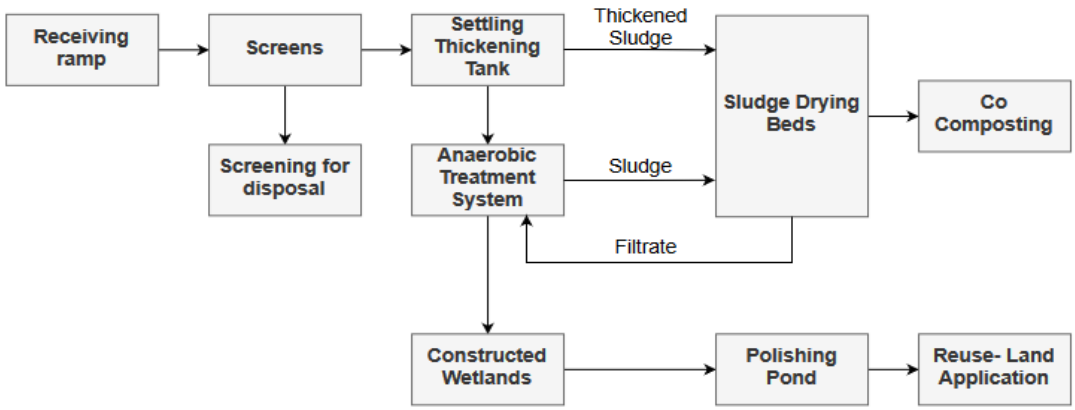
Co Treatment- Puri



The city of Puri has sewered sanitation system and had planned for STP with design capacity of 15 MLD based on aerated lagoon technology. However, due to technical difficulties not all the properties can be connected to the sewerage network and hence co treatment was septage was adopted for completing the non sewered system. Currently the co treatment facility is located at the STP and has been augmented with screens and settling thickening tank (STT) of capacity 50 KLD. The liquid effluent from the STT goes for co treatment into the waste stabilization pond system where as the thickened sludge is sent for drying to sludge drying beds which were planned for STP. The treatment chain for co treatment of septage has been elaborated in the slide above.

Co Treatment- Puri

Septage Treatment Plant- Bhubaneshwar



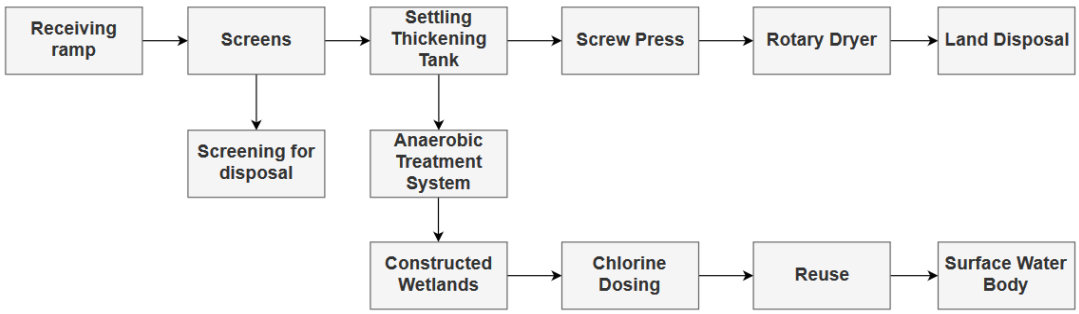
The city of Bhubaneshwar is planning for sewered sanitation system, however, until the sewerage network and STP is developed, Odisha Water Supply and Sewerage board installed a SeTP with design capacity of 75 KLD. The treatment chain is elaborated in the slide above. The plant treats the solids and liquid completely and has been designed as a zero liquid discharge plant. The bio solids are reused for plantation around the plant and the liquid is also completely utilised in and around the plant to maintain the green spaces.

After the receiving ramp, the septage is emptied into the screen chamber, which segregates the solid waste from the septage. The septage then flows into the STT where the solid liquid separation happens and the sludge undergoes thickening process. The thickened sludge is then pumped to the sludge drying beds for further dewatering and drying. The dried solids are then co composted with the organic waste (dry waste from the lawn and plants in the SeTP premise). The liquid from the STT flows under gravity to the anaerobic treatment (anaerobic settler, anaerobic baffled reactor and anaerobic up flow filter) followed by aerobic treatment in constructed wetlands. Finally, the clarified water comes to polishing pond where is disinfected and kept aerated using cascade aeration.

Septage Treatment Plant- Bhubaneshwar

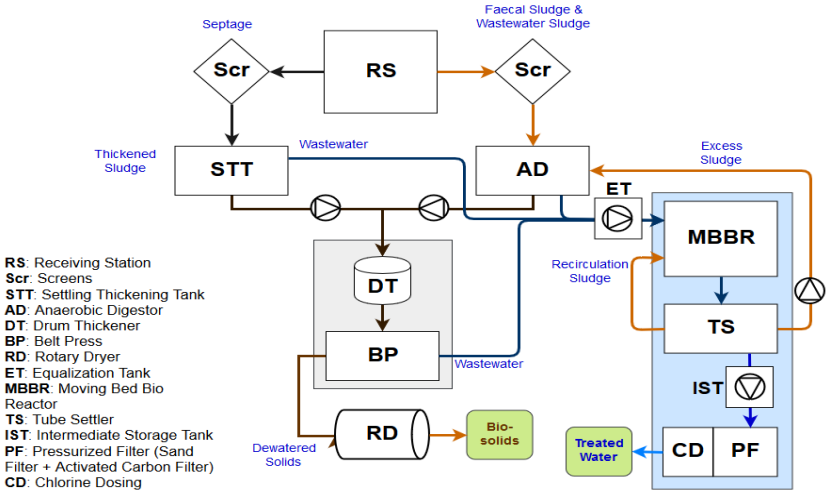
Source: Dhawal Patil, ESF

Septage Treatment Plant- Rudrapur



In case of Rudrapur, similar treatment scheme is used for liquid effluent from STT. However, the thickened sludge is sent for mechanical dewatering using screw press followed by rotary drier which ensures complete disinfection of bio solids. Due to the proximity of the plant to the residential premise and relatively cooler climatic conditions, unplanted sludge drying beds were avoided. The design capacity of the Faecal sludge and Septage Treatment plant is 125 KLD. The treatment chain is shown in the slide above. The bio solids will be sent for land disposal and the treated water will be sent for disposal in the surface water body next to the treatment plant.

FSS Treatment Plant- Port Blair



A faecal sludge and septage treatment plant is planned in city of Port Blair, Andaman Nicobar Islands under their Smart City Project. The city of Port Blair experiences floating population twice its population. The city also serves as entry and exit point for Andaman and Nicobar Islands. Due to undulating terrain, implementation of sewered sanitation system is difficult and expensive. As a result of this, Port Blair Municipal Corporation (PBMC) has resorted to FSSM approach for tackling its liquid waste management. The design capacity of the plant is 42 KLD. The treatment chain is shown in the slide above.

In Port Blair, three types of sludge are expected to be received at the plant- septage from the households, faecal sludge from the public toilets and sewage sludge from resorts. The sludge will be received at the receiving station equipped dumping station and screens. Depending on the type of sludge, it is sent either to STT or anaerobic digester (AD). The thickened sludge from both units is sent for mechanised dewatering which is achieved using belt press. Once the solids are dewatered, they are disinfected using rotary drier where electrical heat is used to dry the solids. The liquid effluent from the STT and AD is sent for further treatment in MBBR where it is treated upto discharge standards. The bio solids and treated water is not discharged into the environment. PBMC is planning to use the bio solids for co composting in their SWM plant and the water will be used for irrigation in the public gardens, construction and curing of RCC roads and cleaning of public places such as parking lot.

Summary

- Non sewered sanitation shall be practiced in mountainous regions of Uttarakhand state.
- Scheduled desludging is pro-environment, however it is difficult to be practiced without appropriate byelaws and data collection
- Combination of different emptying and conveyance technology options is necessary
- Mobile dewatering unit can provide basic FSSM in mountainous region
- Choosing appropriate treatment option is specific to local context and cannot be generalized across the state like Uttarakhand

- Non sewered sanitation shall be practiced in the mountainous region where implementation of sewered sanitation system is economically not viable. This will significantly minimise the pollution of the surface water bodies. Hybrid sanitation systems are prevalent in the most of the towns and FSSM will complete the sanitation systems. Hence, it is recommended that ULBs should start practicing FSSM until sewered sanitation system is implemented and made operational.
- Scheduled desludging is pro-environment and should be practices in ecologically sensitive areas such as ULB close to river bodies and having higher ground water table. However, without complementing bye laws and regulations, it will be a challenge to operationalise scheduled desludging of septic tanks. Considerable data collection is also needed in order to assess the requirement and draft plan of scheduled desludging.
- Because of the undulating terrain and other local constraints, combination of different emptying and conveyance technologies will be required. Vacutug will be required in cities where internal roads are narrow.
- Dewatering trucks are suitable as it eliminates need of designated solids handling site for solid liquid separation. Moreover, this truck can cater to cluster of ULBs if required. Dewatering trucks can also ease and optimise the operation of scheduled desludging services.
- Choosing appropriate treatment option depending on the local context is the most important part of planning of FSSM. Since the climatic and hydrogeological conditions are varying across the state significantly, there is no single options which can be replicated across the state.

Session

04

Exercise: Planning And Finance

1. Exercise – Emptying, Conveyance, Treatment and Property Tariff

Emptying and Conveyance

Input details

No.	Description	No.
1.	Population	1,54,554
2.	Total households (HHs)	29,662
3.	HHs having septic tanks (STs)	19,103
4.	No. of community septic tanks	15
5.	Average volume of HH septic tank	3 cum
6.	Average volume of community septic tank	8 cum
7.	Septic tank desludging frequency	3 years
8.	No. of working days in a year	300 days
9.	Capacity of vacuum truck (VT) per trip	3 cum
10.	No. of trips per VT per day	3 trips / truck * day

Step I

$$\text{HHs to be serviced annually} = \frac{\textit{HHs having STs}}{\textit{Desludging frequency}}$$

$$\text{HHs to be serviced daily} = \frac{\text{HHs to be serviced annually}}{\textit{Total number of working days}}$$

Similarly calculate the Community Toilets to be serviced daily!

Step II

Total volume of FS to be treated daily =
(HHs Septic Tanks serviced daily x Volume of HH Septic Tank) +
(Community Septic Tanks serviced daily x Volume of community Septic Tanks)

Step III

$$\text{Total trips of vacuum trucks} = \frac{\text{Total Volume of FS to be treated}}{\text{Capacity of the vacuum truck per trip}}$$

$$\text{No. of vacuum trucks required} = \frac{\text{Total no. of trips per day}}{\text{No. of trips per vacuum truck per day}}$$

Input details

No.	Description	No.
1.	Average distance per trip (to and fro)	20 km
2.	Fuel price	INR 70 / Lit
3.	Average of the vacuum truck (VT)	5 km / Lit
4.	Average cost of O&M per VT	INR 3000 per month
5.	Persons per vacuum truck	3 per truck
6.	Person month cost	INR 10,000
7.	Overhead + Insurance + Miscellaneous cost	10%

O&M cost of conveyance

(A) *Fuel cost for scheduled desludging =*
(No. of trips of VTs daily × 300 days × Average distance per trip) × $\frac{\text{(Fuel Price)}}{\text{Average of the vacuum truck}}$

(B) *Repair and maintenance cost of VT =*
(No. of VTs required × 12 months × Average O&M cost of VT per month)

O&M cost of conveyance

(C) Human resource cost =
(No. of VTs required × 12 months × No. of persons per VT × person month cost)

(D) Sub total= (A) + (B) + (C)

(E) Overheads + Insurance + Miscellaneous Costs= (D) × 10%

(F) Total O&M cost of conveyance= (D) + (E)

Estimating Techniques - Operation and Maintenance Cost of Treatment

Input details

No.	Description	No.
1.	Energy cost	< 25 cum/d = INR 5,000 25-50 cum/d = INR 10,000 50-75 cum/d = INR 15,000 >75 cum/d = INR 20,000
2.	O&M or electro-mechanical components	INR 5000 per month
3.	Human resource requirement	1 Operator 2 skilled persons 4 guards (2 per shift)
4.	Person month cost	Operator = INR 25,000 Skilled person = INR 15,000 Watchmen = INR 8,000
7.	Overhead + Insurance + Miscellaneous cost	10%

O&M cost of treatment

(A) Energy cost = Energy cost per month × 12 months

(B) O&M cost of electro-mechanical components = O&M cost per month × 12 months

(C) Human Resource cost = (No. of Operator × person month cost × 12 months) + (No. of skilled person × person month cost × 12 months) + (No. of watchmen × person month cost × 12 months)

O&M cost of treatment

(D) Sub total= (A) + (B) + (C)

(E) Overheads + Insurance + Miscellaneous Costs= (D) × 10%

(F) Total O&M cost of treatment= (D) + (E)

Estimating Techniques – Property Tariff Calculations

Property tariff calculation

Assuming that the conveyance and the treatment is handled by the same public utility and the property tax collection efficiency of ULB is 60%

Annual O&M cost = Annual O&M cost of conveyance + Annual O&M cost of treatment

Property tariff = Annual O&M cost / (Total no. of properties × Property tax collection efficiency)

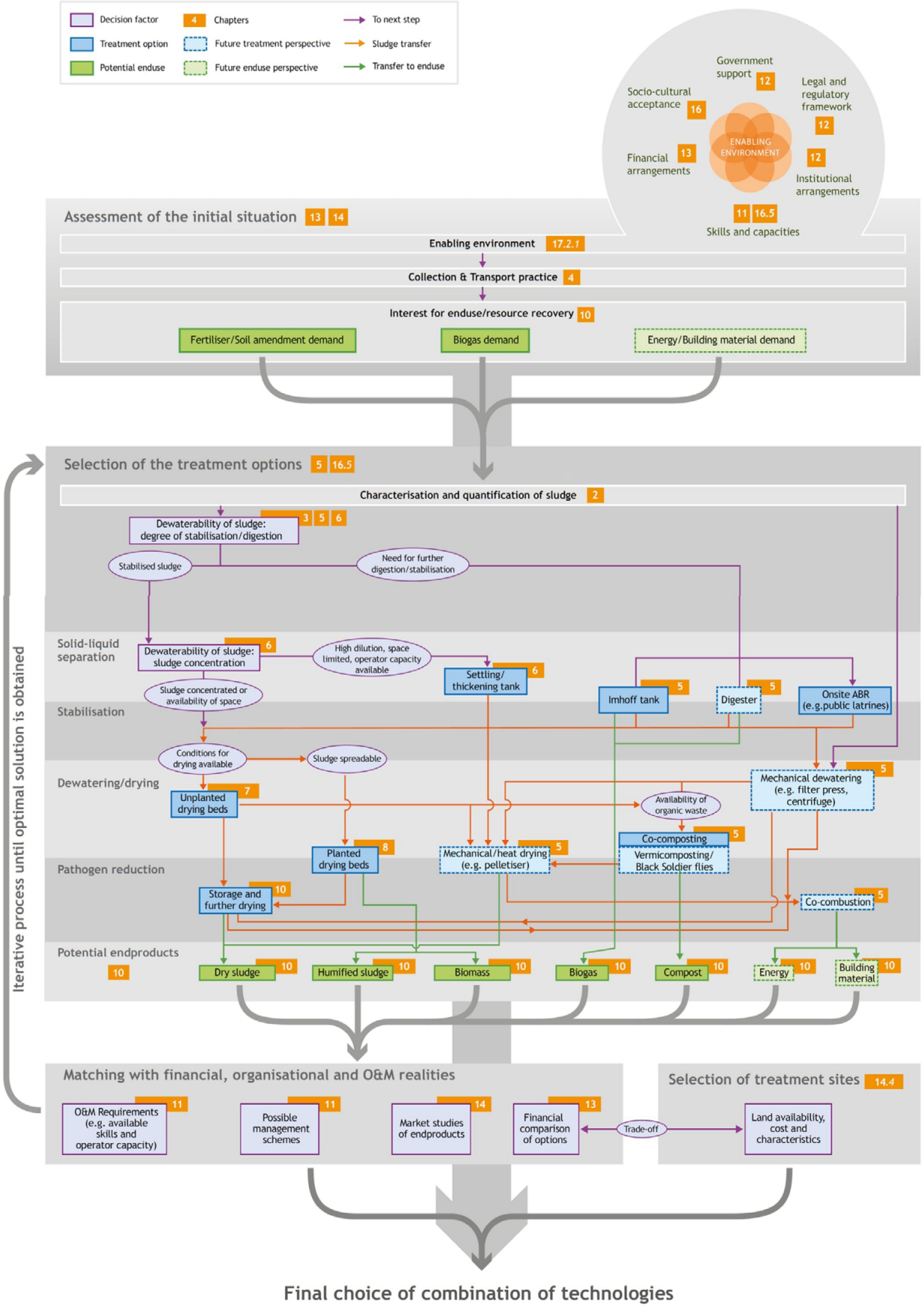
Action plan

	Containment Unit	Emptying & Conveyance	Treatment	Reuse & Disposal
Planning • Stakeholders • Data collection • Type of desludging				
Technology • Identifying suitable technologies				
Management • Legal and regulatory framework • Financial models				

In this exercise, the group has to prepare an action plan. The group has to write down the actions and tasks that need to be taken for operationalising FSSM in their city. The activities can be classified under planning, technology and management. Few pointers are given under each section, Ex. Identification of stakeholders, data collection etc.

The activities will have to be thought for each component of the sanitation service chain- containment unit, emptying and conveyance, treatment and reuse and disposal.

Selecting a context-appropriate combination of faecal sludge treatment technologies



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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.

National Institute of Urban Affairs

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FSSM: ORIENTATION MODULE

PART A: PRESENTATION SLIDES