Ministry of Housing and Urban Affairs
Government of India
सत्यमेव जयते

स्वच्छ भारत
एक कदम स्वच्छता की ओर

ADVISORY
ON
ON-SITE AND OFF-SITE
SEWAGE MANAGEMENT PRACTICES

Central Public Health and Environmental Engineering Organisation (CPHEEO)
www.swachhbharaturban.gov.in
May 2020

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Chapter 1. Introduction

1.1 Background

- Census data 2011 indicates the total urban population of the country at **377.10 million (statuary plus census town)and is projected to touch 600 million by the year 2030**.
- In many low and middle-income cities/towns, installing a comprehensive sewerage system is often not a feasible option due to high capital and O&M cost and availability of adequate piped water supply as a prerequisite.
- In such cases, a properly managed on-site sanitation system [e.g. septic tank + soak pit] coupled with sanitation value chain offers a feasible and affordable solution.

1.2 Current Sanitation Scenario

- **2.7 billion people** around the urban world use on-site sanitation technologies that need faecal sludge and septage management services
- The highest numbers are in **Eastern Asia with 1.1 billion people**, Southern Asia with 593 million people, and Sub-Saharan Africa with 439 million
- As per the 2011 Census, **81.4% urban households** had toilet facilities within their premises, **32.7% households** had water closets connected to sewer system and **38.2% households** were having water closets with septic tank.
- **61 lakh** individual household toilets and **5.82 lakh** Community/Public Toilets seats constructed under **under Swachh Bharat Mission (SBM-U).**

The alarming issues for households covered with onsite sanitation systems are:

- **Poor construction quality** of the septic tanks and soak pits
- Absence of **periodic monitoring** of functioning of these on-site sanitation systems
- No mechanism in place for safe collection, transportation, treatment and disposal of accumulated sludge in septic tanks
- **Unregulated disposal** of faecal sludge and septage
- Substantial number of households which have not installed soak pits discharge about 50% of influent pollution load

1.3 Poor sanitation-Cost to Nation

- As per Word Bank report titled "**Economic Impacts of Inadequate Sanitation in India, 2011**", estimated the annual economic impact of inadequate sanitation in India at **Rs. 2.44 trillion** in the year 2006 which is equivalent to **6.4 percent of the country's GDP**.
- As per Ministry of Health & Family Welfare, official data of 2018, Water Sanitation and Hygiene related diseases registered **69.14 Million cases from 2013 to 2017**.

1.4 Initiatives Taken by Government of India

- **Programmatic initiatives**
  - Swachh Bharat Mission – Urban (SBM-U)
  - Atal Mission for Rejuvenation and Urban Transformation (AMRUT)
- **Policy initiatives**
  - National Urban Sanitation Programme (NUSP), 2008
  - Manual on Sewerage and Sewage Treatment Systems, 2013
  - National Policy on Faecal Sludge and Septage Management (FSSM), 2017
  - Standard Operating Procedure (SOP) for Cleaning of Sewers and Septic Tanks, 2018
  - Advisory on Emergency Response Sanitation Unit (ERSU) 2019
  - Various Advisories on Sanitation

1.5 Regulatory Framework

- Central Laws include the Environment (Protection) Act, 1986, the Water (Prevention and Control of Pollution) Act, 1974
- The provisions of the Bureau of Indian Standards (BIS) (IS:2470)
- The Employment of Manual Scavengers and Construction of Dry Latrines (Prohibition) Act, 1993
- The Government has also laid down standard e.g. IS 11972 – 2002: Code of Practice for Safety Precautions to Be Taken When Entering a Sewerage System

Treated sewage effluent discharge standards

S. no.	Parameters	General norms 1986				MoEFCC Notification, October 2017**	NGT order 2019** (for mega and metropolitan cities)
		Inland surface water	Public sewers	Land irrigation	Marine coastal areas		
1	BOD [mg/l]	30	350	100	100	< 30 < 20 (metro cities)	<10
2	COD [mg/l]	250	–	–	250	Not more than 50 (for new STP design)	< 50
3	TSS [mg/l]	100	600	200	100 process water 10% of influent cooling water	< 100 < 50 (metro cities)2	< 20
4	TKN [mg/l]	100	–	–	100	Not more than 10 (for new STP design)	< 10
5	NH3-N [mg/l]	50	50	–	50	Not more than 5 (for new STP design)	–
6	Dissolved phosphorus [mg/l]	5	–	–	–	–	<1
7	Faecal coliform [MPN/100ml]	–	–	–	–	< 1000	Permissible < 230

Definitions & Terminology

- **Activated sludge:** An aerobic treatment process in which oxygen and micro-organism concentrations in wastewater are artificially elevated to facilitate rapid digestion of biodegradable organic matter.
- **Faecal Sludge:** The accumulated semi-solid or solid portion that settled at the bottom of the septic tank which comprising 20% - 50% of the total septic tank volume is termed as faecal sludge.
- **Off-site sanitation:** A system of sanitation that involves collection and transportation of waste (wastewater either by sewerage or septage/fecal sludge by vacuum truck) to a location away from the immediate locality.
- **Onsite Sanitation:** On-site sanitation is a system of sanitation whose storage facilities are contained within the plot occupied by a dwelling and its immediate surroundings.
- **Sanitation:** Normally sanitation is a broad term and refers to both solid and liquid waste management, however, in this advisory, sanitation is referred to as sewage management only.
- **Septage:** Septage is the liquid and solid material that is pumped from a septic tank, cesspool, or such onsite treatment facility after it has accumulated over a period of time.
- **Sewerage System:** The underground conduit for the collection of sewage is called Sewer.
- **Sludge:** The settled solid matter in semi-solid condition – it is usually a mixture of solids and water deposited on the bottom of all anaerobic and aerobic sewage treatment systems like septic tanks, oxidation ponds and Activated Sludge plants etc.
- **Wastewater:** Liquid wastes from households or commercial or industrial operations, along with any surface water/storm water.

Chapter 2. Objectives & Scope

2.1 Objectives

The main objectives of this Advisory is to:

- **Strengthen on-site sewage management practices** to cover entire urban population with safe sanitation facilities.
- **Facilitate ULB officials with basic knowledge** of the on-site and off-site sewage management techniques and also to empower them to take decisions on suitable technology/ approach
- Detailed **guidance on periodic desludging of septic tanks and treatment of Faecal Sludge and Septage** using various available methods.
- **Help achieve Target 6.2 of Sustainable Development Goals (SDG)**- requiring India to achieve access to adequate and equitable sanitation and hygiene for all by 2030.
- **Facilitate ULBs for faster procurement of services/ products** by way of preparing and providing model tender documents, concession agreement etc.
- **Improve health** as the poor sanitation inflicts huge health hazards.
- Help ULBs meet forthcoming challenges during **implementation of various programmes and missions** of States/GoI.

2.2 Scope

This Advisory inter *allia* covers the following;

- **On-site sewage management techniques** along with their key features, merits and demerits, capital as well as Operation and maintenance costs.
- **Norms on safe containment, collection and transportation** of Faecal Sludge and Septage in urban areas.
- **Standalone treatment of Faecal Sludge and Septage and/or its co-treatment** in other feasible options like Sewage Treatment Plants, Bio-methanisation plants or Thermo-Mechanical Treatments.
- **The Off-site waste water treatment options** with their merits and demerits, requirements of land for its set up and capital as well as Operation and maintenance costs.
- **Reuse/recycle of treated by-products** of Septage/Sewage in the true spirit of circular economy.
- **Procurement of services** including concession agreement

Chapter 3. City Sanitation Planning

3.1 The Planning Process

The City Sanitation Plan preparation broadly involves the following elements.

1. Identifying planning area to cover with safe sanitation facilities
2. Existing sanitation coverage
3. Characteristic of Sewage and Faecal Sludge & Septage
4. Identifying the excreta flow routes in city/town
5. Identify existing Sewage Treatment plants/ Solid waste Plants within the city or in nearby city suitable for co-treatment.
6. Identify available lands for setting up new processing facilities on standalone/ shared basis.
7. Identifying the availability/ constraints of funds
8. Decision making tree to select one of the two feasible options viz onsite & offsite
9. Factors to be considered in Technology choices
10. Plan to operationalize Sanitation Value Chain
11. Reuse of the reclaimed water from treated sewage/septage and conditioned sludge that are hygienically safe
12. Consultation with the stakeholders to evolve a complete acceptance of physical, financial and managerial aspects
13. Collaboration with other planning agencies at local, state and national levels to ensure co-ordination in allocation of priorities and resources
14. Institutional Set up for planning, Implementation, ICT based monitoring and O & M
15. IEC and enforcement of regulations

3.2 City Sanitation Plan Preparation

The planning process elements are briefly elaborated to help in preparing sound City Sanitation Plans.

3.2.1 Identify planning area

The first task will be to determine the planning area. This will be influenced by physical realities, in particular, existing settlement patterns and administrative boundaries. It should be determined in consultation with local government and service providers.

3.2.2 Existing sanitation coverage

The objective of this is to gather information about the coverage and quality of existing services to clarify the key problems to be addressed and priority locations for improvement.

3.2.3 Characteristic of Sewage and Faecal Sludge & Septage

	Sewage	Septage	Public Toilet Sludge
Characteristics	Tropical Sewage	Low Concentration (Well Stabilized)	High Concentration (Mostly Fresh)
COD (mgl)	500–2,500	10,000	20,000–50,000
COD/BOD	2:1	5:1–10:1	2:1–5:1
NH4–N (mgl)	30–70	1,000	2,000–5,000
TS	1%	3%	3.5%
SS mgl	200–700	7,000	30,000
Helminth eggs (no/litre)	300–2,000	4,000	20,000–60,000

Source: *Co-treatment of Septage and Faecal Sludge in Sewage Treatment Facilaities, Dorai Narayana (2020)*

3.2.4 Shit Flow Diagram: A City Sanitation Planning tool

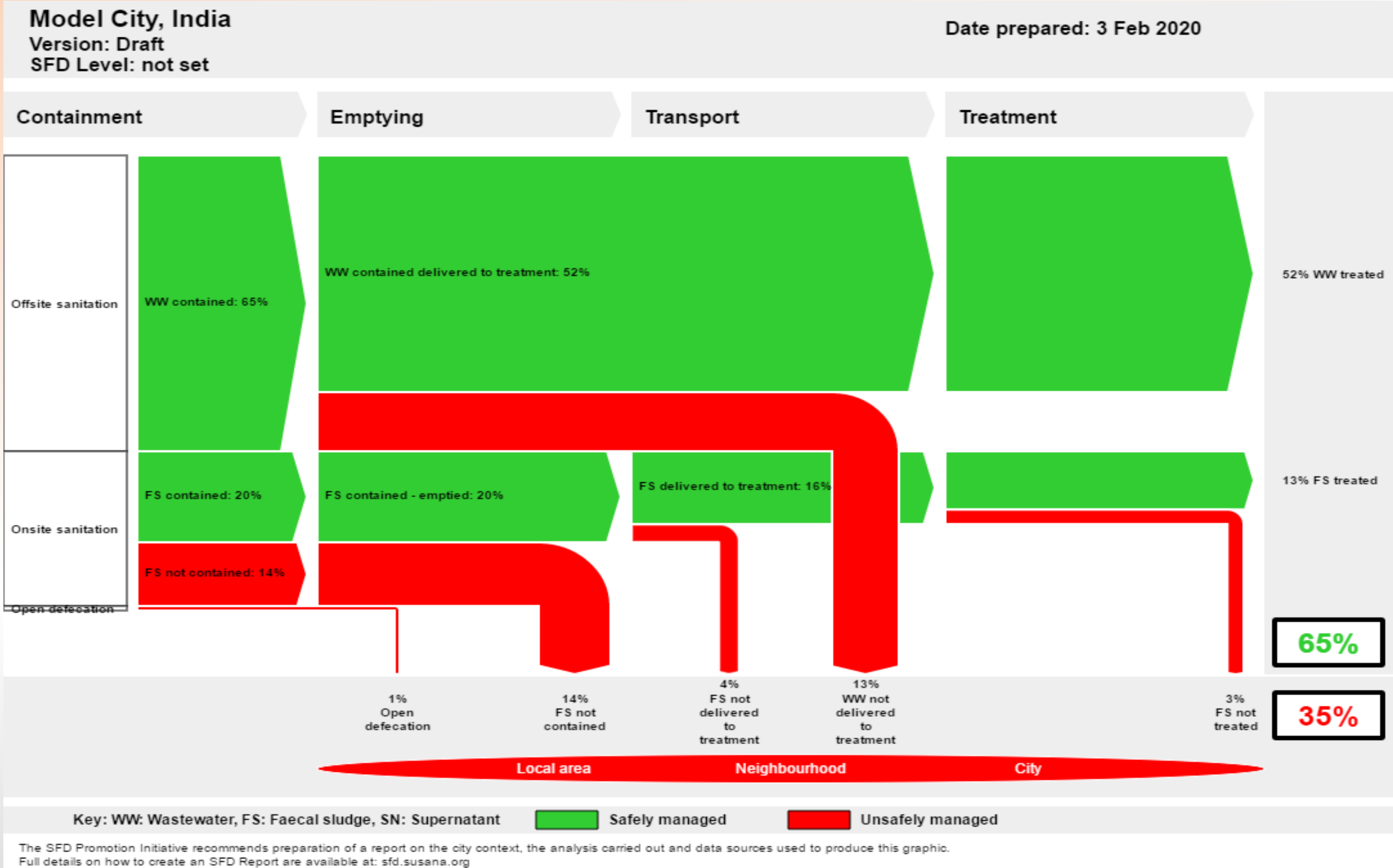
- It is a tool to readily understand and communicate **how the excreta flow through a city or town**. SFD is an innovative way to engage sanitation experts, political leaders and civil society in coordinated discussions about excreta management in a city.

- It also shows how excreta generated in a city are or not contained/processed as it moves from defecation to disposal.

- The sewage and faecal sludge & septage service value chain primarily consists of the following components:

  i. Containment
  ii. Emptying of faecal matter
  iii. Transportation of the emptied sludge/septage/sewage
  iv. Safe treatment of the collected sludge/septage/ sewage
  v. Safe disposal/recycle/reuse of the environmentally stable end product

A typical Shit Flow Diagram of a city depicting safe/unsafe management of excreta is given below:



3.2.5 Existing STPs and SWM Plants

- The data regarding the existing STPs such as **Location and number of STPs, Technology adopted, Mechanical and Electrical equipment available** with details about capacity, Assess condition & efficiency of Mechanical & Electrical equipment, Power bill amount, availability of space in the STP, staff for maintenance, expenditure head wise, Influent quality and effluent quality, process quality after different units, are to be collected and analyzed.

3.2.6 Land Availability to Set Up STPs/FSTPs

- Projects are often delayed because of non-availability or high price of land. ULBs should identify the land bank for treatment facility. It is important to ensure sufficient land is set aside for setting up STPs/FSTPs and its infrastructure at the earliest opportunity and embedded into the local planning scheme.

Measures to be taken while planning for Faecal Sludge Treatment Plant

- Distance of treatment site
- Reliability of electricity
- Neighborhood
- Geological Parameters

3.2.7 Availability of funds

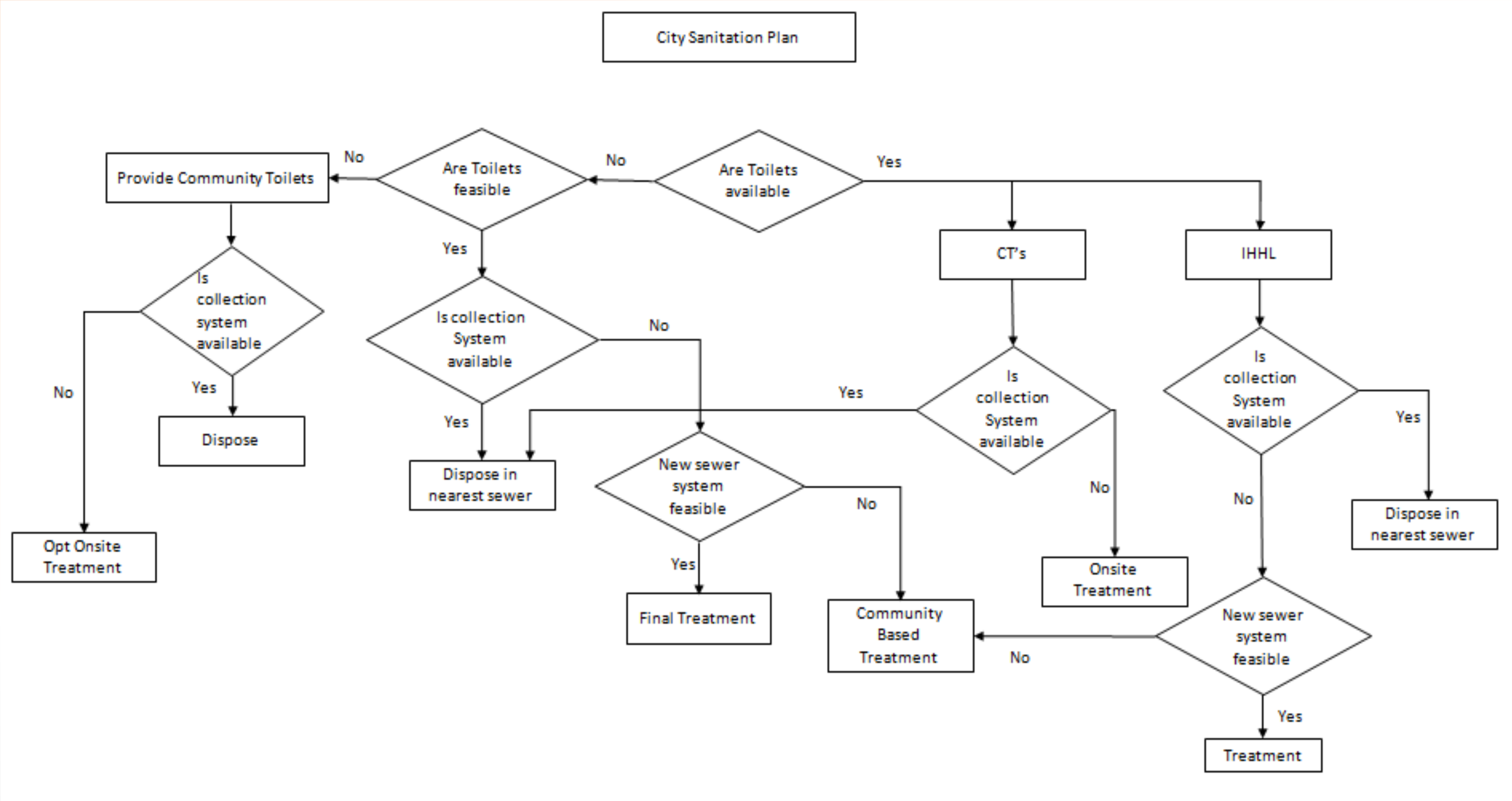
- Assess an estimation of capital and operation and maintenance costs, and a consideration of the options available for **project financing, cost sharing, and revenue generation**.

- It is important to recognize the **potential costs, including hidden operational costs associated with staffing and other overheads**. All components of a sanitation system should be considered in the costing, including those relating to off-site sewers and wastewater treatment where applicable.

- **Operational, maintenance, and rehabilitation costs** should take into account the Routine cleaning of drains and waste disposal

- There are various financing mechanisms and they can be grouped into several categories, including **subsidies and/or grants, public–private partnerships (PPP), Output based aid (OBA), microfinancing or loans, partnerships** etc.

3.2.8 Decision Making Tree: On-site Vs Off-site Sewage Management



3.2.9 Technology Choices

Technology assessment requires information on the following aspects of each technology:

- Land requirement;
- Power requirement;
- the knowledge and skills required for its operation, maintenance, and repair;
- the adequacy of the supply chain for the materials and spare parts that it requires;
- Overall cost, including capital and discounted recurrent costs;
- Operational cost;
- Environmental impact, particularly any local impact on air or water quality.
- Predicted inflow and characteristics of the influent or faecal sludge
- Soil characteristics and topography
- Seasonal and climatic variations;

3.2.10 Sanitation Value Chain

Step by step approach: Operationalizing Faecal Sludge and Septage Management

Transport: Transport describes the movement of sludge across the service chain from individual septic tanks and latrines to municipal or regional treatment facilities.

ULBs must take the following steps:

- Determine how many households use on-site containment systems
- Determine how many septic tanks /pits are emptied annually
- Determine the average price per emptying
- Use the above data to determine as to how many trucks would be needed
- Create a registration system for private truck operators which permit them to legally empty septic tanks within the ULB
- ULBs should mobilize enough vehicles, either through public or private means, to support a three-year emptying system.

Treatment, Disposal, and Reuse Treatment

- ULBs must not dispose the faecal sludge /septage collected from septic tank/pits without any treatment and ULBs must comply with CPCB and SPCB norms before disposal of septage.
- Reuse/disposal refers to the methods in which products are ultimately returned to the environment, as either useful resources or reduced-risk materials.
- The treated septage can be used as a soil enricher or as filling material at construction sites.
- ULB should carry out primary assessment for availability of market and demand for reuse.

3.2.11 Reuse of the Reclaimed Water / Sludge

- Reuse and recycling of domestic wastewater eases the pressure on freshwater resources and provides a solution to the problem of discharge of wastewater into the environment.
- Recycled water can be used for irrigation, pisciculture and toilet flushing.
- Reuse of treated sludge for agriculture application should comply with the standards notified for compost from time to time and MSW Rules.

3.2.12 Consultation with the Stakeholders

To the extent possible, participants should include representatives of:

- Service delivery agencies, including managers, engineers, and social development staff
- Relevant social intermediaries (NGO's, community-based organizations).
- Schools where improvements to school sanitation are envisaged.
- Other specialist workers in water and sanitation-related functions, such as masons or community health workers involved in hygiene promotion.

3.2.13 Coordination with Agencies

- Co-ordination among water boards / PHEDs / Jal Nigams / ULB
- Collaboration with other planning agencies at local, state and national levels
- Collaboration with NGOs for IEC activities, PHE agencies

3.2.14 Institutional Set Up

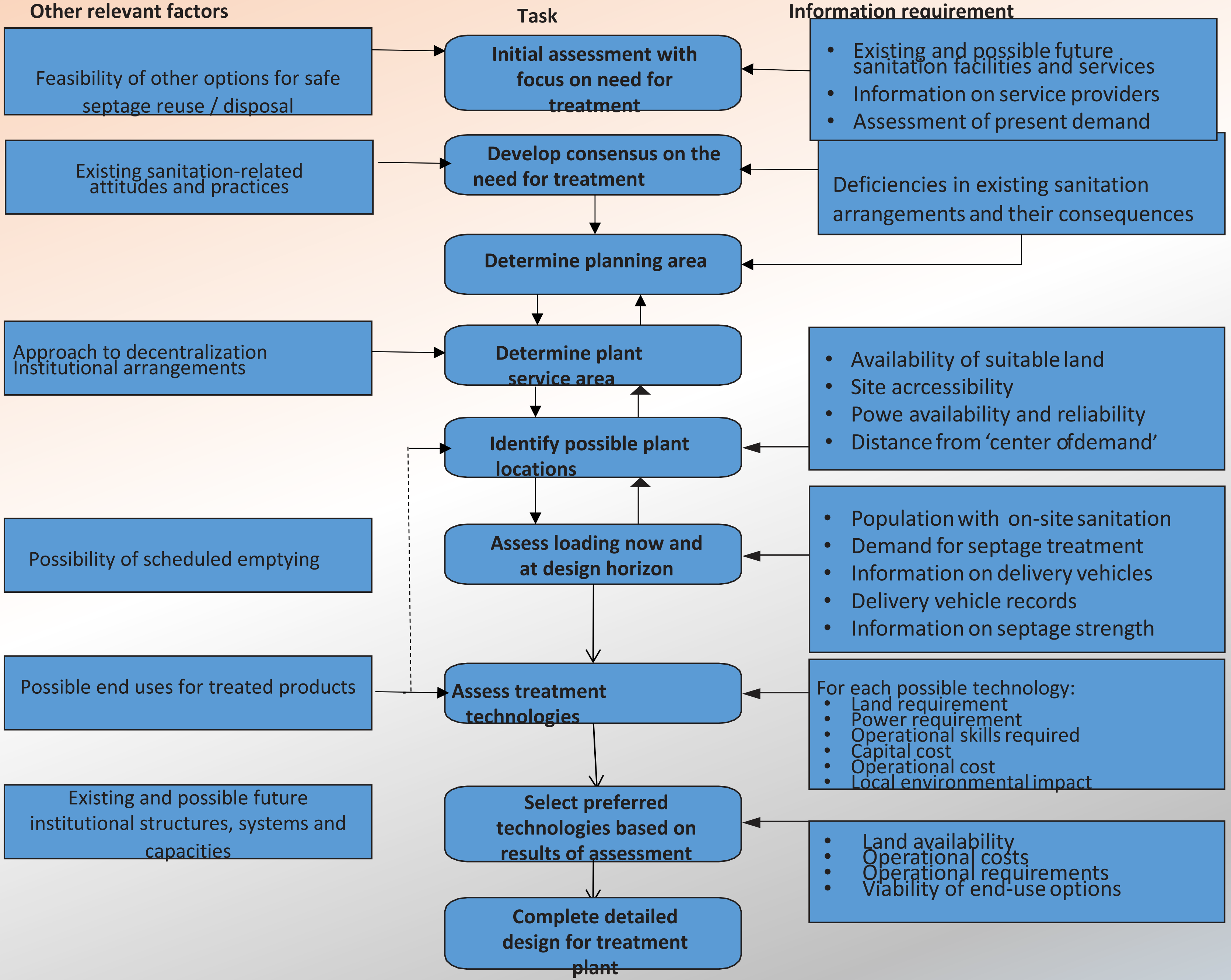
The main focus of the ULB should be:

- Strengthening of the existing organization structure
- Revenue collection and reliability of the ULB has to accessed
- Capacity building needs for the personnel working in the ULB have to be met
- Public Private Partnership should be explored if the ULB doesn’t have the financial capability.

3.2.15 IEC and Enforcement of Regulations

- Information Education Communication (IEC) is used for generating awareness. It means process of working with individuals, communities & societies to develop communication strategies to promote positive behaviour that are appropriate to their settings.
- Behaviour Change Communication (BCC) is used taking another step forward - enabling action. It means provide a supportive environment that will enable people to initiate and sustain positive behaviour.
- The step-by-step description of following sewage and FSSM options, suiting to the requirements of ULB officials, are:
  - On-site sewage treatment systems along with desludging mechanism of faecal sludge & septage its treatment and recycle/ reuse of byproducts
  - Co-treatment of faecal sludge and septage in Sewage Treatment Plants, Bio-methanisation plants or Thermo-mechanical treatment plants.
  - Off-site/ localized sewage conveyance, its treatment systems and recycle / reuse of by-product.

Planning process chart



Chapter 4. On-site Sewage Management

4.1 On-Site Sewage Management Systems

The premises or properties of individuals that are not served by piped sewer systems can adopt on-site sewage treatment systems.

They can be broadly categorized as below:

i. **Conventional Septic tank with soaking options like soak pit, dispersion trenches**

ii. I**mproved Septic tank**

   a. **Up-Flow Anaerobic Filter**

   b. **Package septic tank-Contact aeration type system**

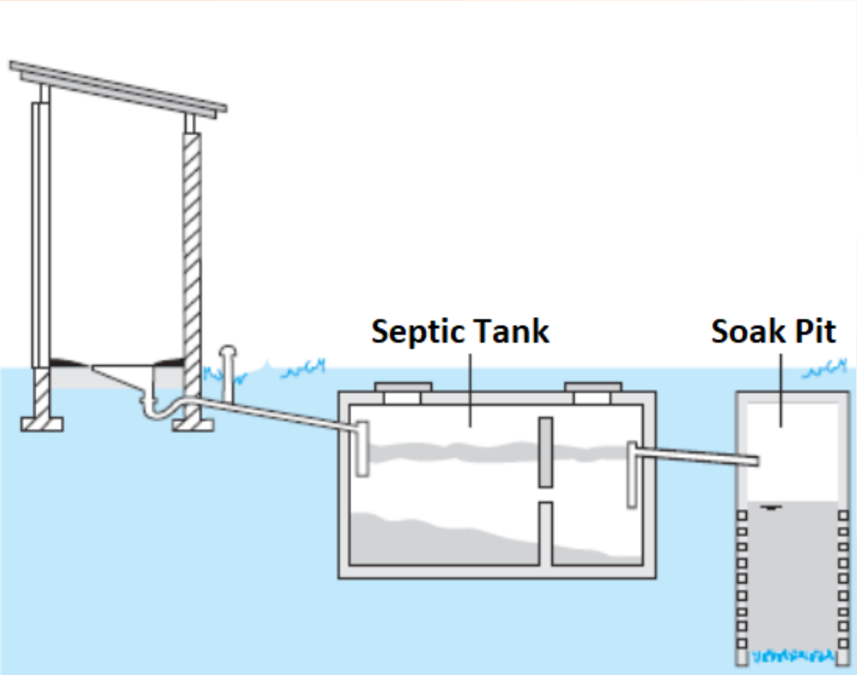
iii. **Johkasou Systems-Advanced On-site Sewage Treatment Systems**

iv. **Bio-Digester**

4.1.1 Conventional Septic tank with soaking options

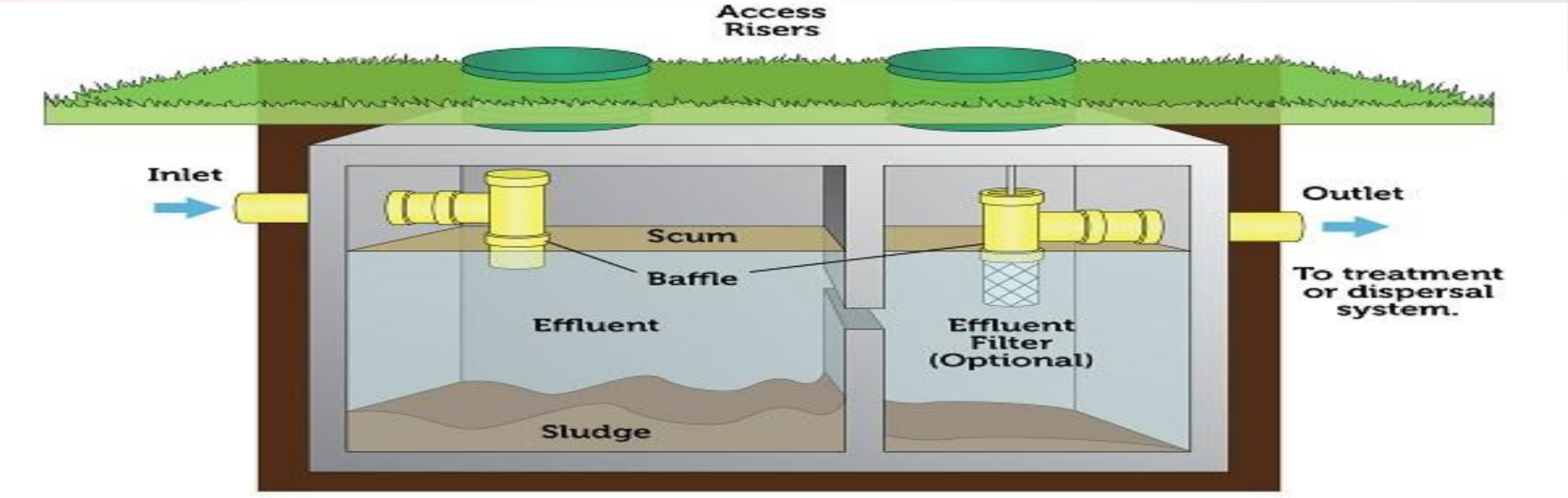
Septic tank combined with soak pit is **the most common type** of on-site sewage treatment system that is currently practiced in various non-sewered areas.

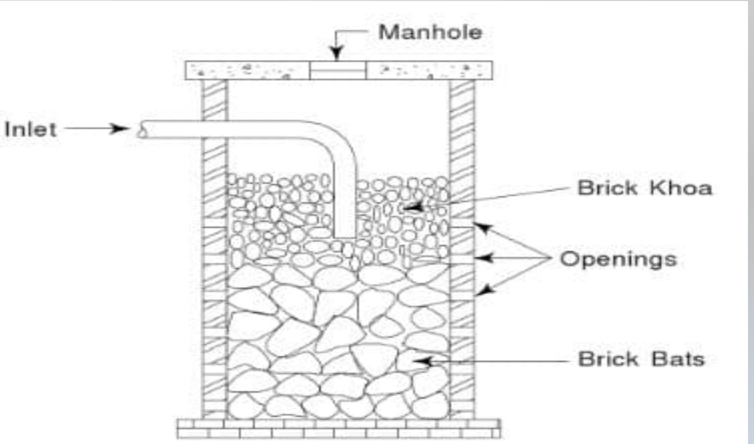
- **Septic tank:** Collects and stores domestic sewage and partially treats it under anaerobic conditions.
- Effluent from septic tank should be discharged to an on-site infiltration system like soak pit or drain field. In practice, **due to space constraints**, as well as, **lack of awareness**, many premises do not have soaking arrangement and thus, they discharge pathogenic effluent directly into open drains posing a public health risk.
- The standard septic tank design incorporates two chambers. Most of the **treatment takes place in the first chamber**.
- Removes about 50–60 percent of the biological load in the sewage. Further, a well-designed soakpit can further remove bacterial load to discharge standards.



No. of Users	Length, m	Breadth, m	Liquid Depth, m	
			For cleaning interval of 2 years	For cleaning interval of 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

Recommended size of septic tank up to 20 users





Processes within a septic tank and soak pit

i. Solids settle in the septic tank and digest anaerobically. This reduces sludge volume and enables overflow effluent to infiltrate into the ground in soak pit without clogging the leaching system.

ii. Sludge settles in the tank and digests anaerobically over time, releasing methane, carbon di oxide and other gases.

iii. Overflow from septic tank is spread over soak pit or drain field.

iv. Septage must be removed from septic tank periodically and transported off-site for treatment prior to recycle/reuse/disposal.

Operation and maintenance

i. Responsibility for operation and maintenance of septic tank & soak pit lies with the owner of the property.

ii. Municipal utility or private contractors are required for periodic desludging of septic tanks and to ensure safe treatment and disposal of septage at a designated facility like Faecal Sludge & Septage Treatment Plant (FSTP) or Sewage Treatment Plant (STP).

Costing

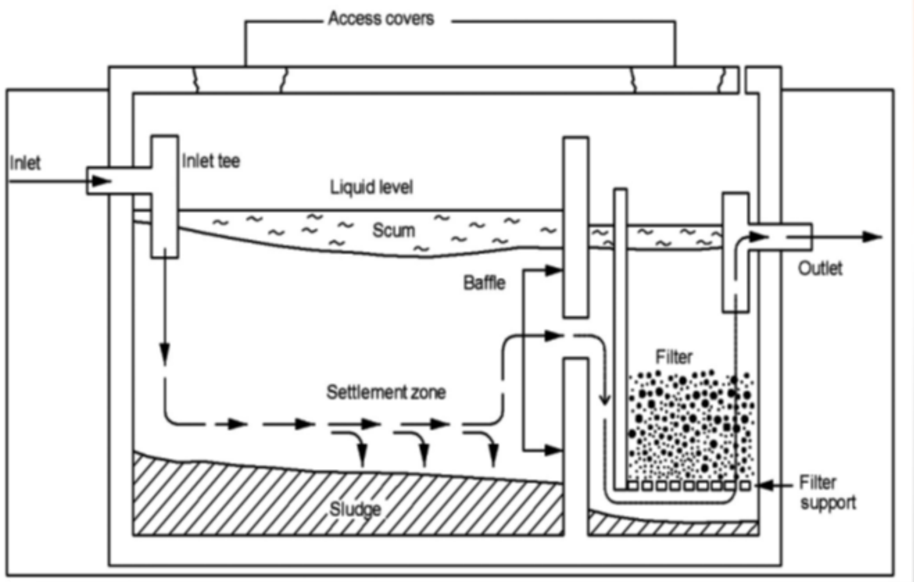
i. Capital costs: Costs range from Rs. 15,000–20,000 excluding cost of superstructure like toilet.

ii. Operating costs: The cost is around Rs. 500 per annum considering desludging frequency every third year.

4.1.2.1 Improved Septic Tank - Up-Flow Anaerobic Filter

Processes within an Up-Flow Anaerobic Filter

- An **anaerobic filter** is a fixed-bed biological reactor.
- It is a submerged filter with **stone media** or half broken chamber well burnt bricks by hand and the septic tank effluent is introduced from the bottom.
- The microbial growth is retained on the stone media, making possible higher loading rates and efficient digestion.
- The up-flow anaerobic filter can either be a separate unit or constructed as an extended part of septic tanks.
- The final effluent from the up flow filter will come out at least 30 to 45 cm above the ground level. At this location an elevated mound of sand can be constructed as a dispersion mound and flowering small plants can be grown for evapo-transpiration



Advantages

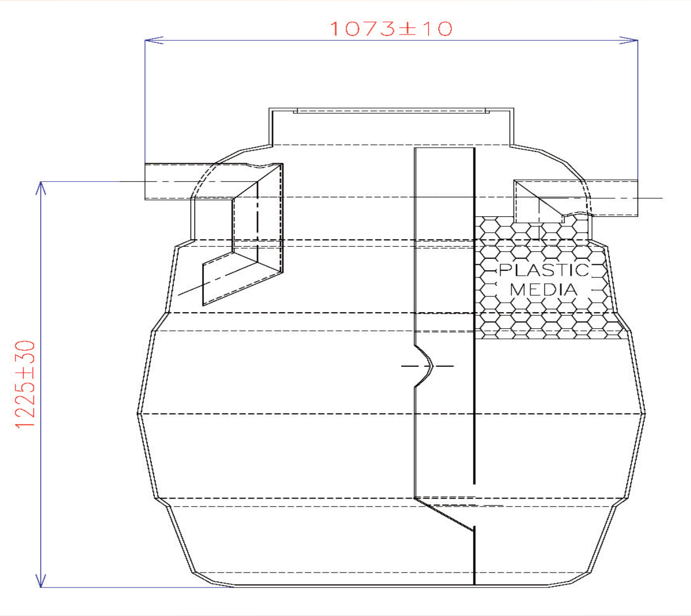
- BOD removals of 70% can be expected
- The effluent is clear and free from odour
- high degree of stabilization;
- little sludge production;
- low capital and operating cost;
- low loss of head in the filter (10 to 15 cm)

Limitations

During times of rainfall, it will be necessary, to provide a temporary cover to prevent direct rainfall over the dispersion trench.

4.1.2.2 Package septic tank -Contact aeration type system

- **Package septic tank - Contact aeration type system** is an improvement of the septic tank in which a contact aeration tank is provided after the septic tank.
- It is developed in line with well-established Japanese on-site treatment systems called **Johkasou**.



Processes within a Contact aeration type system

- The first chamber works as a septic tank.
- Second stage is high specific surface area (100 m2/m3), fixed film plastic media to retain high mass of aerobic microorganism.
- Degradation of the organic matter in the sewage aided by continuous diffusion of controlled air supply from a blower.

4.1.2.3 Johkasou Systems-Advanced Onsite Sewage Treatment Systems

- **Johkasou** is a on-site compact sewage treatment plant. This is developed in Japan and now being implemented in India in cities like Aizwal, Mizoram, Chennai etc.
- **Construction of Tank:** Installed underground single compact tank having five functional chambers namely, sedimentation, anaerobic, aeration, storage and disinfection in a tank.

Processes within a Contact aeration type system

- **Pre-treatment process:** This process removes insoluble substances that are difficult to decompose biologically by means of sedimentation, floating, and screening.
- **Main treatment process:** The system employs a sedimentation tank for solid-liquid separation in most cases.
- **The main treatment process** biologically removes BOD-related contaminants by aerobic treatment and removes nitrogen by combination of anoxic and aerobic treatment.
- **Advanced treatment process (to be installed if necessary):** This process removes COD-related contaminants and **phosphorus** from the biologically treated sewage by means of flocculation sedimentation, sand filtration, activated carbon absorption, and dephosphorization.
- **Disinfection process:** This process disinfects E. coli and other bacteria to make effluent water safer.

Johkasou Systems

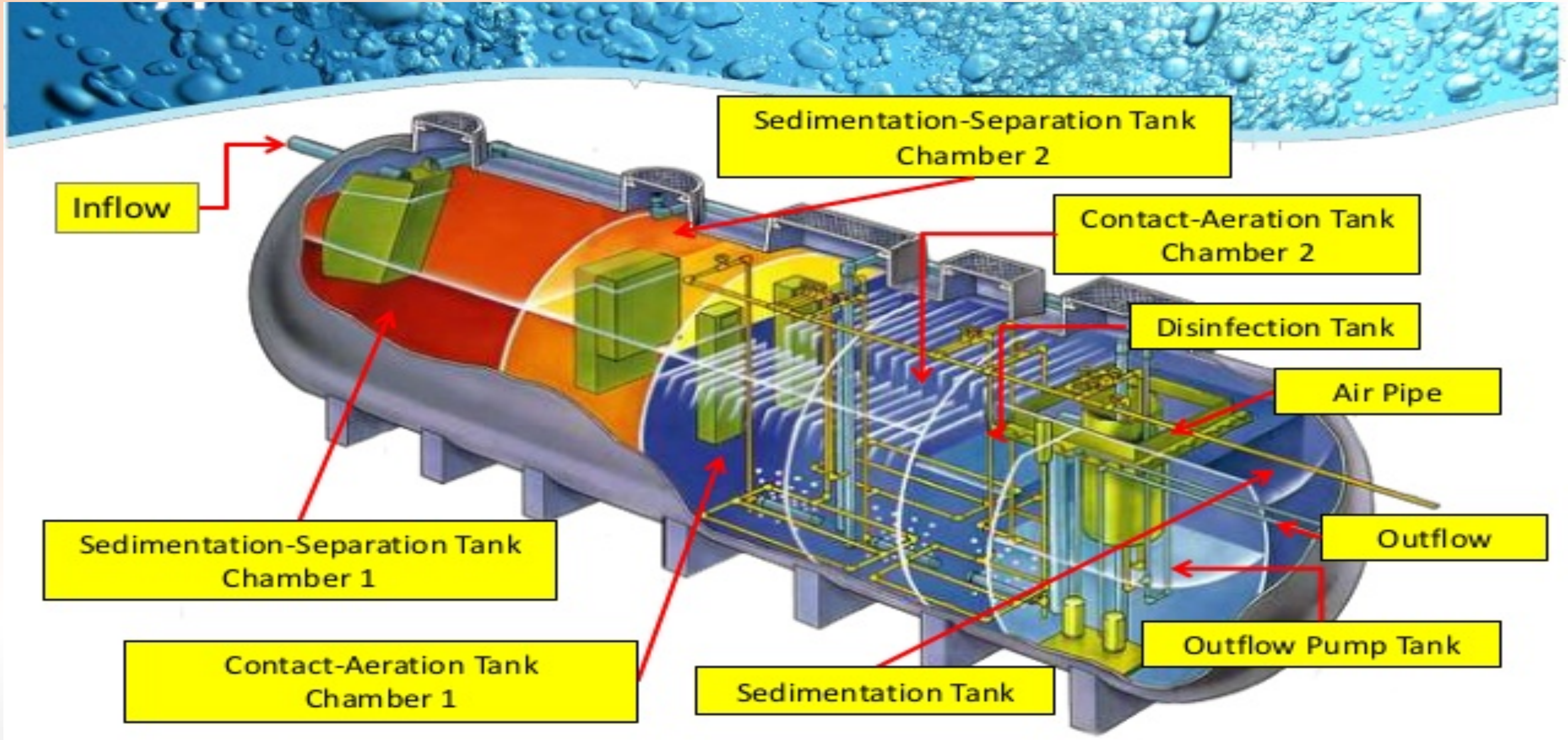


*Image courtesy of Japan Education Center of Environmental Sanitation

4.1.2.4 DRDO Bio-Digester

DRDO has developed a Bio-Digester to suit various climatic conditions and treat biodegradable faecal matter.

Key Features

- Anaerobic microbial inoculum
- Cold tolerant microbial consortium
- Required one-time inoculum charging
- Immobilization matrix for retaining higher microbial mass for survival in adverse conditions.
- Specially designed tank for efficient biodegradation
- Suitable for mobile and stationary platforms
- Permits use of toilet cleansing agents
- Tailor made in respect to number of users, materials, situation and condition

DRDO Biotanks showing different chambers

Current Application

- Thousands of such bio-digesters have been installed at various locations in J&K, Sikkim Lakshadweep, Arunachal Pradesh and other parts of the Country.
- Lakhs of stainless steel made bio-digesters are in operation in different trains of Indian Railways and is planned to install bio-digesters in all trains in the future

Advantages

- Wide applicability
- Minimizes water consumption
- Maintenance free
- Customized & easily adoptable
- Effluent water recyclable
- Organic waste Reduction: > 99%
- Pathogen reduction: > 99%
- Environment-friendly & cost-effective
- Suitable for any geo-climatic condition

A completely covered DRDO Biotank

Different Models of Bio-digester

- Microbial Inoculum (Cold-active)
- High Altitude Model
- Glacier Model
- Railway Model
- Plain Area Model

Limitations of On-site Sewage management Systems

- On-site sewage management systems are spread across various premises and its O&M lies with owners who are often least aware about its periodic requirement of O&M.
- They often **don’t follow the norms** about its size and construction quality
- In majority of cases soak pits either do not exist or **silted badly** to perform any function and discharged in open drains.
- ULBs/ regulatory agencies too do not monitor its functioning and also do not create awareness through SOP’s etc.
- Due to this sludge deposited in Septic tanks creating a situation where septic tanks/ soak pits etc. overflow creating unhygienic condition in the area
- This requires urgent desludging of tanks and its safe treatment and disposal.

Chapter 5. Faecal Sludge & Septage Management

5.1 Faecal Sludge & Septage Management

- **FSSM** involves emptying, transportation and treatment/ disposal of faecal septage from On-site Sanitation Systems (OSS) like Septic Tanks etc.

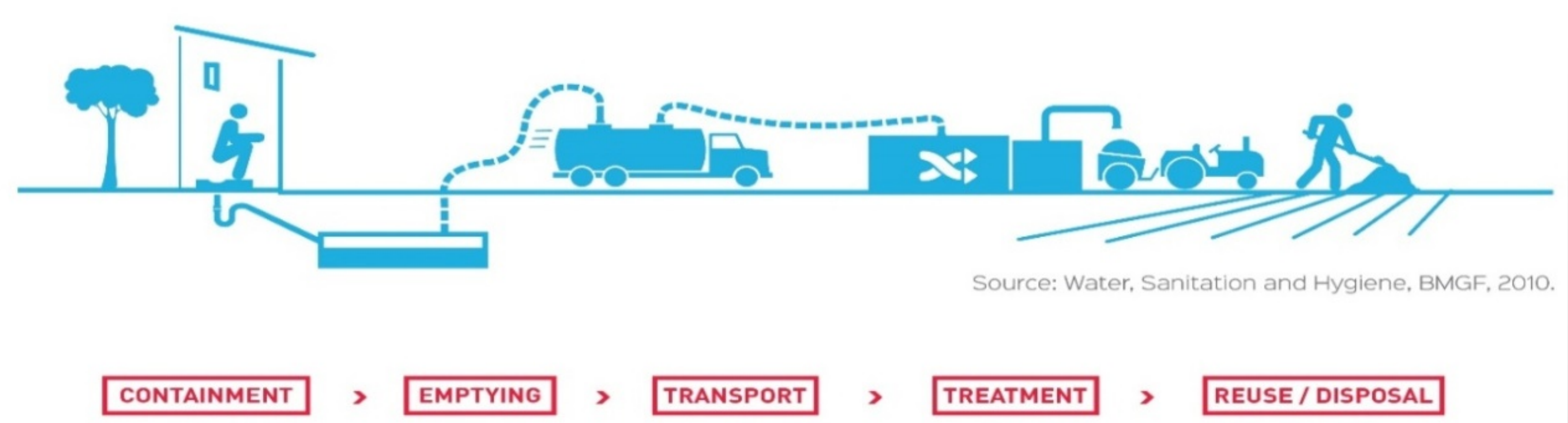
- FSSM assumes **significance** in Indian scenario as about **60% households** are dependent on on-site sanitation systems.

- FSSM is **not a low-cost sewage treatment alternative** to perceived cost intensive off-site sewerage system, but an O & M activity of on-site sewage management systems.

- **Cost of poor sanitation** to nation is humongous. This necessitates the proper management of Faecal Sludge and Septage also collected from onsite sanitation systems (OSS) like septic tanks and leach pits.

5.2 Faecal Sludge & Septage Value Chain

The life cycle of faecal matter from generation to its final disposal.



Containment: Human waste is contained in an on-site system, possibly together with grey water. Waste is partially treated due to the time it is contained, and is known as faecal sludge or septage depending on the system used.

Emptying: The system is emptied, typically by a desludging vehicle truck with a vacuum mechanism.

Transport: Faecal sludge or septage is transported safely in a closed vehicle truck.

Treatment: Faecal sludge and or septage can be treated either at a Faecal Sludge Treatment Plant (FSTP), or co-treated with sewage at a Sewage Treatment Plant (STP).

Reuse / Disposal: The treated waste can now be safely reused or disposed.

5.2.1 Containment

Steps to prevent pollution of the environment:

- **Periodic Audit of toilet facilities**
- **Standardization of Containment Construction**
- **Prevention of any leakages** for containment structure.
- ULB’s may encourage the households to connect their, septic tanks to **settled/ small bore sewer networks**, if construction of soakpit is not feasible.
- In case where no sewerage network exists and there is no space for soaking arrangements as well, in such situations, overflow effluent from septic tank may be collected in well-lined road side drains as an **interim measure**.
- Soak pits should be properly designed and maintained.

5.2.2 Emptying of Containment and Transportation

Emptying: Faecal Sludge and Septage needs to be emptied periodically by mechanical means, so that septic tank/ leach pit don’t get filled and overflow in the open environment.

Periodic/Scheduled desludging: ULBs need to maintain database on onsite sanitation systems and also to develop a zone-wise annual timetable for Periodic/scheduled desludging for the city at an interval of 2-3 years as prescribed by guidelines.

Transportation: There are various types of sludge/septage carrying vehicles like vacuum tankers.

5.2.2.1 Empanelment of registered private service providers

- ULBs should empanel and register private GPS enabled desludging vehicles and service providers in their jurisdiction to prevent unregulated discharge of collected septage in open environment.
- **No. of desludging vehicles:** Total No. of vehicles engaged for desludging can be worked out **@ 12000 persons per vehicle of 2kl capacity**. Vehicles are available in capacity from **2kl to 10kl**, the same may be engaged in suitable numbers based on their feasibility on roads following above basis.

5.2.3 Faecal Sludge and Septage Treatment

Generally, the following three methods of treatment are adopted for faecal sludge and septage:

- Land application
- Co-Treatment at wastewater treatment plants (WWTPs)
- Independent Faecal Sludge &Septage Treatment Plants (FSTPs)

BOX 1

Share of pollution load reduction, as % of Influent raw sewage in Septic tank, due to Faecal Sludge & Septage treatment:

Ex: Pollution load handled by a FSTP plant as % of Influent raw sewage in Septic tank in a city of 1 lakh population.

(1)Considering once in 3 year emptying and treatment cycle.

(2)No of houses to be emptied and treated per day in FSTP = (100000/5)/3/365 = 18 houses

(3) Septage to be emptied from each septic tank (Standard size of 1.5mX.75m X.7 m (excluding free board)) = .79 cum

(4) Representative BOD of septage = 2000 mg/l

(5) Sewage volume entering per day in septic tank per family of 5 persons @ 500 liter

(6) Representative BOD of influent sewage = 300 mg/l

(7) Overall Percent (%) of pollution load handled due to septage treatment =

[18(houses) X 0.79 Cum per house) X 2000(rep BOD load)][100]/ [18(houses) X 0.5 Cum per house per day) X 300 (rep BOD load)X (3 year cycle) X(365 day per year)]

= [1580] X [100]/ [164250]

= 0.96% say 1 %

Overview of Faecal Sludge & Septage Treatment and Disposal options

Method	Description	Advantages	Disadvantages
Land application	• Faecal Sludge & Septage is applied to sites infrequently visited by the public. • Stabilization is required to reduce odour, pathogens and vector attraction. • Land Application may be by trucks fitted with suitable devices to apply septage to the land surface, or by specialized equipment to inject septage beneath the soil surface	• Simple, Economical • Recycles organic material, nutrient to the land. • Low Energy use	• Need for holding facility during periods of non-demad • Need for relatively large, remote land area
Treatment at STPs	Septage may be added to plant headworks, upstream manhole, or sludge handling process for co-treatment with sewage or sludge. Septage volumes that can be accommodated depend on plant capacity and types of unit processes employed	• Most plants are capable of handling some septage • Centralizes waste treatment operations	• Potential for plant upset if septage addition not properly controlled • Increased residuals handling and disposal requirements • Adding septage in manhole should be proper precaution and manhole at trunk sewer line near STP
Treatment at Independent Septage Treatment Plant	A facility is constructed solely for the treatment of septage. Treatment generate residues which must be disposed of.	• Provides regional solution to septage management	• High Capital and Operational & Maintenance (O&M) Costs • Requires skill levels for operation

General Treatment Process

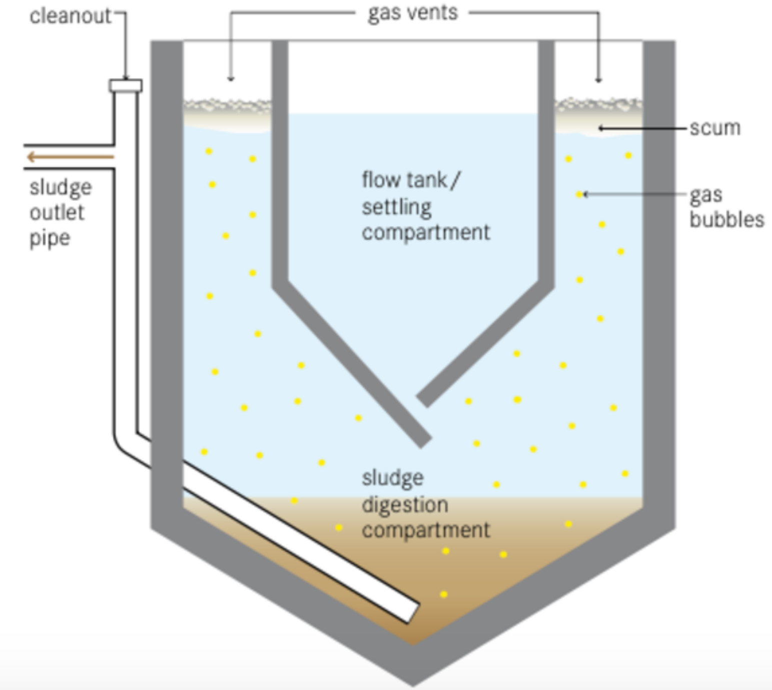
Step I: Pre-Treatment Unit: Depending on characteristics of FS&S and its quantity, involves preliminary **treatments like coarse screen, grit chamber, fine screen, Fat Oil and Grease (FOG) removal** and stabilization.

- **Requirement of Septage Stablization:** Septage taken from septic tanks and wet leach pits will normally offer limited scope for further digestion.
- However, material taken from frequently emptied cess pits and public toilet vaults is likely to be poorly stabilized, with the result that it **smells unpleasant and has poor settling characteristics**.
- **Lime stabilization:** Pre- treatment of septage with lime is carried out in this unit to **raise pH level of septage.** This is further explained later in this chapter. Lime stabilization facility **controls odour, vector and facilitates pathogen destruction**. Lime addition could be done at any of these three points:
  - to the desludger vehicle before the faecal septage is collected,
  - to the hauler truck while the faecal septage is being collected, or
  - to a septage storage tank where septage is discharged from a desludger vehicle.

Step II: Solid – Liquid Separation unit

Overview of technologies currently used for solids−liquid separation are as under:

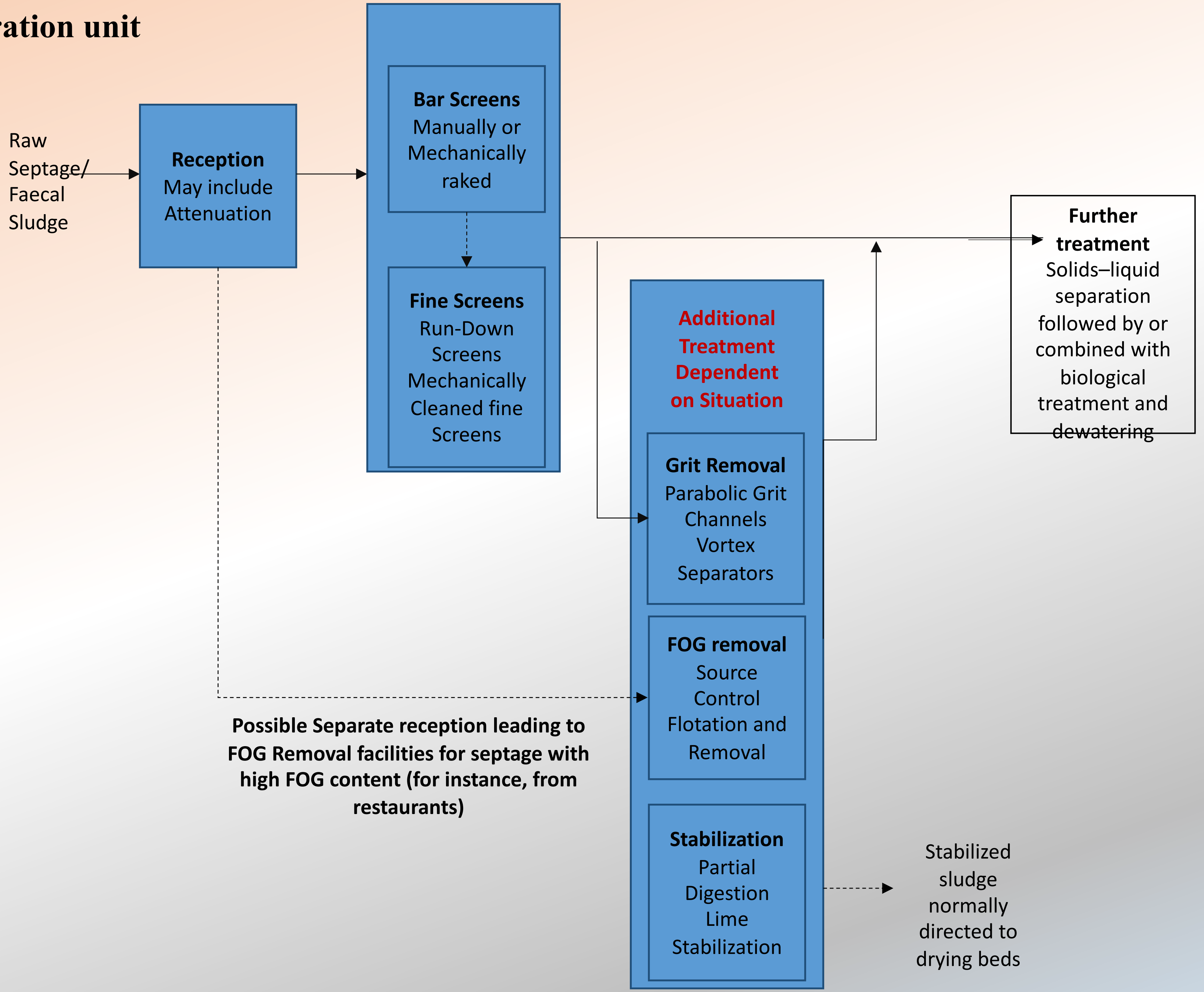
- **Imhoff tanks:** Designed to combine **solids−liquid separation in an upper compartment** with digestion of settled solids in a lower compartment;
- **Settling-thickening tanks:** Rectangular batch-loaded tanks that allow solids to settle while supernatant water continues to liquid treatment facilities;



Imhoff tank

- **Sludge drying beds:** Separate solids and liquid through **evaporation, settling, and filtration**;
- **Anaerobic ponds:** which combine solids−liquid separation with **reduction of the organic loads**;
- **Mechanical dewatering Machines:**
  - ❑ **Belt Filter Press:** It uses filter cloth attached to filter plates to retain sludge;
  - ❑ **Screw Filter Press:** It retain sludge within a cylindrical sieve.

Solid – Liquid Separation unit



Step III: Liquid treatment unit

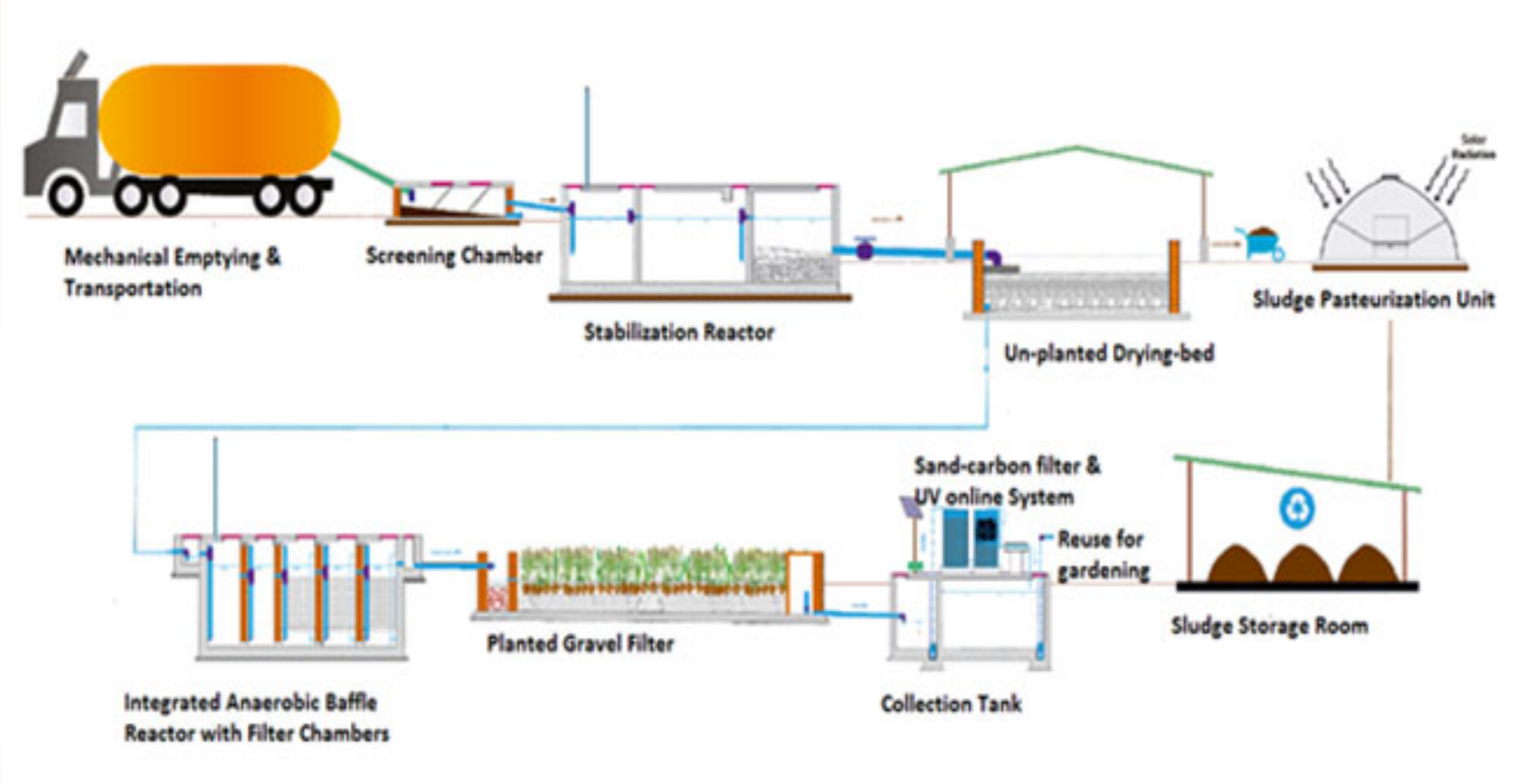
The liquid residual / pressate / filtrate / supernatant from dewatering system can be discharged for further **biological treatment**. Treatment modules for liquid components are:

- Anaerobic Baffled Reactor (ABR) with filter chambers,
- Planted Gravel Filter (PGF) and Percolation pit etc.
- Integrated Settler
- Depending upon the volume of load to be treated and land available the mechanized methods like ASP, MBBR etc. can also be used.

Step IV: Solid treatment unit

- The dewatered sludge can be sent for further drying or composting prior to reuse as **organic fertilizer**.
- The treatment modules for solid components in FSTPs normally consists of **Feeding Tank (FT) with screen chamber, Stabilization Tank (ST), Unplanted Sludge Drying Bed (SDB)**.
- It can also be treated adopting methods **like Composting, Vermi-composting, Thermal Drying & Palletization and Incineration method** etc.
- In case of cold regions/ high rainfall regions **Green House Solar Drier Roof** may also be provided.

The schematic diagram of the FSTP follows the undermentioned sequence



Combinations of treatment technologies used in 11 FSTPs in India

S. no	FSTP location	Technology	Description	Post treatment
1	Bhubaneswar, Odisha	Decentralized wastewater treatment system (DEWATS)	Settler, anaerobic baffled reactor (ABR) and planted gravel filter (PGF)	**No tertiary treatment**
2	Dhenkanal, Odisha	Decentralized wastewater treatment system	Unplanted sludge drying bed (USDB), ABR and PGF	**Tertiary treatment using sand filter and activated carbon filter**
3	Jhansi, Uttar Pradesh	Decentralized wastewater treatment system	Planted sludge drying bed (USDB), ABR and PGF	**No tertiary treatment**
4	Karunguzhi, Tamil Nadu	Decentralized wastewater treatment system	Unplanted sludge drying bed (USDB) and PGF but without ABR	**No tertiary treatment**
5	Ketty, Tamil Nadu	Decentralized wastewater treatment system	Planted sludge drying bed (PSDB) and PGF but without ABR	**No tertiary treatment**
6	Adigaratty, Tamil Nadu	Decentralized wastewater treatment system	Planted sludge drying bed (PSDB) and PGF but without ABR	**No tertiary treatment**
7	Leh, Ladakh	Decentralized wastewater treatment system	Planted sludge drying bed (PSDB) and PGF but without ABR	**No tertiary treatment**
8	Unnao, Uttar Pradesh	Decentralized wastewater treatment system	Screw press technology for solid–liquid separation, integrated settler, ABR, PGF	**Tertiary treatment using sand filter, activated carbon filter and UV radiation**
9	Warangal, Telangana	Package STP and pyrolysis	Anaerobic, anoxic, aeration and sedimentation zones	**Tertiary treatment using sand filter, activated carbon filter and chlorination**
10	Tenali, Andhra Pradesh	Moving bed biofilm reactor (MBBR)	MBBR, tube settler and clarifier	**Tertiary treatment using sand filter, activated carbon filter and chlorination**
11	Kalpetta, Kerala	Tiger bio-filter technology	Anaerobic digestion followed by two stage vermin-filtration	**Tertiary treatment using sand filter, activated carbon filter and chlorination**
12	Bharwara, Uttar Pradesh	STP co-processing	Upflow anaerobic Sludge blanket (UASB), pre-aeration tank, polishing pond	**Tertiary treatment using chlorination**

5.2.4 Recycle and Reuse

Treated Faecal Sludge & Septage can be used in the following ways:

- **Composted** portion is used in agriculture/horticulture to act as **soil conditioner and as a fertilizer**.
- The **anaerobic digestion** of faecal septage produces **biogas**, which in turn can be used as a fuel after removing the hydrogen sulfide to avoid corrosion.
- The treated effluents are commonly used for **irrigation**, **flushing** and **other non-potable uses**.
- It can also be used for **aquaculture** and **growing planktons** or **aquatic plants such as duckweed, water spinach, or water mimosa** as the nutrients can increase their growth.
- The dewatered faecal sludge can be used as an **alternative fuel in the cement industry**.

5.2.4.1 Standards for Recycling and Reuse

- Various standards for disposing off the solid and liquid portion of the treated faecal septage has been discussed in the subsequent paragraphs.

5.2.4.2 Agricultural application

- Properly treated sludge can be reused to reclaim parched land by application as **soil conditioner, and as a fertilizer in agriculture.**
- For the usage of dewatered septage/sludge in agriculture fields, it should satisfy the following criteria of Class A Bio solids of US EPA either by **lime stabilization, solar drying and or composting.**
    - Faecal coliform density of **less than 1,000 most probable number (MPN)** per gram of total dry solids,
    - Salmonella sp. density of **less than 3 MPN per 4 g**

5.2.5.1 Land Application

- This method is most simple, economical and without requirements of skilled O&M. among the three methods of Faecal Sludge and Septage Management mentioned above.

USEPA has identified three broad options for land disposal:

i. Land spreading,

ii. Sub-surface incorporation,

iii. Deep row entrenchment

To reduce vector attraction, USEPA, 1994, has come out with the following three options for domestic septage application to non-public contact sites:

- Subsurface injection.
- Incorporation (surface application followed by plowing within 6 hr).
- Alkali stabilization (pH of 12 or greater for 30 min prior to application).

5.2.5.2 Methods of Land Application of Faecal Sludge & Septage

i. **Land spreading,**

ii. **Sub-surface incorporation,**

- A hauler truck applies septage by **opening a valve** and driving across the land application site.
- A splash plate or spreader plate improves septage **distribution** onto the soil surface.
- Collected trash should be **lime stabilized** and sent to a sanitary landfill.
- The septage must be lime stabilized prior to surface application and injected below the surface or **ploughed into the soil within 6 hr of application** to reduce vector attraction
- **Another common approach is to use a manure spreader** or a special liquid-waste application vehicle that removes screened septage from a holding tank and injects it on or below the soil surface
- **A third approach is to pretreat the septage** (minimum of screening) during discharge into a holding mixing tank by adding lime and stabilizing it to pH 12 for 30 min, and then to spray the septage onto the land surface using commercially available sludge application equipment

5.2.5.3 Deep Row Entrenchment method

Deep Row Entrenchment consists of digging deep trenches, filling them with septage and covering them with soil.

The following precautions to be take in Deep Row Entrenchment

- Site should be far away from surface water body.
- Site should be far away from high water table areas.
- Sites should have low probability of inundation.
- The approach is redundant during monsoon season.
- Installation of CCTV cameras at the site for monitoring.

Advantages

- Trenches can be constructed in remote areas and trees can be planted on the top which benefit from the organic matter and nutrients that are slowly released from the septage.

Disadvantages

- Suitable land may not be easily available and there may be resistance from nearby residents.

5.2.5.4 Odour Control

Odour is a concern during and after septage application and need to be adequately controlled. A well-managed operation that incorporates lime stabilization, subsurface injection, or surface application at or below agronomic rates, however, creates minimal odor emissions.

5.2.5.5 Lime Stabilization

- Septage can be stabilized by adding sufficient lime or other alkali to raise the pH to 12 for a minimum of 30 min. Typically, this requires lime (as CaO or quicklime) of 2.4 to 3.0 kg per 1,000 L of septage, although septage characteristics and lime requirements vary widely.

Key elements are:

- Provision of septage receiving and holding facilities to provide operational flexibility.
- Proper **septage treatment** prior to application as required to meet Centre/States regulatory requirements (need for treatment depends on requirements of application method).
- Control of septage application rates and conditions in accordance with Centre/States rules.
- Proper operation and maintenance of the application equipment.
- Monitoring of septage volumes and characteristics, soil, plants, surface water, and ground water as required by Centre/States/ULBs regulations.
- Odor control.
- Good record keeping and retention for at least 5 years.

Chapter 6. Co- Treatment of Faecal Sludge And Septage

6.1 Background

- It involves treatment of Faecal Sludge and Septage along with other feedstock like Sewage and Organic waste in existing treatment facilities like **Sewage treatment plants, Bio-gas plants and Thermal treatment plants.**

- This is a more preferred option for those towns and cities which have existing treatment plants within the city or in nearby (say 25 km away or so) with unutilized capacities.

- In the backdrop of Swachh Survekshan of MoHUA, many cities and towns have attempted to co-treat its Faecal Sludge and Septage in existing waste treatment facilities, often without having deep insights of co-treatment.

6.2 Co- Treatment of Faecal Sludge and Septage

- Co-treatment of faecal sludge and septage is primarily done in sewage treatment plants like **Activated Sludge Process (ASP), Sequential Batch Reactor (SBR), Upflow Anaerobic Sludge Blanket (UASB) and Waste Stabilization Ponds (WSP) etc.**
- Faecal sludge and/or septage can also be co-treated in **Bio-methanisation plants, compost plants and thermal treatment plants like Incineration, Pyrolysis and Gasification etc.**
- Sludge (solid content > 5%) generated in an on-site treatment facility can be treated using methods like
  - delivery to a sewage treatment facility and treatment with sludge generated in the sewage treatment process,
  - treatment in a special sludge treatment facility,
  - solar drying on a floor, and
  - treatment by a mobile dehydrating truck.

6.2.1 Co-treatment of Faecal Sludge and Septage in ASP

Co-treatment of Faecal Sludge and Septage can be carried out in ASP after ascertaining the following aspects.

i. Volume to be treated and characteristics of Faecal Sludge and Septage particularly COD/BOD and total solids

ii. Concentrations of sewage BOD, flows and Spare capacity of STP

iii. Spare capacity of Bio-gas plant for treatment sludge generated at STP

Addition options of Faecal Sludge and Septage in ASP

I. Solid concentration in sludge is very high (>5%) (e.g. septic tank is emptied after a long period say > 5 years and septic tank is full with sludge) and volume of sludge is very less than Bio-gas Plant within STP.

I. In situations where (a) septic tanks are periodically emptied or (b) most of the population covered with sewerage system with comparatively low no of septic tanks, the thin/ dilute sepatage with solids less than 2%, can be directly put in STP for co-treatment through sewer maintenance manhole or sewage pumping station located at trunk sewer leading to STP or at inlet of STP provided the volume of septage is very less (< 1%) compared to inflow sewage.

II. In normal cases (other than above two scenarioes), collected Faecal sludge and septage could be added in suitably designed proportion so that characteristics of mixed septage and sewer do not exceed the design sewage characteristics.

Summary of Options for Handling Septage at WWTPs

Methods	Description	Advantages	Disadvantages
Septage Addition to upstream sewer manhole	Septage is added to a sewer upstream of the WWTP	• Simple and Economical due to very simple receiving station design • May provide substantial dilution of sewage prior to reaching the WWTP	• Odour Control near Manhole • May be difficult to control access • Potential for accumulation of grit and debris in sewer • Only feasible with large and treatment plants
Septage Addition to plants headwork	Septage is added to sewage immediately upstream of screening and grit removal process	• Simple and Economical due to very simple receiving station design • Allows control of septage discharge by WWTP staff	• May affect WWTP process if septage addition is uncontrolled or the treatment plant is too small • Increase odour potential at treatment plant
Septage Addition to Sludge handling process	Septage is handled as sludge and processed with WWTP sludge after pretreatment in receiving station	• Reduces loading to liquid processes • Eliminates potential for affecting effluent quality	• May have adverse effect on sludge treatment process such as dewatering • May cause clogging of pipes and increase wear on pumps if not screened and degritted in receiving station • Expensive due to receiving station cost
Septage Addition to both Liquid Stream and Sludge Handling process	Septage is pretreated to separate liquid and solid fractions, which are then processed accordingly	• Provides more concentrated sludge for processing	• Requires increased operations for septage pretreatment at receiving station • Expensive due to receiving station cost

6.2.1.1 Stepped Approach on planning for Co-Treatment of faecal septage at STP

- **Step 1**: Identify the existing / proposed treatment facility within 25 km radius or so
- **Step 2**: Assess hydraulic, organic, and solids loadings, treatment efficiency
- **Step 3**: Determine Septage receiving and preliminary treatment requirements like screening, stabilization/ equilisation, solid- liquid separation and options for its mixing into influent sewage.
- **Step 4**: Decide the approach to solids–liquid separation and select an appropriate location and technology, if solid loadings is high in septage.
- **Step 5**: Assess options for liquid treatment
- **Step 6**: Assess solids dewatering requirements and options depending on the characteristics of the solids to be dewatered and the final solids content required.
- **Step 7:**Determine additional treatment required to ensure that treated products are safe and suitable for any proposed end uses like agricultural input

Technological Process Chart

Evaluate Potential

- Large Stps
- Substantial % connected population, others using on-site sanitation systems
- Significant unutilized STP capacity
- Location of STP suitable for sludgeTreatment

Gather Basic Information

- STP Characteristics
- Capacity
- Current Loading
- Process Design Parameters
- Regulated Effluent Standards and current STP performance
- Characteristics and future of prospects of catchment
- Current and Future Sewage Flows and characteristics
- Characteristics and future prospects of sludge catchment
- Estimated Sludge to be treated and projection
- Source of Sludge
- Characteristic of Sludge and changes expected during the planning period

Preliminary Process

- Preliminary Steps:
- Screening
- Grit Removal
- Blending/mixing
- Equalisation

Pre-Treatment

- Stabilization of fresh sludge
- Direct dewatering of sludge from pits, with solids content
- Solids Liquid Separation with the solid part dewatered further for septage for wetter sludge

Co-Treatment

Liquid co-treated with sewage

Check

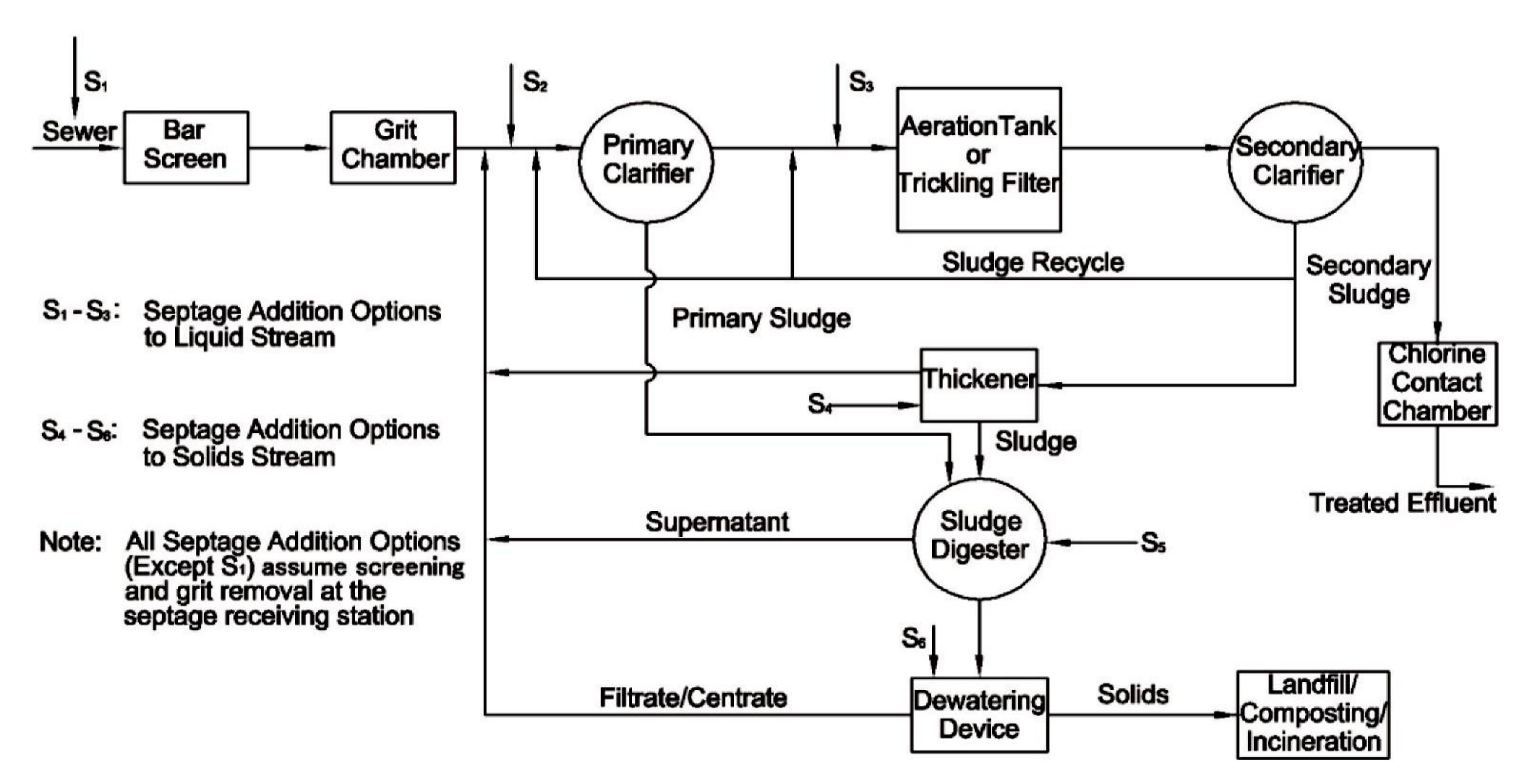
Solid Loading

Organic Loading

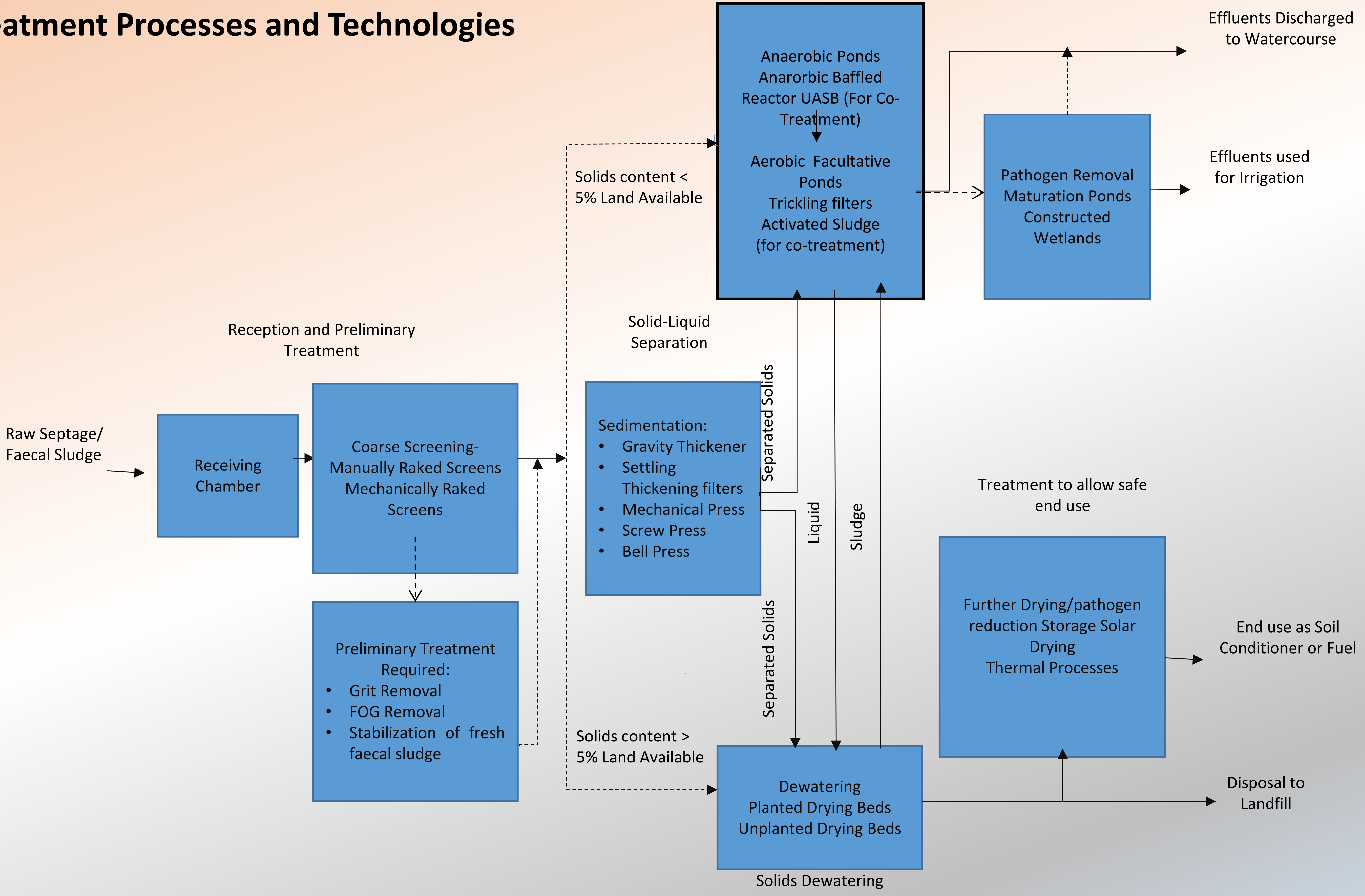
Oxygen Requirements

Nutrient Loading

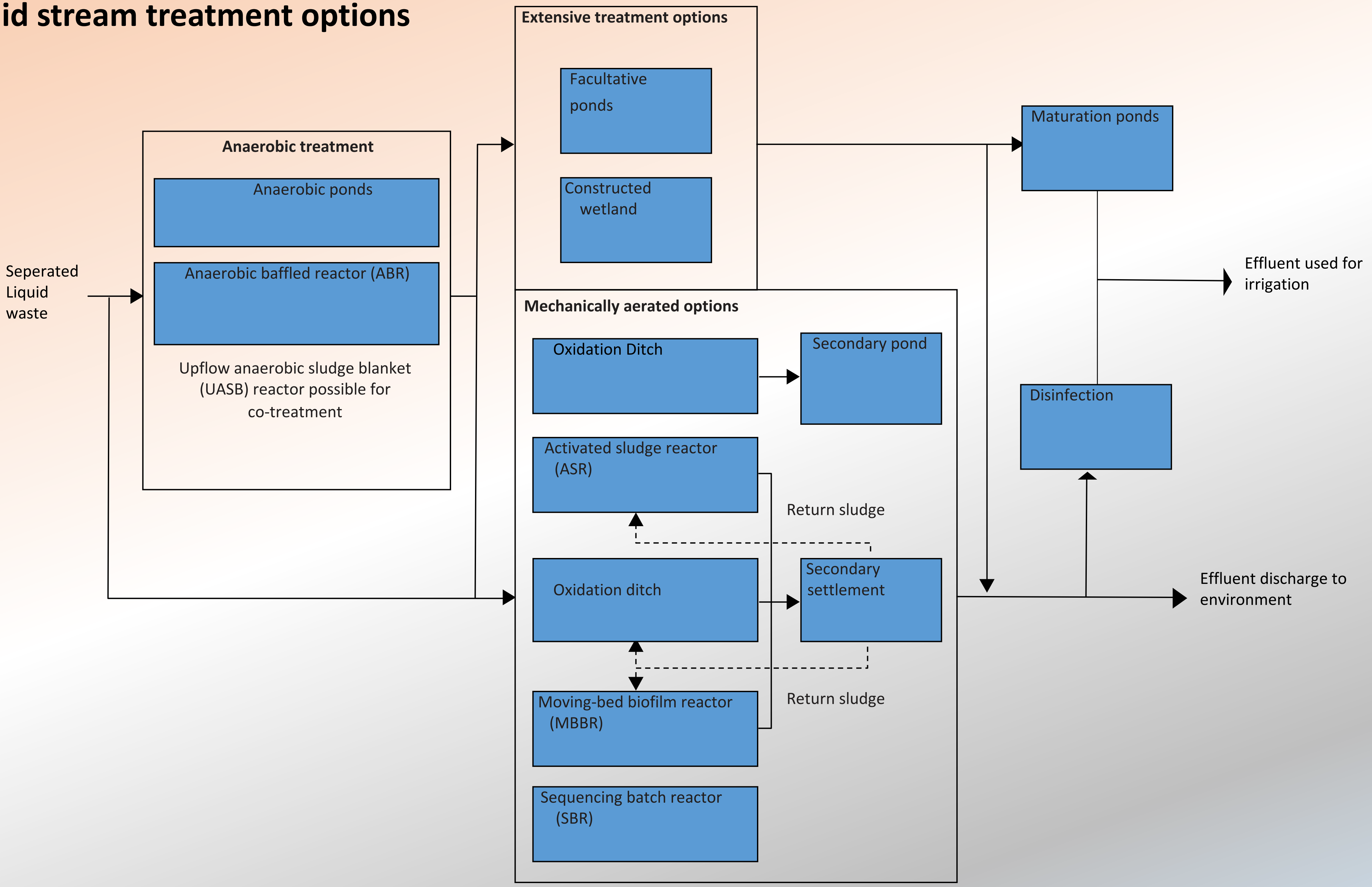
Planning for Co-treatment of FS&S in STPs



Treatment Processes and Technologies

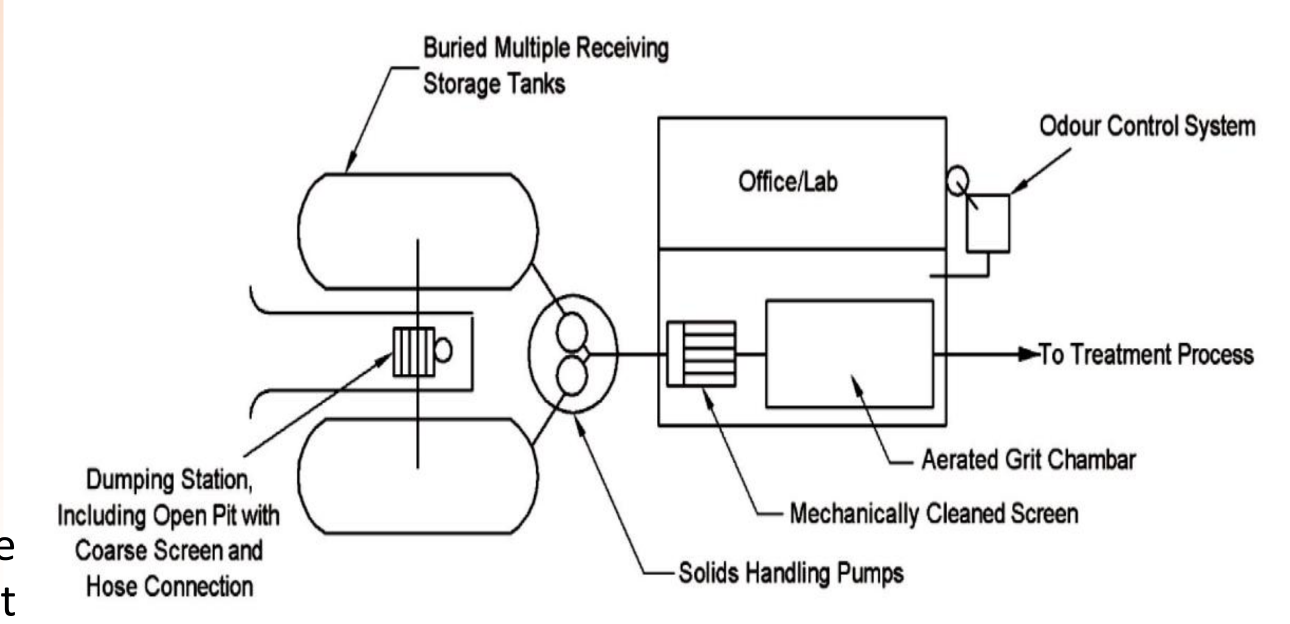


Liquid stream treatment options



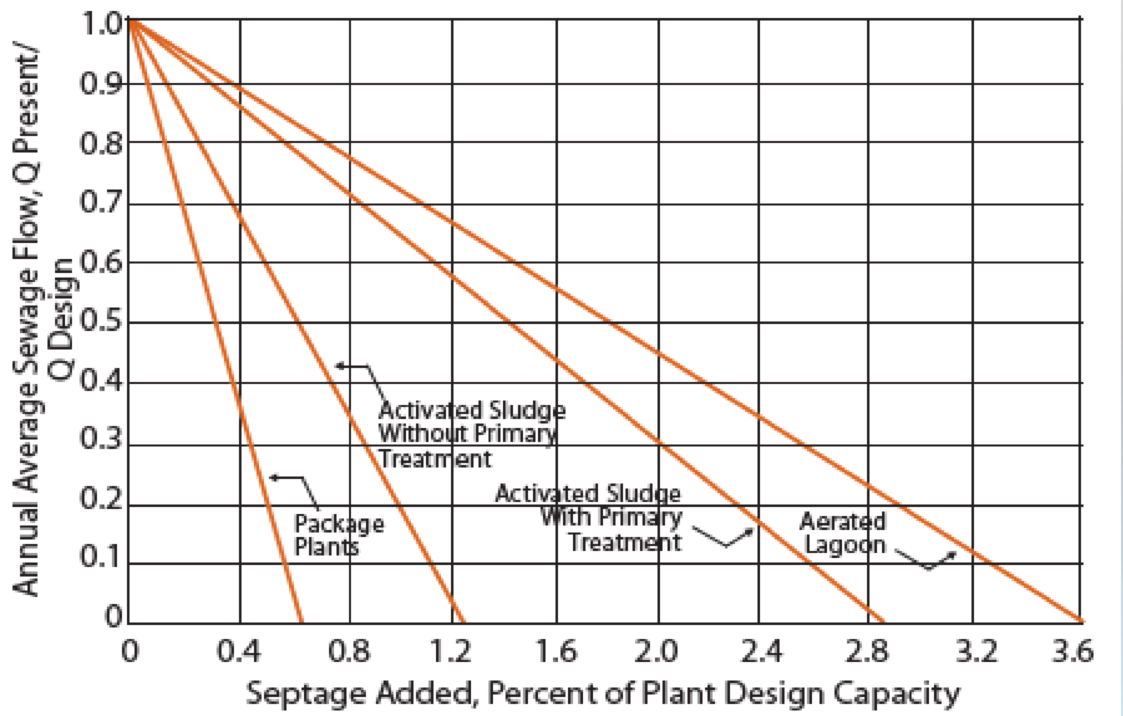
6.2.1.2 Septage receiving facility

- If septage is to be co-treated with sewage, it will be necessary to construct a septage receiving station.
- Such a station will consist of an unloading area, a septage storage tank and one or more grinder pumps



6.2.1.3 Loadings of Septage at STPs

- A chart prepared by USEPA is given below for guidance which takes into account the current loadings to the plant compared with its design loadings.
- The chart can be used to assess the percent of septage by volume that can be co-treated with influent sewage at STP.
- **NOTE:** Detailed technical design of various processes may be seen at publication on
  - Manual on sewerage and sewage treatment (2013), CPHEEO, MoHUA
  - Faecal Sludge and Septage Treatment: A guide for low- and middle-income countries by Tayler, K. (2018).
  - Co-treatment of Septage and Faecal Sludge in Sewage Treatment Facilities, Dorai Narayana (2020)



6.3 Co-treatment of Faecal Septage in solid waste-based Bio-methanisation Plant

- In this treatment, there is microbes driven anaerobic decomposition of organic matter from Faecal Septage to bio-gas. Faecal Sludge and organic solid waste is converted to treated sludge, effluent and bio-gas. Pretreatment of sludge is required but not mandatory.

Advantages

- Established and Mature Technology
- Best Suitable for Wastes with high moisture content
- Technology could be optimized for any scale

Disadvantages

- Odour from the digestate
- Pathogen dissemination from the digestate
- Affected by temperature
- Less efficient in colder climate

BOX 2

Waste to Energy Plant, Nashik, Maharashtra

Scale: Daily 10 to 15 tons of food and vegetable waste from approximately 500 restaurants and 10 to 20 tons of septage from 400 community toilets are collected by trucks and delivered to the plant

Implementing mode: Design – Finance - Build – Own – Operate – Transfer (DFBOOT)

Implementing agency: The Deutsche GesellschaftfürInternationaleZusammenarbeit (GIZ) GmbH

Area: 6000 sq.m, provided by Nashik Municipal Corp (NMC).

Processing Capacity: 30 Tonne/day

Capital Cost: INR 8.02 Crore (INR 6.8 Cr from GIZ and 1.2 Cr from M/s Vilholi Waste Management System Pvt Ltd

Operational since: December, 2017

O&M: NMC will give INR 5 lakh per annum for management

Power Generation: 3300 kWh/day (the purified bio-gas is sent to a Combined Heat and Power (CHP) unit.

6.4 Thermal Drying and Treatment of Faecal Sludge and Septage

6.4.1 Thermal Drying

It allows the removal of all types of liquids from FS. Several types of technologies exist, all based on the ability of evaporating water with heat. These systems require preliminary dewatering if used for sludge that is high in water content.

6.4.2 Thermal Treatment

Thermal drying is followed by thermal treatment which include incineration, pyrolysis or gasification.

6.4.2.1 Incineration: Involves the burning of Septage/ Faecal Sludge at temperatures between 850-900°C. It does not typically take advantage of the potential for resource recovery, however, energy can be captured from the incineration of sludge.

- For better performance Faecal Sludge needs to be dewatered prior to combustion, but stabilization treatment is not necessary as it decreases the volatile content of the sludge.
- The process requires very less space
- One cycle takes a few hours to complete.

6.4.2.2 Gasification

- Gasification involves thermal transformation of organic mass under limited supply of air/oxygen to Syngas.
- In this technology sludge is converted to Syngas & Biochar.
- Gasification is suited for dry feedstock and the drying of Sludge is required prior to treatment.
- It is an energy intensive process and needs to be tested for operational and financial viability under Indian conditions.

6.4.2.3 Pyrolysis: Pyrolysis involves thermal conversion of carbonaceous materials in sludge to produce complex oil in absence of air/oxygen. In this technology sludge is converted to Bio-oil, Pyrolytic Gas and Biochar. It requires trained manpower and has high risk of malfunction if not maintained and operated properly.

Advantage of thermo-mechanical treatment

- Low footprint
- Modular and Scalable
- Bio-safe treatment process for solids and liquids
- No minimum plant capacity required for operation.
- Setup time in 6-7 months from signing of agreements

Disadvantages of thermo-mechanical treatment

- Requires Electricity (Grid / DG)
- Energy Intensive
- High Capital and O&M Cost
- Susceptible to breakdown and malfunctioning
- Skilled manpower

BOX 3

Biochar production from faecal sludge using pyrolysis

To date, most initiatives using pyrolysis to produce biochar or fuel briquettes from faecal sludge have been at the pilot scale. One such initiative is operated by Water for People with support from the Water Research Commission (WRC) in Uganda and involves production of sludge briquettes. Currently the organization is experimenting with two types of small kilns that have previously been used for carbonization of wood: a masonry insulated retort kiln and a metallic kiln. The process involves the following steps:

(1) a start-up fuel (wood or charcoal) is burned at the base of the kiln,

(2) dried sludge is added until the kiln is full,

(3) additional sludge is added as sludge burns down (4–5 hours), and

(4) when the fire penetrates the topmost sludge, the unit is air-locked to allow the pyrolysis process to continue overnight.

In the final step of the process the carbonized biochar is crushed into fine particles and then blended with a binder such as cassava or molasses. Clay may also be added as a filler to reduce the burning rate of the briquettes, although this may not be necessary as the lack of pit lining means that sludge may already contain a high proportion of filler. Crushed charcoal can be added to increase the energy content of the mixture. After blending and addition of water to increase the moisture content, the briquettes are produced using either a mechanized extruder, screw extruder, hand/manual press, or honeycomb press.

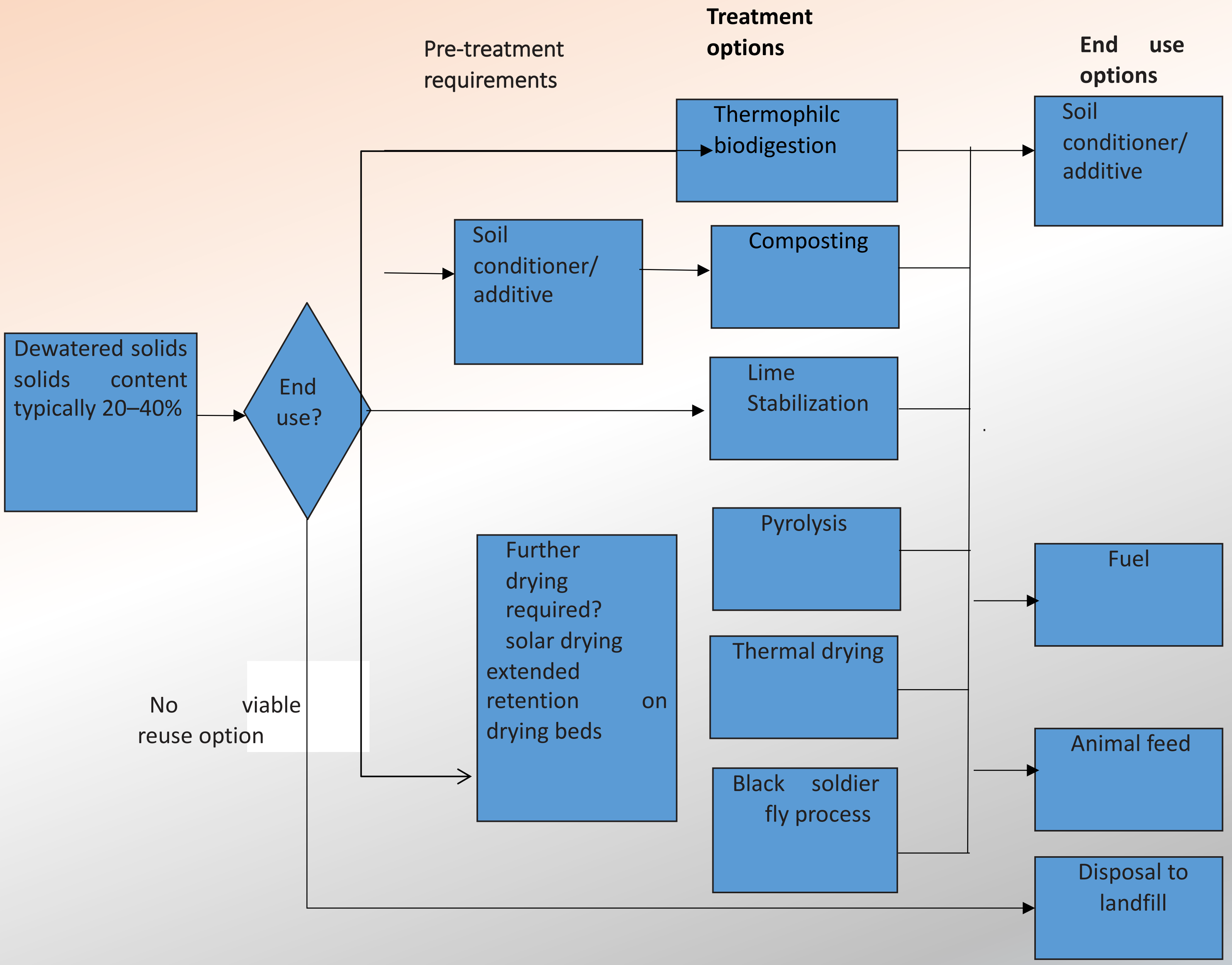
6.5 Co-composting

For dewatered Sludge processing (solid portion), the methods like Co-composting, Vermi-composting can also be used which are briefly described.

6.5.1 Composting: Composting of Faecal Sludge is done together with other waste streams such as municipal solid waste (MSW) following similar procedure of composting as is done for MSW alone.

6.5.2 Vermicomposting: In this method, dewatered faecal sludge is applied to a system inoculated with earthworms whether alone or mixed with food waste.

Overview of end-use and treatment options



Chapter 7. Operation & Maintenance

- **Standard:** In ULBs, septic tanks are often constructed in total **disregard to the Standards** in force, and are often dramatically **undersized/oversized and poor in quality**.
- **Location:** Septic tanks are frequently installed **underneath homes, roads/ lanes due to small lot sizes**, thus making access for inspecting or desludging difficult.
- **Poor Construction:** Often, septic tanks are constructed in such a way that they are **not septic tanks at all, but are instead seepage pits or cesspools.**
- These unlined, earthen receptacles not only perform poorly at treating sewage, but frequently serve as **direct conduits to aquifers**, resulting in fecal contamination that can impact precious drinking water supplies.
- There is a general **lack of awareness** among system owners and ULBs about entire sanitation value chain as to how it should be planned, designed, installed, operated and maintained.
- **Indiscriminate disposal:** In several instances, private desludging operators dispose of Faecal Sludge and Septage in open drains/ land degrading environment.
- Even simplest of STPs/FSTPs do not function properly due to **poor O & M** and lack of skilled manpower.
- This has resulted in pollution of the ground and surface water bodies impacting the public health.

To ensure that entire sanitation value chain performs as per desired objectives, following important aspects need to be taken care;

- Enforcement of regulations to improve on-site and localised sewage management practices
- Monitoring of Sanitation Value Chain
- STP/FSTP routine maintenance
- Institutional Set up for O & M
- Capacity Building and Training
- Availability of O & M funds
- Information Education Communication
- Private Sector Participation

7.1 Enforcement of Regulations to improve on-site and off-site sewage management practices

- To ensure that entire sanitation value chain performs as per desired objectives, following important aspects need to be taken care;
    - Several states have formulated specific sanitation policies to address the issue as given at Annexure II
    - Standardization of Septic tanks

7.2 Monitoring of Sanitation Value Chain

- Periodic Audit of toilet facilities
- Emptying & Transportation
- Truck operators must take the following measures while desludging:
    - The septic tanks should not be fully emptied
    - No fire or flame should be used near the septic tanks
    - Proper safety gear must be used by the operator
    - Operators should clean their surroundings before leaving and after desludging
- ULBs shall take the following steps in order to properly treat faecal sludge
    - Operators shall be forbidden by regulation to dispose of sludge collected from the septic tanks or pits into fields, rivers, nalas, forests, etc
    - ULB should first assess the possibility of sludge treatment at existing STP
    - ULB should plan for new faecal sludge treatment facility
    - Input quality of the collected septage should be tested at the treatment facility
    - Septage should be reused/disposed of only after it meets the specified disposal parameters.

Recommended Measures

Stage	Monitoring
Containment	• Construction as per prescribed standards by BIS or CPHEEO • Construction of the containment by licensed masons and plumbers • Overflow from containment is not diverted in open areas or drains • Census of the OSS and retrofitting of faulty containment is done. If not done within a timeline, defaulters should be charged
Emptying	• Safety standards are followed • Legislative provisions like Manual Scavenging Act, 2013 are followed • Fixed charges are collected by private or government operators
Transportation	• Vehicles are registered with ULBs with transparency • Vehicles are well-maintained • All vehicles are GPS-enabled so that the route followed and point of disposal can be monitored • Septage is disposed in designated disposal or treatment sites
Treatment	• Septage characteristics are determined to design the treatment system • In case of co-treatment at STPs, design parameters to take additional septage load is checked • Effluent resulting from dewatering is treated as per discharge standards • Independent septage treatment plants have adequate provisions for vehicle parking • Sludge drying beds are emptied regularly
Disposal and end use	• Legislative provisions like water pollution and environment protection acts are followed • Defaulters are charged or fined as per provisions • Quality checks of end products is done before end use • Rates of end products are reasonable • Treated wastewater overflowing from containment meets prescribed • standards of end use for designated purposes

7.3 STP/FSTP Routine Maintenance

To achieve it following need to be ensured

i. Treatment capacity matches the load on the plant;

ii. Technology selection takes account of resource availability;

iii. The process design facilitates effective operation;

iv. management systems support and facilitate operational procedures;

v. Facilities are constructed accurately and to the minimum standards required to ensure effective operation; and

vi. Both managers and operational staff have a sound knowledge of the operational requirements of the treatment process.

vii. Written standard operating procedures (SOPs) are available and are routinely followed by staff.

7.4 Institutional Set up for O & M

- **CPCB, 2007 analysis showed that the simplest waste stabilization ponds were among the worst performers.**
- This is bacause that managers assumed **the low maintenance meant no maintenance.**
- The responsibilities of various personnel must be clearly defined and periodically monitored to ensure efficient functioning of the systems

7.5 Capacity Building and Training

ULB need to take the following steps to address the gap in capacity on on-site and localised sewage management practices:

- Training and capacity building of ULB officials and other engaged in the sector
- State level awareness and behavior change campaign
- Create enabling environment for participation of NGOs and CSOs.

7.6 Availability of O & M Funds

- ULBs may develop systems for charging for services that provide mainly public goods.
- An example from the **Philippines** is the introduction of small monthly charges, on water bills in some towns in the Philippines to cover the cost of scheduled pit and tank emptying and the associated transport and treatment services.
- This option has the merit of simplicity but is only possible where most people have a water connection.
- It might also be possible to add the surcharge to electricity bills or property taxes.
- The **Maharashtra Government** has also suggested the alternative of introducing a new sanitation tax, noting that this would be possible under existing legislation.
- **Hyderabad** add sewage cess as percent of water supply charges.

7.7 Information Education Communication

The IEC plan identifies the steps for:

- Creating the message;
- Producing the materials;
- Launching the outreach activities;
- Monitoring and Evaluation (M&E); and
- Adjusting the message and outreach based on the M&E.

7.8 Private Sector Participation

- Private Sector can bring about technical know-how and innovation and operational efficiency in on-site and localised sewage management practices.
- ULBs should develop operational and financial models to engage the private sector and attempt to make the projects financially viable.
- ULBs also need to empanel private desludging vehicles
- The empanelment should be done through a tender basis to maintain transparency

Chapter 8.   Off-Site Sewage Management

8.1 Off-Site Sewage Management Systems

- This concept implies localized collection, conveyance and treatment of excreta and sullage in micro zones within a major habitation.
- This depends on densification of locality and progressively keeps on duplicating as and when population in other micro zones get dense.

8.1.1 Collection and Conveyance Systems

- **Simplified Sewerage:** Simplified Sewerage is defined as "an off-site sanitation technology that removes all wastewater from the household environment."
- **Small Bore Sewer System**: Small bore sewer system is designed to collect and transport only the liquid portion of the domestic sewage for off-site treatment and disposal.
- **Shallow Sewers:** They are a modification of the surface drain with covers and consist of a network of pipes laid at flat gradients in locations away from heavy imposed loads (usually in backyards, sidewalks and lanes of planned and unplanned settlements).
- **Twin Drain System:** This is an integral twin drain on both sides of the road. The drain on house side receives the sewage and the drain on road side is the storm water drain.

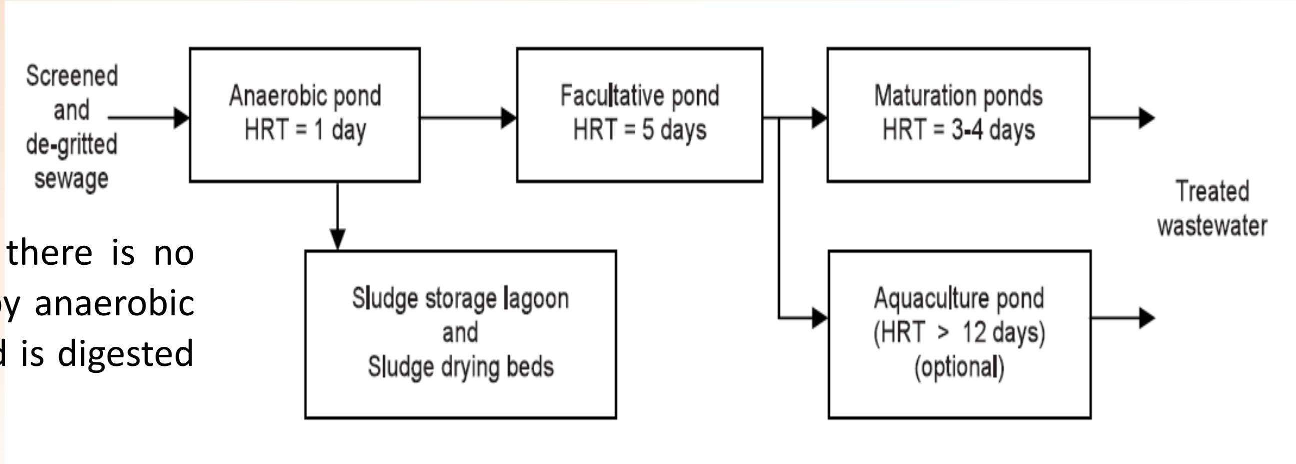
8.2 Off-site Sewage Treatment Technologies

1. **Physical Treatment** which comprises of Physical Straining, screens, filters, press, centrifugation, sedimentation
2. **Chemical Treatment** such as Activated Carbon, ion-exchange, Disinfection- Chlorine, ozone or Ultra violet disinfection
3. **Bio-chemical treatment** which utilizes beneficial microbes to breakdown the waste matter into simpler stable compounds. The main bio-chemical processes could be further distinguished as given below:

   - **Aerobic processes**- the stabilization reaction occurs in presence of air/ oxygen, wherein a certain strain of microbes is prevalent, which help to break the sewage down into simpler stable oxidised end products by combining it with the oxygen available/ supplied to the reactor.

   - **Anaerobic processes** – the stabilization reaction takes place in absence of air/ oxygen, where- anaerobic bacteria predominate and the waste is reduced through putrefaction to combine with Hydrogen available in the sewage.

8.2.1 Waste Stabilisation Ponds (WSP)



Types of Waste stabilization ponds (natural ponds)

- **Anaerobic ponds:** Comparatively small and deep (3–4 m) as there is no need for aeration. They receive raw sewage which is treated by anaerobic bacteria, while sludge that builds up in the bottom of the pond is digested by anaerobic micro-organisms.
- **Facultative ponds:** Shallower (1.5–2 m) with a larger surface area than anaerobic ponds. They consist of an aerobic zone close to the surface and a deeper, anaerobic zone.
- **Maturation ponds:** Shallow (1–1.2 m) with a large surface area to enable light penetration. They receive treated effluent from the facultative pond and provide tertiary treatment to remove turbidity, pathogens, and nutrients.

Key features of the technology

- Simple to construct, operate and maintain
- Does not involve installation of expensive and electro-mechanical equipment
- Operates on a combination of solar energy and natural forces and thereby has very low O&M costs
- Extremely robust and can withstand hydraulic and organic shock loads
- Effluents from maturation pond and safe for reuse in agriculture and aquaculture

Performance

- Can reliably produce high quality effluent with low BOD, SS, Fecal Coliform and high DO levels
- BOD reduction of the order of 80% and more
- Suspended solids reduction is somewhat less due to possible overflow of algae
- Coliform reduction could be up to 6 log units
- Total nitrogen removal between 70-90%
- Total phosphorus removal between 30-45%

Applicability

- Suitable under warm Indian climatic conditions
- For areas with easy availability of land
- In areas with social preference for aquaculture
- In areas with low, unreliable or expensive power supply

Advantages

- The inherent simplicity of construction offers low cost technology option
- High quality effluent at least operating costs
- Low skill requirement for operation of the plant
- Fish yield from aquaculture ponds around 4-7 tonnes/ha/year

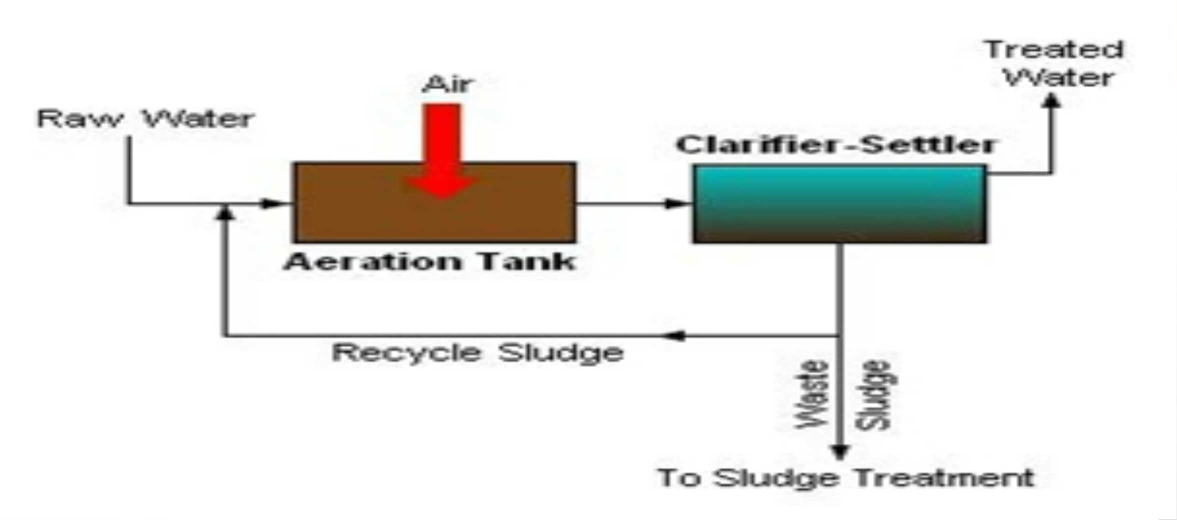
Disadvantages

- Large land requirement
- High cost of lining
- Likelihood of odour nuisance and mosquito breeding in poorly maintained VVSPs
- If unlined, likelihood of groundwater contamination in porous and fractured strata

Cities where working

WSP based plants are working in plenty in various parts the country i.e in **Vrindavan** in Uttar Pradesh, **Mysore** in Karnataka and various cities including **Kolkata** in West Bengal.

8.2.2 Activated Sludge Process (ASP)



Key features

- Wastewater aeration in the presence of a microbial suspension,
- Solid-liquid separation following aeration,
- Discharge of clarified effluent,
- Wasting of excess biomass, and
- Return of remaining biomass to the aeration tank.
- Proven and tested for more than 7-8 decades all over world
- Several modifications/advances possible to meet specific requirements

Advantages

- Performance is not significantly affected due to normal variations in wastewater characteristics and seasonal changes
- Less land requirements

Disadvantages

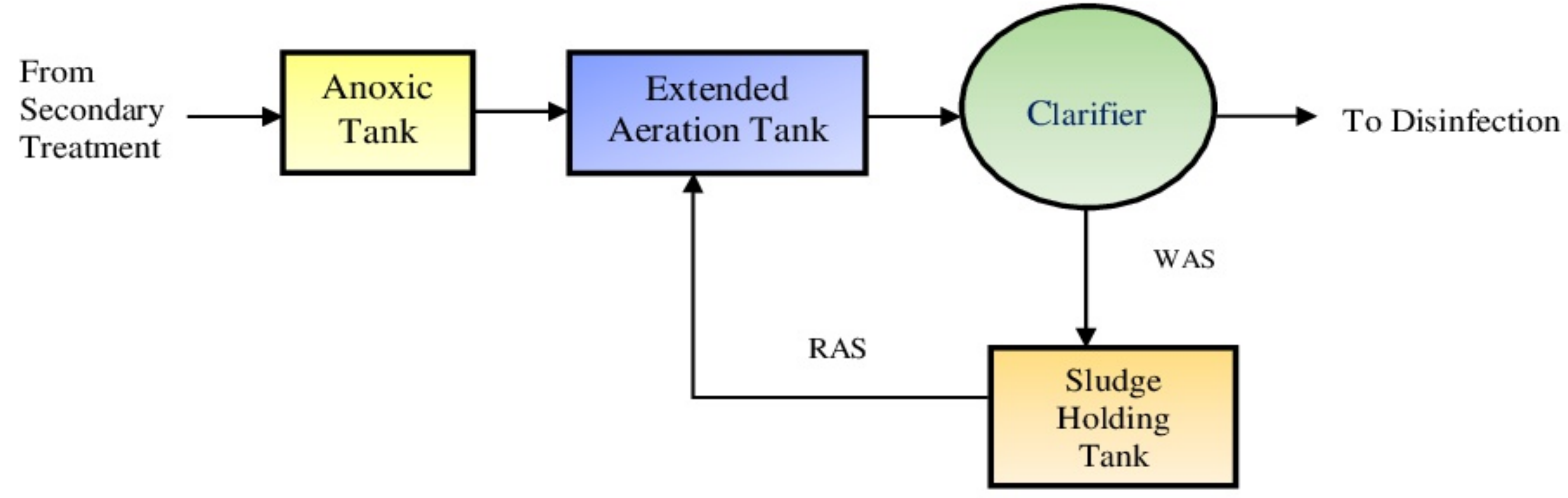
- High recurring cost
- High energy consumption
- Performance is adversely affected due to interruption in power supply even for a short period
- Foaming, particularly in winter season, may adversely affect the oxygen transfer and hence performance
- Requires elaborate sludge digestion/drying/disposal arrangement

Cities where working

ASP based plants are working in plenty in various parts the country like Agra, Lucknow & Kanpur in Uttar Pradesh, Bengaluru in Karnataka and Chennai in Tamil Nadu etc.

8.2.3 Extended Aeration

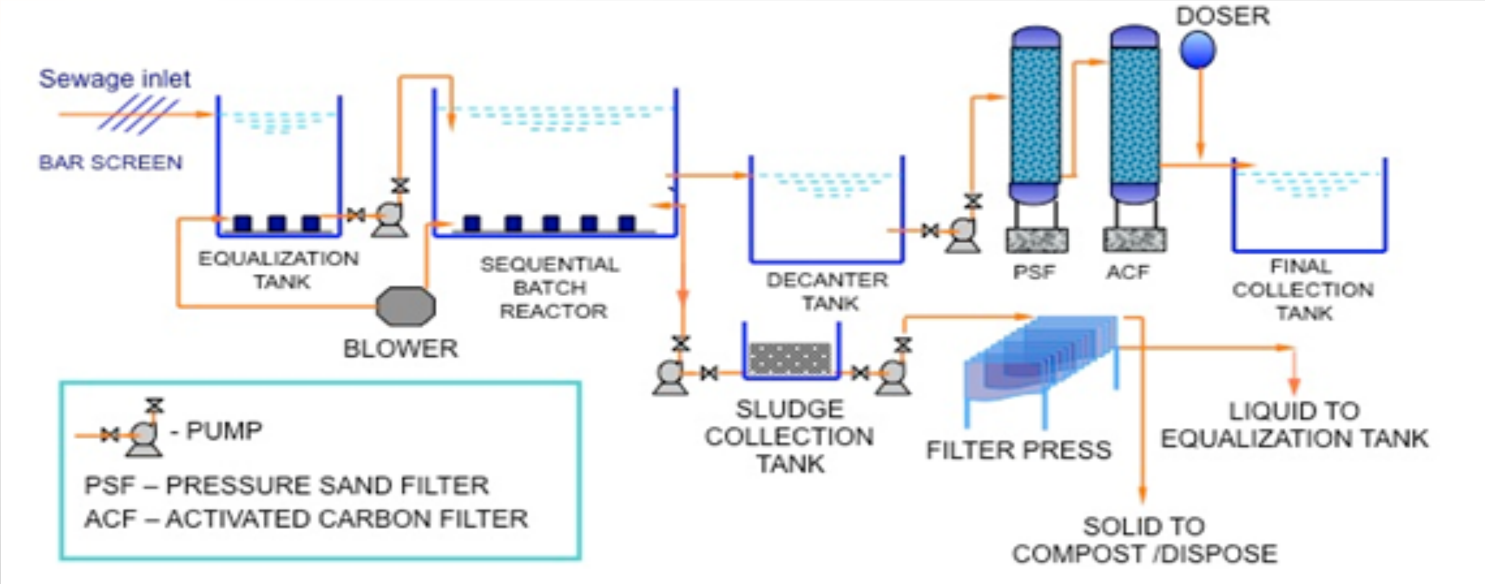
- Extended aeration is a method of sewage treatment using modified activated sludge procedures. It is preferred for relatively small waste loads, where lower operating efficiency is offset by mechanical simplicity.
- It is a major modification of Activated Sludge Process and is generally considered as a stand-alone development.
- In extended aeration process the raw sewage goes straight to the aeration tank for treatment. The whole process is aerobic. This simplification implies longer aeration time which has earned for the process the name "extended aeration".
- The BOD removal efficiency of the extended aeration process is higher than activated sludge process



Extended Aeration System (EA)

8.2.4 Sequential Batch Reactor

- **Key Features**
- SBR operates by developing mixed culture of bacteria (biomass) which is effective for removal of BOD, COD and nutrients commonly found in wastewater.
- SBR functions as equalization tank, aeration tank and clarifier within single reactor.
- For large quantities of wastewater flow (more than 500 cubic meters /day) two or more reactors are utilize in predetermined sequence of operation.
- **Applicability**
- Ideal for treatment of wide range of domestic and industrial waste water at flow ranging from few thousand liters to millions of liters per day.



Advantages:

- Offer consistent effluent quality to desired limits;
- Designed to minimize operation & maintenance cost;
- Eliminates return activated sludge piping;
- Excellent effluent quality
- Smaller footprint because of absence of primary, secondary clarifiers and digester
- Recent track record available in large applications in India also
- Biological nutrient (N&P) removal
- High degree of coliform removal
- Less chlorine dosing required for post disinfection
- Ability to withstand hydraulic and organic shock loads

Disadvantages

Comparatively high energy consumption

To achieve high efficiency, complete automation is required

Highly skilled operators needed

No energy production

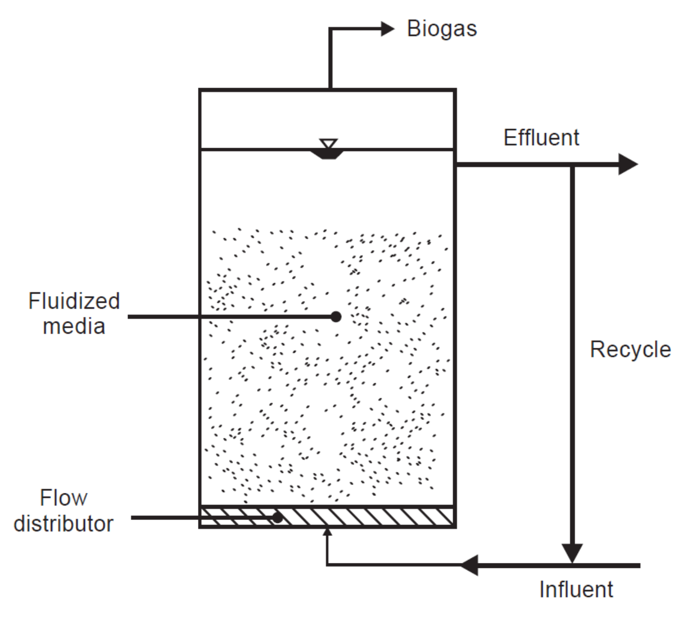
Uninterrupted power supply required

Cities where working

SBR based plants are working in plenty in various parts the country like Varanasi in Uttar Pradesh, Delhi, Bengaluru in Karnataka etc.

8.2.5 Fluidized Aerated Bed (FAB)

- **Key features of the technology**
- A compact and robust system involving extended aeration process with submerged aeration.
- Biomass growth on fluidized bed of plastic media enabling retention of biomass and long solid retention time in the reactor leading to low ‘food to micro-organism ratio and higher organic removal
- Two stage biological oxidation
- Flexibility in handling organic load by adjusting quantity of fluidized media
- Treatment scheme excluding primary sedimentation and sludge digestion
- Reactors up to 5 m deep enabling low land requirements
- Tube settlers again offer space economy
- Ability to withstand limited organic overload



Advantages

- Exclusion of primary treatment step of sedimentation
- Deep reactors enabling small space requirements
- Ability to effectively treat dilute domestic wastewaters
- Elimination of the need for sludge recirculation and monitoring of MLSS in the reactor
- Capacity to handle shock loads
- Low head loss in the fluidized filer bed
- Low and stabilized sludge production eliminating the need for sludge digestion
- Simple and reliable operation
- Absence of odour and improved aesthetics
- Absence of emission of corrosive gases

Disadvantages

- Reliance on patented filter media
- Reliance on flocculants, polyelectrolyte and chemical disinfectant (Optional)
- Requires skilled manpower
- Choking of reactor due to floating plastic matter

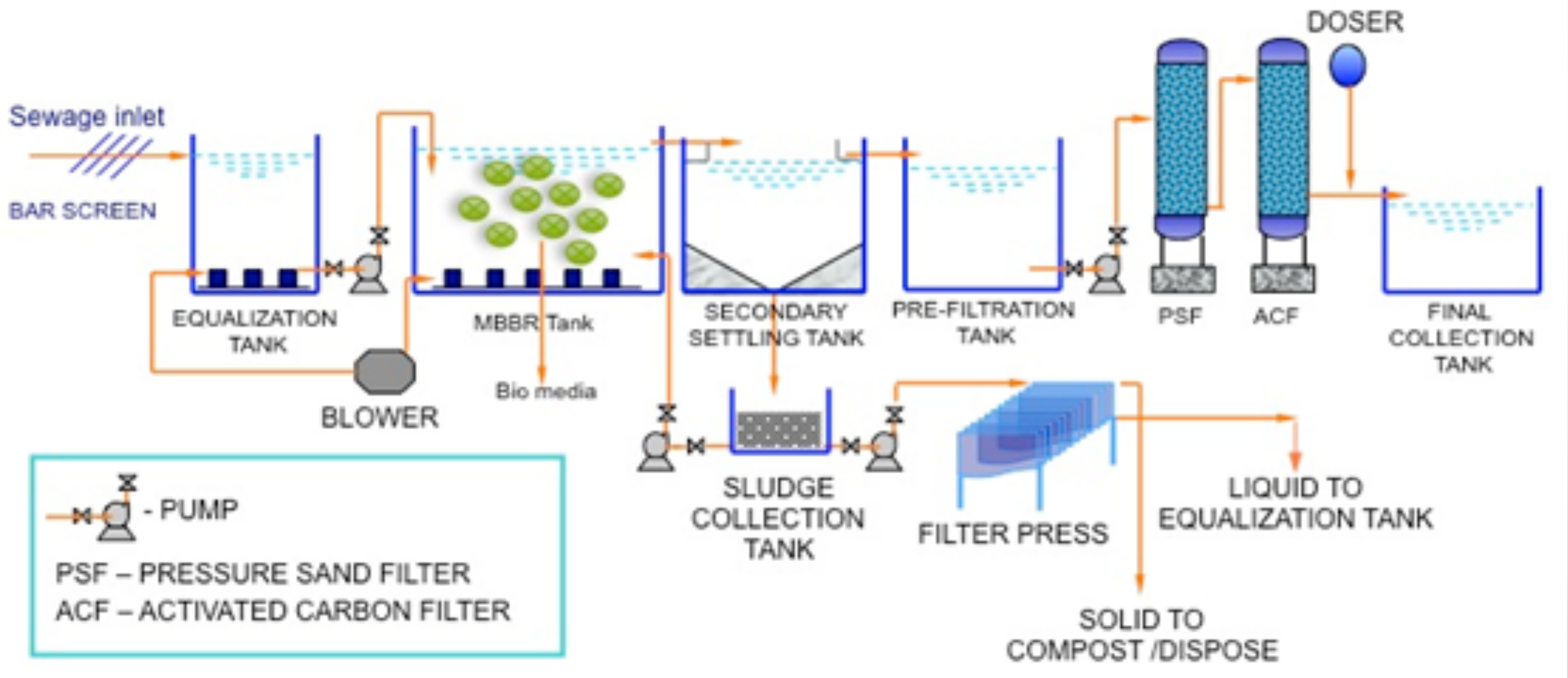
Cities where working

FAB based plants are working in plenty in various parts the country like Chandigarh, Renukoot in Uttar Pradesh, Delhi, PimpriChinchwad, Pune in Maharashtra etc.

8.2.6 Moving Bed Biological Reactor (MBBR)

Advantage

- Perfect Wastewater Solution for Space Constraints
- Easy to Use for Inexperienced Plant Operators
- Resistant to Shock Loads
- Works Quickly With a Low Hydraulic Retention Time
- Compact Design – A fraction of the size of ASP
- Expandable – Capacity could be easily upgraded by increasing the biofilm carrier
- No Return activated sludge stream required
- High Response to shock load
- Minimal maintenance of MLSS
- Moving Bed Biofilm Reactor needs less space since there is no primary clarifier and detention period in reactor is generally 4-5 h.
- Ability to withstand shock load with equalization tank option
- High operator oversight is not required



Disadvantage

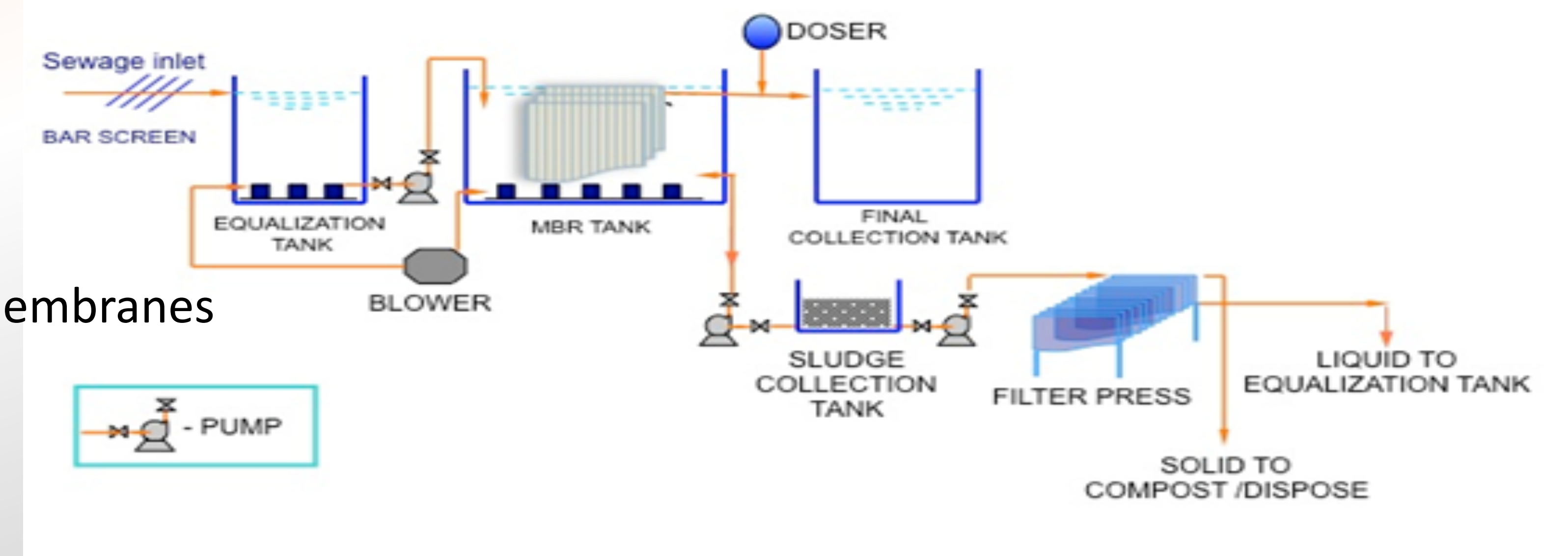
- Manual monitoring
- Skilled experts
- Insects
- Escaping carriers
- Skilled operators needed
- No energy production
- Effluent quality not up to the mark in India
- Much less nutrient removal
- Designed criteria not well established

Cities where working

MBBR based plants are working in plenty in various parts the country like Panchkula in Haryana, Vishakhapatnam in Andhra Pradesh, Tharangambadi in Tamil Nadu etc.

8.2.7 Membrane Bioreactors (MBR)

- **Advantages**
- Low hydraulic retention time and hence low foot print (area) requirement
- Less sludge production
- High quality effluent in terms of low turbidity, TSS, BOD and bacteria
- Stabilized sludge
- Ability to absorb shock loads
- **Disadvantages**
- High construction cost
- Very high operation cost
- Periodic cleaning and replacement of membranes
- High membrane cost
- High automation
- Fouling of membrane
- No energy production



Cities where working

MBR based plants are working in plenty in various parts the country like Rahimatpur in Maharashtra, Delhi, Udaipur in Rajasthan, Bengaluru in Karnataka etc.

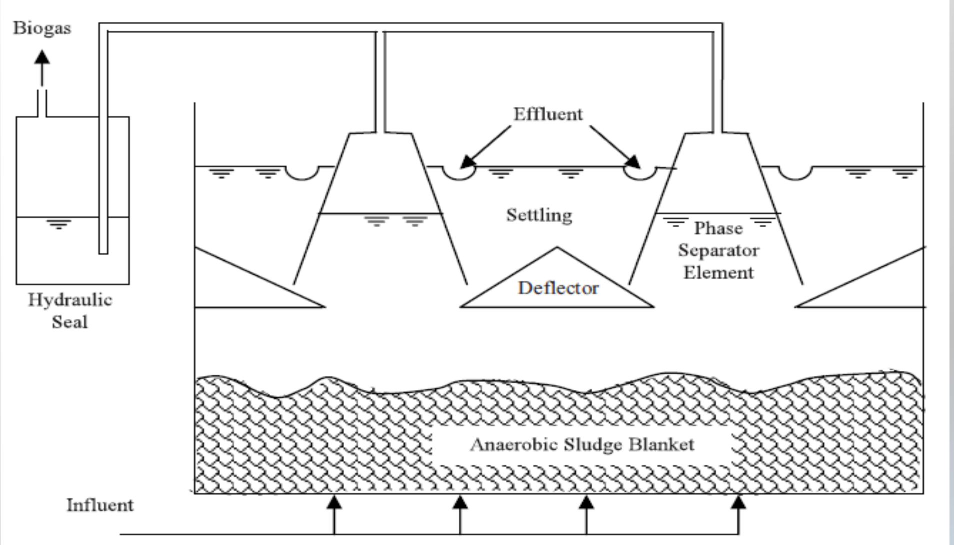
8.2.8 Upflow anaerobic sludge blanket (UASB)

Key features

- No mechanical components or external energy requirements in the reactor, therefore, process not vulnerable to power cuts
- No primary treatment; suspended solids in the wastewater serve as carrier material for microbial attachment
- Recovery of gas with high calorific value
- Low sludge production
- Relatively simple routine operation and maintenance
- Biological activity can be restarted without any external seedling or special care after interrupted

Advantages

- Sludge handling is minimized
- Power supply interruptions have minimal effect on plant performance
- Cab absorb hydraulic and organic shock loading



Disadvantages

Long start-up and high initial oxygen demand of effluent during this period may causeoxygen depletion in receiving water bodies.

Sensitive to seasonal temperature variations and low removal efficiency in winter.

Release of corrosive and odorous hydrogen sulfide and ammonia in the air.

Stability in performance is questionable unless sludge wash out is prevented

Fecal and total coliform removal is poor

Aesthetically the effluent has poor acceptability due to its black color

Exploitation of biogas generated is unsustainable during domestic sewage treatment

Cities where working

UASB based plants are working in plenty in various parts the country like Mathura-Vrindavan, Ghaziabad in Uttar Pradesh, Agartala in Tripura, Vijayawada in Andhra Pradesh etc

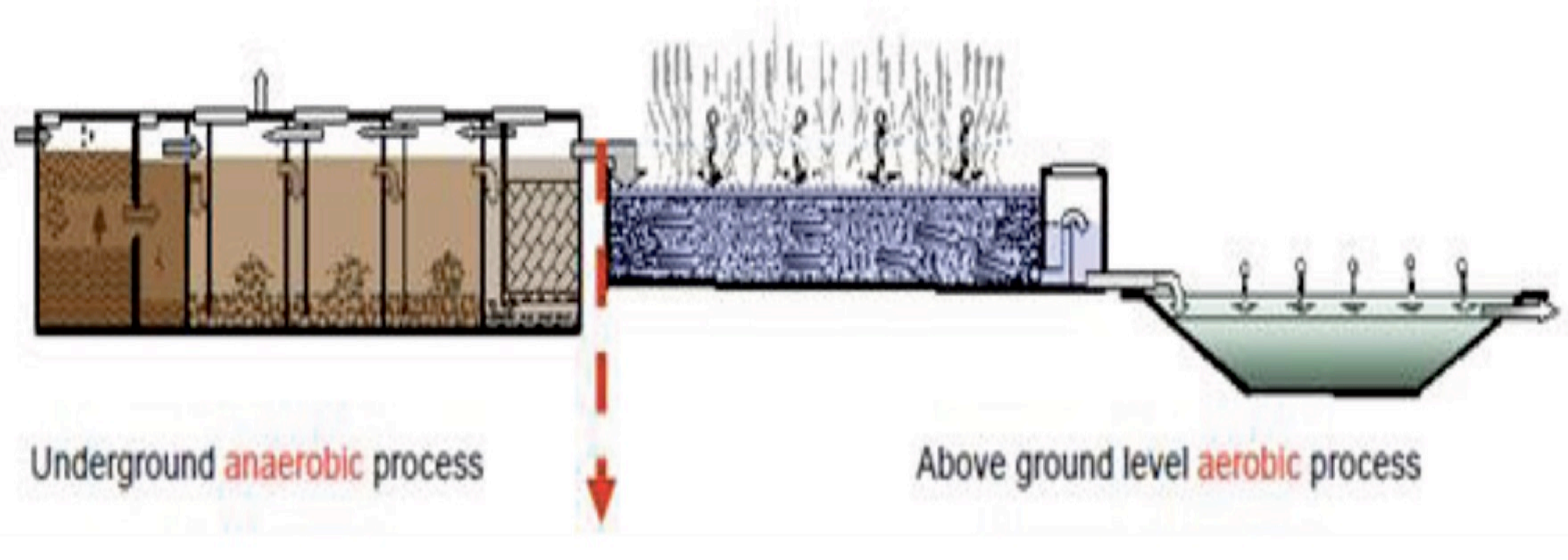
8.2.9 Phytorid Processes- Also called Wetlands, Reed Beds

Advantages

- Simple to construct and operate and maintain
- Low operating and maintenance cost
- Self sufficiency, ecological balance, and economic viability is greater
- Possibility of complete resource recovery
- Good ability to withstand hydraulic and organic load fluctuation

Disadvantages

- Careful design is required to ensure that the filter media is of appropriate grain size and quality.
- Reed beds require a large amount of space, up to 5 m2 per person,
- Odour caused by ponding on the surface,
- Large evaporation loss of water
- Not easy to recover from massive upset
- If liner is breached, groundwater is impacted
- Effluent quality may vary with seasons
- No energy production
- No nutrient removal
- Odor and vector nuisance
- Loss of valuable greenhouse gases to the atmosphere



Cities where working

Phytorid/Reedbed/Wetland Processes based plants are working in plenty in various parts the country like Powai Mumbai in Maharashtra, WAPCOS office premises, Gurgaon and Shahadra in Delhi.

8.3 Brief performance of various wastewater treatment technologies

8.3.1 Performance of various wastewater treatment technologies in Ganga Basin

Criteria	ASP	UASB+ASP	SBR	MBBR	MBR	WSP
Performance in terms of quality of Treated Sewage						
Potential of Meeting the RAPs TSS, BOD, and COD Discharge Standards	High	High	Very High	Very High	Very High	Medium
Potential of Total / Faecal Coliform Removal	High	High	Very High	Very High	Very High	Low
Potential of DO in Effluent	High	High	High	High	High	High
Potential for Low Initial/Immediate Oxygen Demand	Very High	Very High	Very High	Very High	Very High	Very High
Potential for Nitrogen Removal (Nitrification-Denitrification)	Low	Low	Very High	Medium	Medium	Low
Potential for Phosphorous Removal	Low	Low	Very High	Medium	Medium	Low
Performance Reliability	Very High	Medium	Medium	High	Very High	Medium
Impact of Effluent Discharge						
Potential of No Adverse Impact on Land	Medium	Medium	High	High	Very High	High
Potential of No Adverse Impact on Surface Waters	High	High	High	High	Very High	High
Potential of No Adverse Impact on Ground Waters	High	High	High	High	Very High	Medium
Potential for Economically Viable Resource Generation						
Manure / Soil Conditioner	Medium	Medium	Medium	Medium	Low	Low
Fuel	High	Medium	Low	Low	Low	Low
Economically Viable Electricity Generation/Energy Recovery	Very High	High	Low	Low	Low	Low
Food	High	Low	Low	Low	Low	Low
Impact of STP						
Potential of No Adverse Impacts on Health of STP Staff/Locals	Medium	Low	High	High	High	Medium
Potential of No Adverse Impacts on Surrounding Building/Properties	High	Medium	High	High	High	Very High
Potential of Low Energy Requirement	Medium	Medium	Medium	Medium	Low	Very High
Potential of Low Land Requirement	High	Medium	High	High	Very High	Low
Potential of Low Capital Cost	Medium	Medium	Medium	Medium	Low	Very High
Potential of Low Recurring Cost	Medium	Medium	Medium	Medium	Low	High
Potential of Low Reinvestment Cost	Medium	Medium	Medium	Medium	Low	High
Potential of Low Level of Skill in Operation	High	Medium	High	Low	Low	Very High
Potential of Low Level of Skill in Maintenance	High	Very High	High	Medium	Low	Very High
Track Record	Very High	High	High	Low	Low	Medium
Typical Capacity Range, MLD	All flows	All flows	All flows	Smaller	Smaller	All flows

Low	Medium	High	Very High

8.3.2 Performance of various decentralized wastewater treatment technologies

S.No.	Process	Effluent Quality	Coliform Removal	Nitrification Denitrification	Phosphorus Removal	Process Reliability	Land Use	Ease of Operation	Ease of Maintenance	Energy recovery	Electrical demand	Capital Cost	Track Record	Typical Capacity Range (MLD)
1	ASP	G	G	P	P	VG	G	G	G	VG	A	A	VG	AF
2	EA	VG	G	P	P	VG	A	VG	VG	P	P	G	G	SF
3	MBR	VG	VG	P	P	G	VG	P	P	P	P	P	P	SF
4	MBBR	VG	VG	P	P	P	G	VG	P	A	P	A	G	SF
5	SBR	VG	VG	VG	VG	G	VG	G	G	P	A	A	G	AF
6	UASB	A	A	P	P	G	G	A	VG	G	A	A	G	AF
7	WSP	A	P	P	P	P	P	A	VG	P	VG	G	A	AF
8	CW	P	P	P	P	P	P	A	P	P	VG	G	P	AF

Abbreviations-
ASP-Activated Sludge; EA-Extended Aeration; MBR-Membrane Bio Reactor; MBBR-Moving Bed Biofilm Reactor; SBR-Sequencing Batch Reactor; UASB-Up flow Anaerobic Sludge Blanket; WSP-Waste Stabilization Pond; CW-Constructed Wetlands; VG-Very Good; G-Good; A-Average; P-Poor.

Source: *Guidelines for Decentralized Wastewater Management Prepared By Department Of Civil Engineering, Indian Institute Of Technology Madras – Chennai, India*

8.3.3 Comparative Capital and O&M cost of various wastewater treatment technologies

Parameter	WSP	ASP	SBR	FAB	MBBR	MBR	UASB	CW
Capital Cost (per MLD)(Rs. In crore)	1.1	2.1	2.5	2.2	2.3	6.5	1.8	3
O&M Cost (per anuum/MLD)Rs. In Lakhs)	2.5	12.5	17	21.4	9.6	42	3.6	3
Energy Requirement kWh(units)/MLD	10	180-225	153.70	99 to 170	282	305	10-15	Negligible
Land Requirement (hectare/MLD)	0.80-2.3	0.15-0.25	0.03	0.06	0.05	0.05	0.2-0.3	0.16-0.18

Source: The above mentioned capital and O&M cost as well as the land requirements per MLD is worked out based on analysis carried out by Compendium Of Sewage Treatment Technologies by IIT Kanpur and also data collected from various cities.

Chapter 9. Financial Models And Bidding Parameters

Model I: Separate service providers for collection and treatment

Part 1

- ULB to notify charges for cleaning of Septic tanks on cubic meter basis to be payable to empaneled service provider.
- ULB to empanel service provider to empty septic tank and discharge to FSTP/STP on fee basis to be collected from users.
- ULB may or may not pay some portion of charges towards emptying septic tank.

Part 2

- Grant component for setting up of FSTP/STP for different scenarios/percentage
- FSTP operator charges for treatment and safe disposal of per cubic meter of septage
- Desludgers may or may not pay to plant operator for desludging septage.

Model II: Service provider for integrated collection and treatment

Part 1

ULB to notify charges for emptying of Septic tanks on cubic meter basis to be payable to empaneled service provider.

Part 2

- Grant component for setting up of FSTP/STP for different scenarios/percentage
- FSTP/STP operator charges for treatment and safe disposal on per cubic meter/MLD of septage.

Model III: Hybrid Annuity Model

Part 1

- ULB to notify charges for cleaning of Septic tanks on cubic meter basis to be payable to empaneled service provider.

Part 2

- Grant component of 40% (progress linked) for setting up of FSTP/STP for different scenarios/percentage
- Remaining 60% grant over ten years period based on satisfactory performance along with O&M charges on per cubic meter/MLD.

BOX 4

Under the Namami Gange Project, two methods of evaluation of financial bids have been followed

Method 1

The only criterion for evaluation and comparison of Financial Proposals is the Bid Price. Each bidder will have to mention the four parameters in the bid.

a) the Bid Project Cost (calculated based on the state schedule of rates)

b) the O&M Charges for the first year after COD;

c) the Guaranteed Energy Consumption for each year of the O&M Period; and

d) the Land Requirement /Based on the above 4 components quoted by the Bidders in the Bid Price Sheet, the Bidder shall calculate the Bid Price using the following formula:

Bid Price = Bid Project Cost + (O&M Charges x 5 years) + Power Charges+ Land Price

Method 2

The method uses weighted averages to calculate the Final score for the project. The Technical proposal is dependent on multiple factors and is calculated as a weighted average.

The lowest Financial Proposal (FM) will be given a financial score (SF) of 100 points. The financial scores of other Proposals will be computed as follows:

SF = 100 x FM/F

(F = amount of Financial Proposal)

Proposals will finally be ranked according to their combined technical (ST) and financial (SF) scores as follows: S = ST x Tw + SF x Fw

Where S is the combined score, and Tw and Fw are weights assigned to Technical Proposal and Financial Proposal, which shall be 0.70 and 0.30 respectively

The Selected Bidder shall be the first ranked Bidder (having the highest combined score). The second ranked Bidder shall be kept in reserve and may be invited for negotiations in case the first ranked Bidder withdraws, or fails to comply with the requirement.

9.2 Bid Document Framework

9.2.1 Eligibility Criteria

S No.	Eligibility Criteria	Documents to be submitted
1.1	FINANCIAL QUALIFICATION The firm, and the Lead Member in case of a Consortium, to be a company registered under the act of 1956/2013 and in existence at least for 5 (five) years at the end of preceding financial year, i.e., 20-- - --.	Copy of Certificate of Incorporation.
1.2	The firm, and the Lead Member in case of a Consortium, to have declared net profit at the end of preceding financial year, i.e., 20-- - --.	Copy of the balance sheet / auditor certificate.
1.3	The Bidder to have a minimum average annual turnover of INR ----- (in word) crore in the last 5 (five) consecutive financial years preceding the Bid Due Date and in case of a Consortium, the cumulative average turnover of all the Members of Consortium would be reckoned.	Audited balance sheets / Auditor's Certificate.
1.4	Minimum Net Worth of INR ----- (in word) crore at the end of preceding financial year, i.e., 20-- - --and in case of a Consortium, the criteria has to be satisfied as per the share of each member of the Consortium in the equity capital of the SPV. In case any of the Bidders is the Lowest Bidder in more than one Package and the Authority decides to award, subject to Clause 3.3.6, more than one Package to such Bidder(s); the Bidder(s) should have minimum Net Worth corresponding to the number of Packages awarded to them. For the sake of clarity and by way of illustration, if 2 (two) Packages are awarded to one such Lowest Bidder(s), then the minimum Net Worth of such Bidder(s) shall be INR ---- (in word) crore at the end of preceding financial year. i.e., 20-- - --.	As certified by a Chartered Accountant.
2.1	TECHNICAL QUALIFICATION The firm to have prior experience and expertise in developing and/or designing and constructing and operating waste water / septage management /waste to compost / Bio-methanation projects in India. The Bidder should have commissioned at least one project _______of the above specified in the last 5 (five) years. In case of Consortium, the criteria can be complied by any one Member of the Consortium for project development experience and the other for O & M experience. To claim design and construction experience /operations experience, the entity claiming the experience should have been appointed/ hired directly by the relevant government /private entity for execution/operations. Any subcontracting work shall not be considered.	Copies of firm orders / contract along with Certificates, if any, issued by Government Organizations / Municipal Corporations or their equivalent / private entities to demonstrate its experience of developing / commissioning and operating the project in the last 5 (five) years.

9.2.2 Evaluation criteria

S No.	Evaluation of Financial and Technical Qualifications	Max. Marks	Documents to be submitted
1	Experience in developing and/or designing and constructing and operating waste water / septage management / waste to compost / Bio-methanation projects in India for at least ---- (in word) years: 1. 1 (one) project: 30 marks; and 2. More than 1 (one) project: 40 marks; In case of Consortium, the criteria can be complied by any one Member of the Consortium for development/designing and construction of the project and the other for O & M experience. To claim relevant development and/or designing and constructing /operations experience, the entity claiming the experience should have been appointed/hired directly by the government /private entity for project execution / operations. Subcontracting will not be considered.	40	Photocopies of project completion / commissioning certificates, any other relevant documents / certificates should be established. The details should cover Bidder experience in development of the facility.
2	Average annual turnover from any projects dealing with waste water / septage management /waste to compost / Bio-methanationprojects in India in the last ---- (in word) years: 1. Turnover of minimum INR ___ - 10 marks; 2. Turnover of INR _______ to _____-15 marks 3. Turnover >_______– 20 marks. In case of a Consortium, the combined turnover of all the Consortium Members shall be taken into consideration.	20	Auditor/CA certificate.
3	Proposed processing technology option clearly outlining the technical and other advantages of the proposed option along with the business plan and the methodology of Project development. Evaluation of methodology for carrying out proposed task (weight-age) assigned in %) 1. Technical plan including identification of risks and mitigating plan: 10%; 2. Bio-solids output indicators: a. Removal of Helminths eggs and pathogens: 5%; b. Lowering of moisture content: 5%; 3. Range of influent characteristics the designed plant can handle: 10%; 4. Range of characteristics ofEffluent discharged.10% 5. Plan on reuse of treated effluent 16% 6. Ease of operations & maintenance 10% 7. Organization & staffing: 8%; 8. Change management: 5%; 9. Hazard risk management: 8%; and 10.Less land requirement due to technology advantage-20%.	40	To be submitted in the format of appendix III of this RFP. Additionally, Bidders whose Bids were declared responsive in accordance with Clause 3.2 and who also meet the criteria set out in Clause 2.2.1 have to give a presentation before Technical Advisory Committee.
	Total	100	

Chapter 10. Conclusions And Way Forward

10.1 Conclusion

- The spurt in developmental activities coupled with fast pace of urbanization is giving rise to sanitation challenges in urban areas in our country and is bound to further worsen if adequate steps are not taken in time.
- This Advisory has shown the way of integrated planning of sanitation in a city comprising of on-site and off-site sewage management systems.
- The Advisory has covered all aspects of planning of On-site and Off-site sanitation options including conveyance, treatment and recycle and reuse for implementation.
- Finally, the Advisory is enriched with insights on different procurement models, it cross refers various resource documents and also contains several case studies to fully meet the requirements of ULBs while planning city sanitation.

Way Forward

- Different routes of flow of excreta from a city (Shit Flow Diagram) to be mapped and to safely transport, treat and dispose of, a **city sanitation plan** to be developed containing short- and long-term targets.
- City sanitation plan need to **identify priority areas** to be covered with off-site (sewerage system) and remaining with strengthening of on-site sewage management
- The present surge of FSSM (which addresses only **1% of influent pollution load**) , undermining the robust sewerage system, will lead cities nowhere on city sewage management, especially to those cities which are **misunderstanding FSSM as alternative to Sewerage systems**.
- Covering entire urban population with safe sanitation is not **too cost intensive** as often perceived.
- Developing a **receptive market for usage of end products** of sewage treatment/faecal sludge treatment. Recycle and reuse need to be supported by regulations .
- Generate awareness among the community towards **hazards of poor sanitation** and cost directly or indirectly each citizen pays for it.
- **Building capacity** of the urban local bodies and other institutions working on ground will save public funds in long run.
- **Institutional set up** is important at Central / State/ ULB level to achieve city wide sanitation at economical rate.

Annexures

Annexure I Case studies –Faecal Septage Management Practices

- International Practices: Malaysia
- National Practices: Greater Warangal Municipal Corporation
- Faecal Sludge Management in Odisha
- Wai Municipal Council

Annexures II

- List of States Formulated Specific Sanitation Policies

Sl. No.	Name of the State/UTs/ULBs	Title of Document	Year of Release
1.	Andhra Pradesh	Faecal Sludge and Septage Management Policy and Operative Guidelines for Urban Local Bodies	2018
2.	Chhattisgarh	Policy on Faecal Sludge and Septage Management	2017
3.	Gujarat	Faecal Sludge and Septage Management Policy	2017
4.	Karnataka	Operative Guidelines - Septage and Faecal Sludge Management for Urban Local Bodies	2015
5.	Kerala	State Sanitation Strategy	2015
		Brahmapuram Septage plant Guidelines	2015
6.	Madhya Pradesh	State Level Policy for Wastewater Recycle & Reuse and Faecal Sludge Management	2017
7.	Maharashtra	Guidebook for Urban Local Bodies to Implement Septage Management Plan	2016
		Guidelines for Septage Management in Maharashtra	2016
8.	Odisha	Odisha Urban Sanitation Policy	2017
9.	Punjab	Policy & Guidelines for Septage Management in Punjab	2017
10.	Rajasthan	Draft Policy - Faecal Sludge & Septage Management	2018
11.	Tamilnadu	Operative Guidelines for Septage Management for Local Bodies	2014
12.	Telangana	Policy on Faecal Sludge and Septage Management	2018
13.	Uttar Pradesh	Draft - Guidelines for Faecal Sludge and Septage Management in Uttar Pradesh	2018
14.	Greater Visakhapatnam Municipal Corporation	Faecal Sludge and Septage Management Policy and Operational Guidelines	2017

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ii. Compendium of Sewage Treatment Technologies, 2009, National River Conservation Directorate, Ministry of Environment Forest & Climate Change

iii. National Policy on Faecal Sludge and Septage Management, 2017, Ministry of Housing and Urban Affairs

iv. Guidelines for Decentralized Wastewater Management, 2012, Ministry of Housing and Urban Affairs, IIT Madras (Chennai)

v. Faecal Sludge and Septage Management Policy and Operational Guidelines, 2017, Greater Visakhapatnam Municipal Corporation

vi. A Guide to Decision making, Technology Options for Urban Sanitation in India, 2008, Water and Sanitation Program-South Asia, World Bank, Ministry of Housing and Urban Affairs

vii. Recent Trends in Technologies in Sewerage System, 2012, Ministry of Housing and Urban Affairs

viii. Faecal sludge and Septage Treatment- A guide for low and middle income countries, Kevin Tayler, 2018

‘Cleanliness is Godliness’

-Mahatma Gandhi

Thank you Sir