NFSSM ALLIANCE

MANUAL FOR CO-TREATMENT, PLANNING AND DESIGN

A Workbook for Practitioners to plan and implement Co-treatment of faecal sludge in STPs

NFSSM ALLIANCE

The National Faecal Sludge and Septage Management (NFSSM) Alliance, a national working group, comprises 30+ organisations and individuals across India. Supported by the Bill and Melinda Gates Foundation, the NFSSM Alliance was convened in January 2016, with a mandate to build consensus and drive forward the discourse on faecal sludge and septage management (FSSM) in India.

The Alliance works in collaboration with the Ministry of Housing and Urban Affairs (MoHUA) and the Department of Drinking Water and Sanitation (DDWS), under the Ministry of Jal Shakti, which are the central ministries responsible for sanitation in India. Members of the Alliance also work with several State governments across the country.

The vision of the Alliance is to "create an enabling environment to accelerate progress towards universal access to safely managed urban sanitation". The Alliance works towards this vision by addressing the massive challenge of safe storage, collection, transport, treatment, and reuse of human waste in India. It is focussed on all aspects of faecal sludge management across the sanitation value chain.

The NFSSM Alliance has been successful in enabling a range of policy initiatives, e.g., the National Policy for Faecal Sludge and Septage Management. In the past few years, members of the Alliance have supported several state governments with technical assistance and enabled commitments from select states on the scaling up of faecal sludge treatment plants (FSTP) and FSSM solutions, demonstrating viable models and best practices for wider emulation.

While these are critical initiatives to enable safe sanitation at scale, the Alliance understands that providing evidence, planning tools and ready reckoners to support on-ground implementation of FSSM is necessary to ensure last-mile delivery of quality and safe sanitation services across urban India. The Innovation & Technology Taskforce of the NFASSM Alliance has the mandate to codify and disseminate technology related learning and best practices. One of its key priorities to provide a range of technology solutions to enable safe treatment of 100% faecal sludge. Co-treatment at Sewage Treatment Plants (STPs) provides the fastest and most cost-effective pathway to this goal.

Manual for Co-treatment Planning and Design is developed by the Innovation & Technology Taskforce under the aegis of the NFSSM Alliance. It facilitates assessing feasibility of and planning for co-treatment in a town with one or more STPs and allied infrastructure. A practical, step-by-step workbook style booklet provides handholding support to users. The manual also highlights the need for and benefits of co-treatment of faecal sludge at STPs in bridging critical gaps in faecal sludge treatment infrastructure in urban India.

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While literature on co-treatment exists, a practitioner friendly manual to support implementation has not been developed so far. The Manual is based on expertise of several leading practitioners and on-ground experience from existing facilities to bring the latest understanding of co-treatment. This understanding has been codified into simple data formats in a stepwise guide to assess feasibility, help plan and implement co-treatment in STPs with spare capacity, thus fulfilling an important gap in sanitation sector. The manual also includes several case studies with illustrations from across the country which bring out the nuances in co-treatment planning and implementation. It is meant for administrators and technical personnel in the local governments/utility boards, consultants, STP operators, and other practitioners. We hope such practitioners will benefit from the manual to rapidly and responsibly scale-up co-treatment across STPs in our country.

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Abbreviations

CPCB : Central pollution control board
CPHEEO : Central public health and environmental engineering organisation
FS : Faecal sludge
FSSM : Faecal sludge and septage management
FSTP : Faecal sludge treatment plant
KLD : Kilo litres per day
MLD : Million litres per day
NIUA : National Institute of Urban Affairs
SPS : Sewage pumping station
STP : Sewage treatment plant

Key Definitions

Bio-chemical oxygen demand (BOD): Biochemical oxygen demand (BOD) is the amount of dissolved oxygen (DO) needed (i.e. demanded) by aerobic biological organisms to break down organic material present in a given water sample at a certain temperature over a specific period of time. The BOD value is most commonly expressed in milligrams of oxygen consumed per litre of sample during 3 or 5 days (as represented by BOD_3 and BOD_5 respectively) of incubation at 20°C and is often used as a surrogate of the degree of organic pollution of water.

Biosolids: Biosolids are a product of the wastewater treatment process. During this process, liquids are separated from the solids. Those solids (called sewage sludge) are then treated to produce biosolids.

Co-treatment: It is a process of treating faecal sludge and septage along with sewage in a sewage treatment facility.

Current BOD (or TSS): This refers to the average readings of BOD (or TSS) and other characteristics taken over 7 consecutive days during the feasibility assessment for co-treatment.

Current inflow: The average per day flow rate of wastewater into the STP estimated by measuring over 5 consecutive days during the feasibility assessment for co-treatment. This is also referred to as operational capacity.

Design BOD/TSS: This refers to the BOD and TSS values (and other characteristics) assumed during the design of the STP.

Design inflow: The hydraulic design capacity of the STP expressed as volume of wastewater the STP is designed to handle in a day. This is also referred to as design capacity.

Faecal sludge (FS): A mixture of human excreta, urine and flush water accumulated in on-site containment units such as septic tanks, holding/ storage tanks, and pits. Faecal sludge from septic tanks is also called Septage. In this document, the term faecal sludge is used to denote faecal sludge and septage. Industrial or other process sludges not consisting of exclusively of human wastes are not considered faecal sludge.

Faecal sludge management: A system of practices, services and regulations to ensure that excreta collected in onsite containment systems are safely, completely and sustainably emptied, transported, treated and reused or safely disposed.

Grit: Grit includes sand, gravel, cinder, or other heavy solid materials that are "heavier" (higher specific gravity) than the organic biodegradable solids in the wastewater.

Headworks: Also known to be a preliminary treatment stage, this refers to the upstream processes prior to the primary treatment used in sewage treatment. These may generally refer to systems such as wet well, screening and grit removal processes, etc.

Design organic Load: The quantity of organic pollutants that a sewage treatment plant is designed to treat. It is expressed in kgs BOD/Day.

Lift Station: They are used to lift sewage from lower elevation to higher elevation. These are small and compact as compared to sewage pumping station, and most often found in machine (sewerage access) holes.

Sewage pumping stations: They are used to convey sewage over long distances, up to the STP/or subsequent pumping stations. Sewage pumping stations often have wet wells and large pumping equipment as compared to lift stations.

Peak flow: The quantity of sewage flowing into the treatment plant varies overtime throughout the day. Peak flow is the maximum flow per unit time (hourly) that is expected to arrive at the treatment plant based on its design.

Receiving station: A dedicated area accessible by trucks to dispose the faecal sludge. It may also contain holding tanks, screening and grit removal systems.

Sewage Sludge: It is the semi-solid by-product of sewage treatment. When treated, it is called biosolids

Sewage treatment: Sewage treatment is the process of removing pollutants from the wastewater conveyed by sewers to adhere to standards prescribed by the local/regulatory body.

Total Suspended Solids (TSS): These are particles that are larger than 2 microns found in the wastewater. It is measured in dry weight and expressed as mg/litre.

FSSM – A key component for achieving ODF++

Swachh Bharat Mission Urban 2.0 (SBM-U 2.0) and Atal Mission for Rejuvenation and Urban Transformation 2.0 (AMRUT 2.0), launched on October 1, 2021, have brought a sharp focus to wastewater management. Cities and towns are gearing up to implement a combination of sewerage networks, interception & diversion mechanisms, and on-site sanitation systems with regular desludging. In addition, implementing Sewage Treatment Plants (STPs) for treating 100% of the wastewater and faecal sludge will help cities and towns achieve ODF++ status.

This is a huge challenge given the infrastructural gap caused by rapid urban expansion across the country. With about 40% of urban India being connected to sewer networks and about 1,630 operational/under construction Sewage Treatment Plants (STPs), a majority of the toilets (60%)[1]rely on on-site sanitation systems (OSS). Sewerage networks are limited to the central parts of most metros with peripheral areas remaining unserved. The gap is more glaring in non-metros with only 10% of the 4000+ statutory towns having any sewerage systems[2] or STPs. Proper maintenance of these OSS is important for safe sanitation;not desludging septic tanks or doing so irregularly increases the pollution in open drains, while indiscriminate dumping of faecal sludge adds to pollution of water bodies.

The safe emptying transport, treatment, and reuse or safe disposal of human excreta from OSS is called Faecal Sludge & Septage Management (FSSM). Most urban centres across the country are served by small private enterprises providing collection and transport (desludging) services. FSSM is thus a low-cost and easily scalable sanitation solution. However, a large gap exists in treatment infrastructure when it comes to safe management of the collected faecal sludge. Implementing FSSM is thus critical in ensuring public health and environmental outcomes as envisaged under the ODF ++ protocols.

The SBM 2.0 and AMRUT 2.0 missions provide impetus to used water infrastructure using a multi-solution approach, with sewerage networks and STPs complemented by the FSSM. Such an approach can help achieve outcomes faster by leveraging existing and proposed STPs effectively.

[1]https://washdata.org/data/household#!/table?geo0=region&geo1=sdg accessed 17-12-2020

[2]Analysis of Census 2011 data

Co-treatment of faecal sludge in STPs

Co-treatment is the combined treatment of faecal sludge and sewage in an STP. Most STPs are designed for long time horizons and have excess capacity available throughout their life cycles. The latest report on National Inventory of STPs in India (June 2020) shows a cumulative average utilization of 75% of current STP capacity across the country. This translates to about 9,167 MLD of available capacity from 1631 STPs. Conservative estimates show that this capacity can treat faecal sludge from a population of 43.5 crores. This is a nominal figure and the actual treatment potential will be severely constrained by the distance the faecal sludge has to be transported, to reach STPs.

Faecal sludge, though different from sewage in its characteristics, has similar constituents but with higher concentrations. Therefore, with minor additional infrastructure and operational measures, a sewage treatment plant can treat faecal sludge safely. It is clear, however, that faecal sludge from non-sewered areas can be addressed through co-treatment.

The benefits of co-treatment are tangible and immediate. Several case studies from across the country, presented as part of this report, demonstrate that co-treatment is the quickest and most inexpensive form of faecal sludge treatment. Co-treatment presents the fastest way for cities and towns with partial sewerage coverage to extend FSSM coverage for ODF++ status, achieve 100% wastewater management and overall FSSM. Under SBM-U 2.0, all new STPs are expected to be co-treatment ready. This will enable small towns (Class II and below) to also reach treatment requirements effectively.

The benefits of co-treatment can be further extended to rural areas adjoining cities and towns, where feasible. This provides synergies by treating faecal sludge generated in rural areas while maximizing the utilization of urban STPs. Urban local bodies are encouraged to work with district administrations to explore these potential benefits.

Purpose of this document

Co-treatment has been discussed as a method for faecal sludge treatment in the CPHEEO *Manual on Sewerage and Sewage Treatment Systems - 2013* (chapter 9 - On-site sanitation system). Other literature, mainly studying the effects of adding faecal sludge to an STP, is available as well. Though the subject is reasonably well understood, a practitioner friendly manual has thus far not been available. A stepwise guide to help plan and implement co-treatment in STPs having spare capacity fulfils a genuine need in the sanitation sector. This document is a synthesis of experiences from various STPs across the country and captures multiple approaches to co-treatment. The stepwise guidebook format will ease the process of data collection, planning, and decision-making. The manual has simplified and codified the knowledge related to co-treatment. However, it is suggested that for any approaches, examples or systems, that are not mentioned in this manual, documents listed in the references may be referred.

Further, at each step, appropriate formats, checklists, and guidance documents have been provided to help the user. This manual is meant for both administrators and technical personnel in the local governments/utility boards, consultants, STP operators, and other practitioners.

Further, at each step, appropriate formats, checklists, and guidance documents have been provided to help the user. This manual is meant for both administrators and technical personnel in the local governments/utility boards, consultants, STP operators, and other practitioners.

How to read this manual?

The manual consists of information and tools for the reader to plan and take decisions related to co-treatment. The document is divided into various sections. Each section corresponds to a stage in the planning and implementation of co-treatment. It is recommended that users follow all the stages illustrated in this manual to make the best use of this document.

Each section consists of a) checklist or data collection tools, b) calculator or template for data analysis, c) inputs for decision-making and d) reference for detailed design/calculation etc.

Worksheets for planning co-treatment

As practitioners work through the co-treatment manual during the planning process, it is recommended that they update the data calculations and information on this worksheet to inform decision-making.

Step 1: Estimating the quantity and quality of faecal sludge generated in the city/town

1.1 Estimating the faecal sludge generation in the city/town

METHOD	QUANTITY OF FAECAL SLUDGE GENERATION ESTIMATED (KLD)

Output:

Final estimated quantity of faecal sludge to be treated "Q" = ______________________ KLD

1.2 Quality of faecal sludge generated in the city/town Number of samples collected

Number of samples collected					
Sl. NO.	**PARAMETER**	**UNIT**	**MIN VALUE**	**MEDIAN VALUE**	**MAX VALUE**
1	Colour	-			
2	pH	-			
3	Electrical Conductivity, EC	mS/cm			
4	Temperature	°C			
5	Total dissolved solids, TDS	mg/L			
6	Total suspended solids, TSS	mg/L			
7	Total Solids, TS	mg/L			
8	Total Volatile solids, TVS	mg/L			
9	Phosphates as PO43-	mg/L			
10	Ammonium as NH4+	mg/L			
11	Biochemical Oxygen Demand, BOD (5 day @ 20°C)	mg/L			
12	Chemical Oxygen Demand, COD	mg/L			
13	Escherichia coli[3]	MPN/100mL			
14	Helminth Eggs[3]	No. per g			

Output:

Do the results from the samples collected fall in the range as indicated in Table 3?

☐ **Yes**

☐ **No**

[3]These parameters are not needed for design as they are typically high but are recommended to be measured to establish baseline.

Step 2: Identify a STP/SPS for co-treatment

Output:

The following STPs and SPSs have been identified for further analysis based on initial feasibility

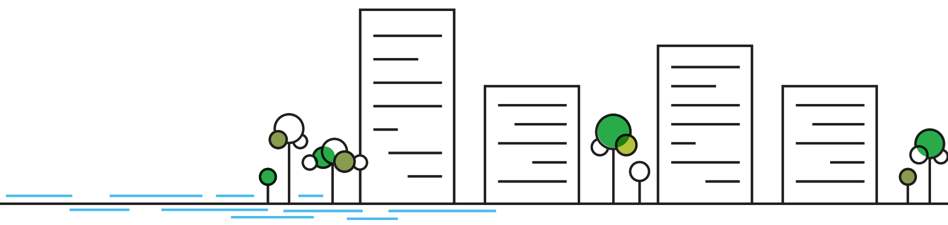
Sl. NO	NAME/ LOCATION OF THE STP WHICH SATISFY CRITERIA # 1, 2 AND 3	NAME/LOCATION OF THE SPS WHICH SATISFIES CRITERIA # 4
	STP 1 -	SPS 1.1 -
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Step 3: Assess the Sewage treatment plant and the SPS

Output:

The following STPs and SPS have been studied in details and are found to be feasible to undertake co-treatment of faecal sludge

Sl. NO	NAME/ LOCATION OF THE STP WHICH SATISFY CRITERIA # 1, 2 AND 3	NAME/LOCATION OF THE SPS WHICH SATISFIES CRITERIA # 4
	STP 1 -	SPS 1.1 -
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		



Step 4: Determine the co-treatment capacity

Output:

The following is the co-treatment potential calculated from the list of STPs and SPSs identified as feasible for co-treatment. List of STPs:

Sl. NO	NAME/ LOCATION OF THE STP	METHOD (DIRECT ADDITION/ SOLID-LIQUID SEPARATION)	CO-TREATMENT POTENTIAL (FAECAL SLUDGE THAT CAN BE ADDED IN KLD) – P1 (OR) P2
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

List of SPS:

SL. NO	NAME/ LOCATION OF THE SPS	NAME AND LOCATION OF THE STP DOWNSTREAM	CO-TREATMENT POTENTIAL (FAECAL SLUDGE THAT CAN BE ADDED IN KLD) THE STP – P1	QUANTITY OF FAECAL SLUDGE THAT CAN DISPOSED AT THE SPS – P1.1
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

Step 5: Identifying the co-treatment infrastructure

List of infrastructure required at the SPS identified for faecal sludge disposal (separate tables for each SPS)

NAME AND LOCATION OF THE SPS	
Quantity of FS that can be added (Step 4 - P1.1 feasible)	
S.No	Description of infrastructure that has to be added at the SPS for FS disposal
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

List of infrastructure required at the STP identified for faecal sludge treatment using direct addition method (separate tables for each STPs)

NAME AND LOCATION OF THE STP	
Quantity of FS that can be added (Step 4 – P1)	
S.No	Description of infrastructure that has to be added at the STP for co-treatment
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

List of infrastructure required at the STP identified for faecal sludge treatment using solid-liquid separation method (separate tables for each STPs)

Name and location of the STP	
Quantity of FS that can be added (Step 4 – P2)	
S.No	Description of infrastructure that has to be added at the STP for co-treatment
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

List of infrastructure required at the STP identified for faecal sludge treatment using solid-liquid separation method (separate tables for each STPs)

Step 6: Commissioning

The STPs and SPSs have been checked for the following parameters and are certified to be commissioned

Name of the STP/SPS and location		
Sl.No	**Checklist**	**Yes/No**
1	Organisation and persons engaged to manage the co-treatment infrastructure.	
2	Responsible person (engaged for management of co-treatment facilities) are trained on operations	
3	Operations manual of the STP is updates, operators trained on the updated version	
4	Hydraulic testing of all new modules and equipment carried out successfully	
5	All modules and equipment are tested to operate with faecal sludge, at designed capacity and are observed to be operating satisfactorily.	

Why do STPs have buffer capacity?

Sewage treatment plants are typically designed for long life cycles due to the high investments and their critical function. As per the CPHEEO Manual on Sewerage and Sewage Treatment Systems - 2013, all STPs must be designed for a project period of 15 years. It assumes that over a period of 15 years, the inflow into the system due to an increase in population will match the design capacity. Thus, there shall always be unutilized capacity in these STPs for the entire design life. Figure 1. depicts the hydraulic loading of STPs – the graph shows how STPs have unutilized capacity. The red dotted line depicts actual inflows to the STP while the blue line shows capacity. The gap between the two lines shows unutilized or available capacity. Each step depicts a period of 12-15 years when STP capacity is increased to meet the additional demand. The STPs are heavily underutilized in the initial years due to a combination of reasons, i) lag in implementing sewerage infrastructure, ii) delay in connecting households to sewerage networks, iii) low population compared to ultimate design period population, iv) lower than expected per capita water supply.

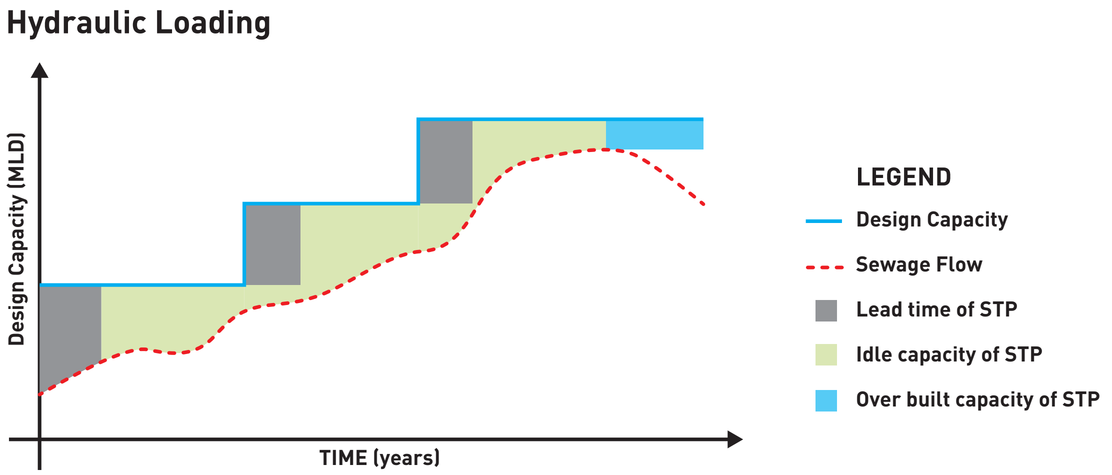
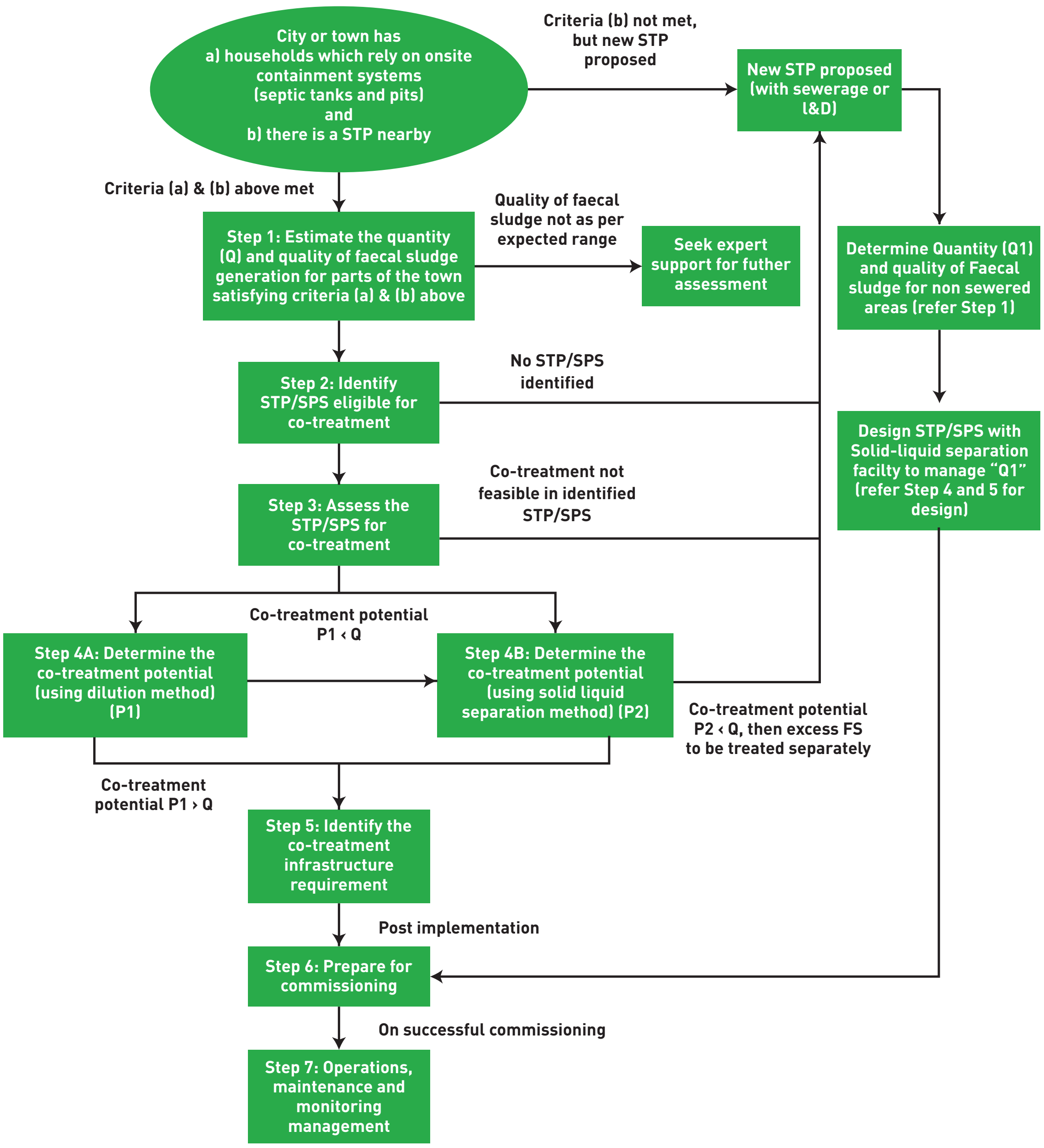


Figure 1: Hydraulic loading of STPs. Figure source: Adapted by NIUA/SCBP for co-treatment training module from CPHEEO sewerage and septage manual 2013.

Planning and implementation of co-treatment

It is essential to follow a scientific planning process before taking the decision to add faecal sludge to a sewage treatment plant. This will prevent any drop in performance or a potential collapse of the treatment process at the STP. A systematic process will guide the user to arrive at the appropriate choice of co-treatment approach. The planning and implementation of co-treatment have been broken into a step-by-step process as shown in Figure 2.



Step 1: Estimating the quantity and quality of faecal sludge generated in the city/town

First, the city or town must estimate the quantity and assess the characteristics of faecal sludge being generated.

At the end of this step, you will determine:
Quantity of faecal sludge that needs treatment, expressed as Kilo litres per day (KLD)
Range of faecal sludge characteristics in the city/town.

1.1 How to estimate the quantity of faecal sludge?

The amount of FS that is generated can be estimated in three different ways:

a) Thumb-rule method

The *Manual on Sewerage and Sewage Treatment Systems - 2013*, published by CPHEEO (CPHEEO, 2013), provides an estimate of the sludge accumulation in pits and recommends sizes of septic tanks based on number of users. The per capita faecal sludge generation for these two systems are as given in Table 1.

Table 1: CPHEEO recommended accumulation rates

TYPE OF SYSTEM	SLUDGE ACCUMULATION RATE IN LITRES PER PERSON PER ANNUM
Single Pit latrine (A)	67 litres
Septic tank (B)	120 litres

How to calculate

$$\text{Estimated quantity of Faecal sludge generated (in KLD)} = \frac{\text{Project population x \{(\% of septic tank users x B) + (\% of pit users x A)\}}}{(365 * 1000)}$$

b) Survey of containment units[4]

A sample survey of containment units (both households and commercial) is carried out in the project area to collect details on the type, volume and desludging interval of the containment system. This data is analysed to get an estimate of faecal sludge generated in the city.

How to calculate

$$\text{Estimated quantity of faecal sludge generated (in KLD)} = \text{Projected population X Average of} \left[\frac{\text{Volume of containment unit in liters} \div \left\{ \text{Number of users X Desludging frequency in years} \right\}}{365 \div 1000} \right]$$

c) Interview of desludging operators

In this method, faecal sludge is estimated by gathering information on the current demand for desludging and projecting it for the future population.

[4] For a discussion regarding the nature of containment units please see Annexure 6

How to calculate

$$\text{Estimated quantity of faecal sludge generation (in KLD)} = \left(\frac{\text{Projected population}}{\text{Current population}}\right) \times \left(\frac{\text{Average no. of desludging trucks operating everyday} \times \text{average capacity of each truck in litres} \times \text{average no. of trips hauled everyday}}{1000}\right)$$

It is not necessary that all the three methods have to be used for arriving at the quantity. However, it is recommended that to get a realistic estimate of the faecal sludge generation/collection in the city/town, all three methods are used and compared to arrive at the quantity that will be chosen for further planning.

In case the city or town is planning to adopt scheduled desludging, then the faecal sludge generation estimates using (a) or (b) above can be used.

1.1 Final estimated quantity of faecal sludge to be treated "Q" = ________________ KLD.

1.2 How to estimate the range of faecal sludge characteristics ?

Once the quantity of faecal sludge is estimated for designing a treatment facility, it is also important to understand the range of characteristics of faecal sludge in the city/town. The characteristics of faecal sludge depend on many factors like type of containment system, frequency of desludging, groundwater table, water supply etc, which vary within local bodies. Therefore, understanding the range of faecal sludge characteristics becomes key for selecting the appropriate technology for faecal sludge management.

Method to characterise faecal sludge in a city/town:

i. **Number and type of samples** - Sufficient number of evenly distributed samples need to be collected from across the city. This sample should be in proportion to different types of containment systems, and distinguished for dry and wet seasons. This will help in accounting for the variability in the characteristics of the faecal sludge.

ii. **Place of sampling** – The sample should be collected from the desludging vehicle at the discharging point. The source of the sample should also be recorded including the locality, type of containment system, period of desludging.

iii. **Method of sampling** - Due to the variable characteristics of the faecal sludge, a composite from multiple samples should be made instead of one grab sample. The samples need to be collected in a clean bottle.

A **grab sample**, also known as a **catch sample**, consists of a single sample taken at a specific time.

A **composite sample**, also known as an **integrated sample**, is a sample which consists of a mixture of several individual grab samples collected at regular and specified time periods, each sample taken in proportion to the amount of flow at that time. Composite samples are a more representative sample of the characteristics of wastewater/FS over a longer period of time samples need to be collected in a clean bottle

iv. **Analysis of sample** – The collected sample must be sent to a NABL accredited laboratory within 6 hours of sample collection.

v. **Parameters to test**- Listed in the table below

The parameters listed in the test results format in Table 2: Parameters for qualitative analysis of faecal sludge need to be analysed:

Table 2: Parameters for qualitative analysis of faecal sludge

SL.NO.	PARAMETERS	UNIT	TEST METHOD
1	Colour	-	Manual
2	pH	-	APHA 23rd edition, 4500-H+ B
3	Electrical Conductivity, EC	mS/cm	APHA 23rd edition, 2510-B
4	Temperature	°C	APHA 23rd edition, 4500-H+ B
5	Total dissolved solids, TDS	mg/L	Determination using TDS Meter
6	Total suspended solids, TSS	mg/L	Spectroquant Method No. 182
7	Total Solids, TS	mg/L	APHA 23rd edition, 2540 B
8	Total Volatile solids, TVS	mg/L	APHA 23rd edition, 2540 E
9	Phosphates as PO43-	mg/L	Merck Catalog No. 1.00798.0001
10	Ammonium as NH4+	mg/L	Merck Catalog No. 1.00683.0001
11	Biochemical Oxygen Demand, BOD (5 day @ 20°C)	mg/L	Respirometric determination using Oxitop Measuring System
12	Chemical Oxygen Demand, COD	mg/L	Merck Catalog No. 1.14538.0065,1.14539.0495
13	Escherichia coli[3]	MPN/100mL	ISO 9308-2:1990
14	Helminth Eggs[3]	No. per g	ZnSO4 Method

Fill the results obtained from the lab in *Table 3: Reporting of analysed samples of faecal sludge.*

Table 3: Reporting of analysed samples of faecal sludge

	Number of samples collected				
SL.NO	**PARAMETER**	**UNIT**	**MIN VALUE**	**MEDIAN VALUE**	**MAX VALUE**
1	Colour	-			
2	pH	-			
3	Electrical Conductivity, EC	mS/cm			
4	Temperature	°C			
5	Total dissolved solids, TDS	mg/L			
6	Total suspended solids, TSS	mg/L			
7	Total Solids, TS	mg/L			
8	Total volatile solids, TVS	mg/L			
9	Phosphates as PO43-	mg/L			
10	Ammonium as NH4+	mg/L			
11	Biochemical Oxygen Demand, BOD (5 day @ 20°C)	mg/L			
12	Chemical Oxygen Demand, COD	mg/L			
13	Escherichia coli	MPN/100mL			
14	Helminth Eggs	No. per g			

The parameters (range – min and max value) from Table 3: Reporting of analysed samples of faecal sludge should be compared with the typical (expected) range in Table 4: Range of faecal sludge characteristics and checked if they meet the expected values.

In case values outside this range are found, competent technical assistance may be sought.

Table 4: Range of faecal sludge characteristics

PARAMETERS	FACEAL SLUDGE	SEPTAGE	SEWAGE
CHARACTERISTIC	**HIGHLY CONCENTRATED, FRESH EXCRETA, STORED FOR WEEKS OR MONTHS**	**LOW CONCENTRATION, MORE STABILIZED, STORED FOR SEVERAL YEARS**	**TROPICAL SEWAGE**
COD [mg/L]	20 - 50,000	< 10,000	500-2,500
COD:BOD Ratio	2 - 5	5 - 10	2
NH4 - N [mg/L]	2 - 5,000	< 1,000	30 - 70
Total Solids [%]	3.5%	< 3.0%	< 1.0%
Suspended Solids [mg/L]	30,000	≈ 7,000	200 - 700
Helminth Eggs (no.L)	20 - 60,000	≈ 4,000	300 - 2,000

Source: USEPA Handbook on Septage Treatment and Disposal

Do the results from the samples collected fall in the range as indicated in table 4??

☐ **Yes**

☐ **No**

Proceed further only if Yes, if no, seek expert technical assistance.

Step 2: Identify STP/SPS for co-treatment

Identify and map all nearby STPs and Sewage Pumping Stations (SPSs) in and around your city/town. While STPs are used for co-treatment, SPSs can be used as a disposal point from where FS can be pumped to the STP for co-treatment. This step involves identifying STPs or SPSs to be further assessed for co-treatment feasibility.

By the end of this step, you will be able to list down potential STPs and SPSs which can be physically inspected for technical feasibility.

A potential STP for co-treatment should fulfil the criteria in Table 5: *Criteria for STP identification:*

Table 5: Criteria for STP identification

SL.NO	CRITERIA	REQUIREMENT	YES/NO
1	Distance of the STP or SPS from FS generation areas	Between 10-15 km or 30-45 minutes travel time with all-weather access road	
2	The STP must be operational with proper performance	Treated wastewater conforms to applicable pollution control board norms for last 6 months	
3	Available capacity at the STP	Current total inflow into the STP should be less than 90% of the design hydraulic capacity	
4	Available capacity at the SPS	Average inflow for the duration (in hours) FS disposal is permitted, (e.g., between 8 am - 8 pm) should be less than 80% of peak flow. However the minimum of average flow in the above duration at the SPS should be 25 times more than FS flow rate planned to be disposed.	

For co-treatment to be feasible, existing STP must conform to items 1,2 and 3. In case disposal is planned at an SPS, all the four parameters should be satisfied. It should be noted that faecal sludge can be disposed into only those SPS which is connected to STPs satisfying items 2 and 3 in Table 5.

In case of more than one STP or SPS satisfying the above conditions, each of them should be independently evaluated for subsequent steps. If there are no STPs satisfying the above parameters (regardless of SPS), the city/town must plan for other faecal sludge treatment options. Once the STPs and SPSs are identified, list them in Table 6: List of STPs and SPSs identified for further assessment.

Table 6: List of STPs and SPSs identified for further assessment

SI. NO	NAME/ LOCATION OF THE STP WHICH SATISFY CRITERIA # 1, 2 AND 3	NAME/LOCATION OF THE SPS WHICH SATISFIES CRITERIA # 4[3]
	STP 1 -	SPS 1.1 -
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

[3] Only SPS linked to the selected STP should be listed. In case an STP is not suitable for co-treatment, then all the SPS located in its upstream network become unsuitable for the direct addition of faecal sludge.

Co-treatment for new STPs under SBM-U 2.0

Sewerage network implementation typically lags behind STPs by a few years. This is due to longer construction periods and time taken by households to connect to the network. Also, peripheral areas and technically infeasible pockets may still rely on OSS. So, wherever new STPs are proposed, they should be designed for co-treatment catering to households and commercial units that rely on OSS. However, a new STP may not have sufficient sewage flows to dilute the faecal sludge through direct addition method. Therefore, solid-liquid separation method should be preferred for new STPs.

In small towns, a proportion of the households are expected to rely on interception and diversion (I&D) of wastewater flowing in open drains and nallahs. Such households continue to rely on OSS and will generate faecal sludge. STPs proposed for areas where interception and diversion (I&D) of existing drains/nallahs is implemented may be operating at full capacity from the beginning. This will leave very little capacity for the direct addition of faecal sludge. Also, the nature of flow (quantity and quality) in these drains are very unpredictable. Therefore, direct addition as an approach to co-treatment must be avoided in these STPs. Rather solid-liquid separation should be preferred.

STPs typically include sludge handling units which can also treat faecal sludge. The quantity of faecal sludge expected from a given population is much less than the expected sewage sludge for that population. Therefore, the additional cost is expected to be very low for a new STP to be designed for co-treatment.

It is therefore recommended that for all new STPs:

1. Co-treatment should be implemented along with the STP
2. Solid-liquid separation method of co-treatment should be preferred as an approach

Step 3: Assess the Sewage treatment plant and the SPS

Once the potential STPs or SPSs are identified, they need to be evaluated for their technical feasibility of faecal sludge treatment.

By the end of this step, you will be able to identify STPs which can treat faecal sludge/septage and identify SPS where FS can be discharged for transfer to STPs.

3.1 Feasibility of Sewage treatment plant

STPs identified as feasible at the end of step 2 (table 6) must be physically inspected for data requirements in Table 7: Data collection checklist for STPs.

Table 7: Data collection checklist for STPs

#	PARAMETER			VALUES
1	Capacity of the STP, as per design (in MLD)			
2	Design year and period of the STP (base year and design period)			
3	Current inflow - average of 5 day reading in both dry and wet weather flow conditions (in MLD)			
4	**Characteristics of wastewater**	**Design inlet**	**Actual at inlet**	**Actual at outlet**
4a	BOD			
4b	TSS			
4c	COD			
4d	NH4- N			
5	Land available for additional expansion **near headworks** (in sq,m)			
6	Current loading of the solid handling facility (in kgs/day)			
7	Design loading rate of the solid handling facility (in kgs/day)			
8	Current hydraulic loading of the solid handling facility (in KLD)			
9	Design hydraulic loading rate of the solid handling facility (in KLD)			
10	Whether the solid handling facility is functional?			Yes/No
11	Whether STP headworks is accessible for desludging trucks (sufficient space should be available for trucks to enter, dispose, turn around and return. Space must also be available to contain and manage any spillages)			Yes/No
12	Operational capacity of aeration equipment (in m^3 per hour)			
13	Designed capacity of aeration equipment (in m^3 per hour)			

Based on the above collected information, analyse the parameters Table 8: Analysis of STPs for co-treatment feasibility and check for compliance.

Table 8: Analysis of STPs for co-treatment feasibility

#	PARAMETER	EXPECTED RANGE/ VALUE	VALUE	COMPLIANCE (YES/NO)
1*	Current inflow/Design inflow	< 0.8		
2*	Current concentration of BOD_{inlet}/Design concentration of BOD_{inlet}	≤ 1		
3*	Spare capacity of sludge handling facility = Current loading rate of the solid handling facility/Design loading rate (both in kgs/day)	≤ 0.8		
4*	Spare hydraulic capacity of sludge handling facility = Current hydraulic loading rate of the solid handling facility/ Design hydraulic loading rate (both in KLD)	≤ 0.8		
5*	Operational aeration capacity/Design aeration capacity	≤ Current inflow/ Design inflow		
6*	Receiving station for faecal sludge at the headworks/ screen chamber of the STP, which is accessible by truck	Available		
7	Holding tank for faecal sludge with pumping arrangement into the headwork of the STP	1 day retention time		
8	Receiving station for faecal sludge at the solid handling facility of the STP, which is accessible by truck	Available		
9	Decanting facility at the headworks	Thickening tank/ mechanical dewatering equipment		
10	Decanting facility at the solid handling facility	Thickening tank/ mechanical dewatering equipment		
11	Land availability	2 – 10 m^2 per KL of FS (Q x 5 m^2) (Minimum required area = 25 sq.m)		

Parameters with "*" are mandatory for the STP to co-treat FS. Parameter 10 – which is land availability -- is mandatory if any of the infrastructure requirements listed as parameters 6,7,8 and 9 are not available at the STP currently.

This analysis has to be carried out for all STPs listed in Table 6 above. In case no STP fulfils this criterion, then other approaches for FS treatment should be explored.

3.2 Feasibility of Sewage pumping stations

In order to analyse the feasibility for disposal of FS into a SPS connected to an identified STP (which is able to co-treat), the data requirements in Table 9: Data collection checklist for SPS has to be collected

Table 9: Data collection checklist for SPS

#	PARAMETER	VALUES
1	Current inflow (in MLD) – average of 5 day reading in both dry and wet flow	
2	Design inflow (in MLD)	
3	Availability of screening system	Yes/No
4	Is the SPS accessible by desludging trucks (sufficient space should be available for trucks to enter, dispose, turn around and return. Space must also be available to contain and manage any spillages)	Yes/No
5	Land available for additional expansion (in sq.m)	

The data collected from Table 9: Data collection checklist for SPS is analysed in Table 10: Analysis of SPS for disposal of faecal sludge

Table 10: Analysis of SPS for disposal of faecal sludge

#	PARAMETER	EXPECTED RANGE/ VALUE	VALUE	COMPLIANCE (YES/NO)
1*	Current daily inflow/Design daily inflow	< 0.8		
2*	Current peak flow/Design peak flow	< 0.8		
3	Screening system	Functional		
4*	Receiving station for faecal sludge at the SPS, which is accessible by truck	5m wide road access to the faecal sludge disposal point at SPS		
5	Land available for additional infrastructure	2 – 10 m^2 per KL of FS (Q x 5 m^2) (Minimum required area = 25 sq.m)		

Parameters with as "*" are mandatory for the SPS to accept FS. Parameter 5 – which is land availability -- is mandatory if the infrastructure requirement listed as parameter 3 is not available at the SPS currently.

Only those SPS' that satisfy feasibility requirements as per Table 10 should be considered for co-treatment. If no SPS satisfies criteria, then disposal at eligible STPs should be considered.

Based on the above assessment of STPs and SPSs, list down the name and location of those where co-treatment is feasible.

SI. NO	NAME/ LOCATION OF THE STP WHICH SATISFY CRITERIA # 1, 2 AND 3	NAME/LOCATION OF THE SPS WHICH SATISFIES CRITERIA # 4[3]
	STP 1 -	SPS 1.1 -
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

For detailed assessment of the STP – Check NFSSM alliance checklist for assessment of STPs feasibility for co-treatment (CDD Society, 2021)4

[4]https://drive.google.com/file/d/16rjx6HxetclflCWocV1U_DN4NUewpEzW/view?usp=sharing

Step 4: Determine the co-treatment capacity

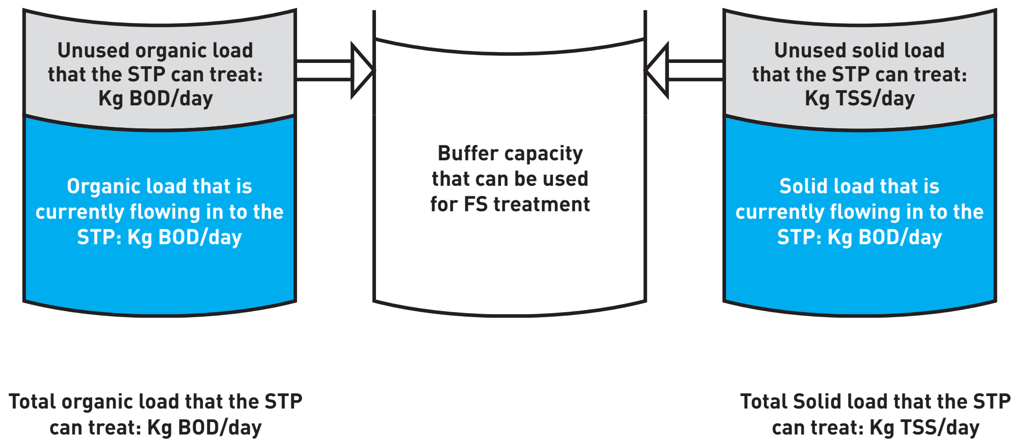
Once an STP is deemed suitable for co-treatment, as a first step, the available spare capacity of the STP to undertake co-treatment should be assessed. Also, the SPSs identified in Step 3 need to be analysed for their potential capacity to intake FS.

By the end of this step, you will be able to determine
i.The method of co-treatment to adopt
ii.The volume of faecal sludge that can be treated at each STP or disposed at each SPS.

There are two ways in which co-treatment may be undertaken (see Annexure 1 for description of each method). The two methods are a) direct addition and b) solid-liquid separation. Direct addition method is a quick and low investment solution for co-treatment. Hence, this should be explored as a primary solution for existing STPs. In case by direct addition method, the potential of the STP to co-treat FS is not sufficient to cater to the need – "Q" (estimated in Step 1) then solid-liquid separation method should be considered.

4.1.A Calculating co-treatment capacity for Direct addition method at STP

Sewage treatment plants are designed for a specific organic (BOD) and solid (TSS) loading rate. This is expressed in kg BOD/day and kg TSS/day. By calculating the spare capacity in the STP on these two parameters, one can estimate the quantity of faecal sludge that can be added.



Estimate the current spare capacity of organic and solid load in the STP using Table 11: Estimation of spare treatment capacity at STP

Table 11: Estimation of spare treatment capacity at STP.

	PARAMETER	EXAMPLE VALUE	UNITS	CALCULATED VALUE
(i)	Design capacity	50	MLD	
(ii)	Design concentration (BOD)	300	mg/litre	
(iii)	Design concentration (TSS)3	600	mg/litre	
A1 = (i)x(ii)	Design BOD loading rate	15000	Kg BOD/day	
A2 = (i)x(iii)	Design TSS loading rate	30000	Kg TSS/day	
(iv)	Current flow rate3	30	MLD	
(v)	Current concentration (BOD)3	250	mg/litre	
(vi)	Current concentration (TSS)3	550	mg/litre	
B1	Current BOD loading rate	7500	Kg BOD/day	
B2	Current TSS loading rate	16500	Kg TSS/day	
C1 = A1-B1	Spare BOD capacity	7500	Kg BOD/day	
C2 = A2-B2	Spare TSS capacity	13500	Kg TSS/day	

Once the spare capacity is estimated as per Table 11: Estimation of spare treatment capacity at STP, it is used to assess the quantity of faecal sludge that can be co-treated as per Table 12: Calculating the quantity of faecal sludge that can be added in STP. Table 12

Table 12: Calculating the quantity of faecal sludge that can be added in STP

	PARAMETER	EXAMPLE VALUE	UNITS	CALCULATED VALUE
(i)	Spare BOD capacity (C1 from Table 11)	7500	Kg BOD/day	
(ii)	Spare TSS capacity (C2 from Table 11)	13500	Kg TSS/day	
(iii)	Maximum BOD of FS	10000	mg/litre	
(iv)	Maximum TSS of FS	30000	mg/litre	
D1 = (i) x 1000/(iii)	Quantity of FS that can be treated within the spare organic load capacity	750	KLD	
D2 = (ii) x 1000/(iv)	Quantity of FS that can be treated within the spare solids load capacity	450	KLD	
P1 = Minimum (D1, D2)	Quantity of FS that can be co-treated	450	KLD	
Feasibility assessment	If P1 > Q, dilution method is considered feasible at this STP. Check further requirements.	Otherwise, the S-L separation method should be considered		

The minimum of the two estimates of faecal sludge capacity is taken to ensure that neither BOD nor TSS loading rates exceed the design capacity of the STP during co-treatment. In no case should adding faecal sludge lead to exceeding the design capacity of the STP for any parameter.

Decision Making

Use the flow chart in Figure 3 to determine the quantity of faecal sludge that can be co-treated at the STP.

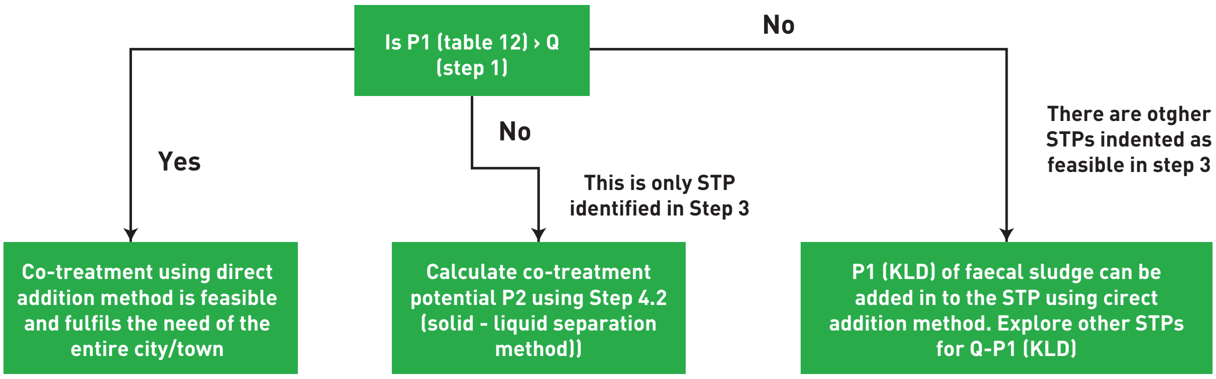


Figure 3: Decision making for choosing co-treatment approaches

Faecal sludge should be added into the STP in a uniform manner, spread evenly through the non-peak hours. The flow rate of such an addition should not exceed the design flow rate of the STP and its systems.

The quantity of faecal sludge that can be co-treated at the selected sewage treatment plant "P1" = ________________ (KLD)

4.1.B Calculating co-treatment capacity for Dilution method at SPS

For estimating the quantity of faecal sludge that can be disposed at a SPS, the below Table 13: Calculating the quantity of faecal sludge that can be added at the SPS can be used for the calculations:

Table 13: Calculating the quantity of faecal sludge that can be added at the SPS

	PARAMETER	EXAMPLE VALUE	UNITS	CALCULATED VALUE
(i)	Design sewage inflow rate at the SPS (average during non-peak hours)	500	Litres per second (LPS)	
(ii)	Current sewage inflow rate at the SPS (average during non-peak hours)	475	Litres per second (LPS)	
P1.1 = ((i)-(ii)) x (3600/1000) x no. of non-peak hours of SPS within the septage disposal timings (e.g.: 8 am – 7 pm, or any other timing determined for FS disposal)	Spare flow capacity	(500-475) x (3600/1000) x 11 hrs = 990	KLD	

The quantity of FS that can disposed into the SPS is P1.1 =_____________KLD

Decision Making

If P1.1← P1 (for the STP located in the network), then P1.1 (KLD) can be discharged at the selected SPS. If not, only P1 (KLD) can be discharged. The value that can be discharged is called $P1.1_{feasible}$

Note: The quantity of faecal sludge that can be co-treated must always be determined by the buffer capacity of the sewage treatment plant the SPS is serving. Thus, the amount of FS that can be disposed at a SPS must not exceed what the STP (connected to the SPS) can handle.

Quantity of faecal sludge that can be disposed at the selected sewage pumping station = "$P1.1_{feasible}$" = __________________ (KLD)

STP NAME AND LOCATION	QUANTITY OF FS THAT CAN BE CO-TREATED (P1)	QUANTITY OF FS THAT CAN BE DISCHARGED AT THE SPS (SUM OF $P1.1_{FEASIBLE}$)	DISPOSAL POINT - DIRECT STP (P1 – P1.1)
STP 1			
STP 2			
STP 3			
STP 4			
STP 5			
STP 6			
STP 7			
STP 8			
STP 9			
STP 10			
Total			

4.2 Calculating co-treatment capacity for solid-liquid separation method at STP

Sewage treatment plants have dedicated infrastructure for the handling of sewage sludge. The solids generated from the solid-liquid separation of faecal sludge should be further treated using this infrastructure. Thus, the amount of faecal sludge that can be treated depends on the excess capacity of sewage sludge treatment units. Table 14: *Estimating the quantity of faecal sludge that can be treated in STP using solid-liquid separation method* can be used to arrive at the capacity of such infrastructure present and their remaining capacities for additional treatment.

Table 14: Estimating the quantity of faecal sludge that can be treated in STP using solid-liquid separation method

	PARAMETER	EXAMPLE VALUE	UNITS	CALCULATED VALUE FOR MODULE 1	CALCULATED VALUE FOR MODULE 2
(i)	Design sewage sludge treatment capacity (value from DPR)	40,000	Kg solids (Dry weight)/day		
(ii)	Current sewage sludge treatment capacity = (Wasted sludge TSS concentration x quantity of wasted sludge per day)	16500	Kg solids (Dry weight)/day		
F = (i) – (ii)	Spare capacity	23500	Kg solids (Dry weight)/day		
(iii)	TSS of faecal sludge	30000	mg/litre		
P2 = Fx 1000/(iii)	Quantity of FS that can be added (choose minimum of all values)	(23500x1000) /30000 = 783	KLD		

STPs can have several modules for processing sewage sludge, such as, dewatering, drying, pathogen reduction etc. Each of these modules may have a different excess capacity for faecal sludge. However, the lowest excess capacity among all modules will be the quantity of faecal sludge that can be added to the system.

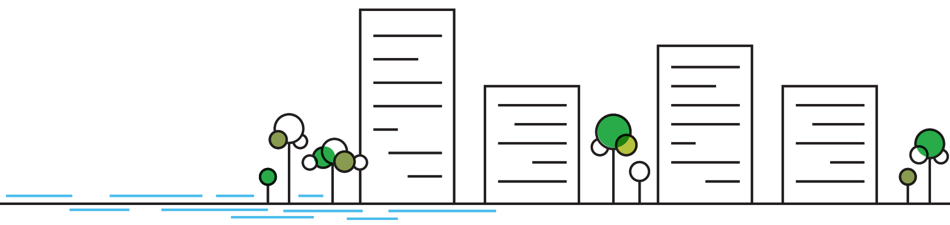
Therefore, this method should be used for all procedures involved in the sewage sludge treatment (such as dewatering, drying, digestion and pathogen reduction) at the STP. Each system should be assessed independently (add more columns in Table 14: *Estimating the quantity of faecal sludge that can be treated in STP using solid-liquid separation method* above as required) and the minimum value of FS quantity (G) that is arrived should be considered as the available excess capacity.

G = Available co-treatment capacity of STP for S-L separation method = Minimum ($P2_{system1}$, $P2_{system2}$, ...) in KLD.

Only one of the two methods must be employed at a STP. The above calculations can be carried out for multiple STPs which have been identified in step 2. In case the total co-treatment potential from STPs calculated using above method is still below "Q" (the faecal sludge quantity generated in the city/town), then the excess faecal sludge needs to be treated using other methods (such as standalone faecal sludge treatment plants).

Quantity of faecal sludge that can be co-treated at the existing sewage treatment plant using solid-liquid separation approach = "P2" = ____________________ (KLD)

Once the quantity of faecal sludge that can be treated at a STP is calculated, then one has to identify the modifications that may be required to enable this co-treatment.



Step 5: Identifying the co-treatment infrastructure

Depending on the approach chosen, the co-treatment infrastructure required at the STP can vary. In this step, the type and design of the co-treatment infrastructure for both these approaches are discussed.

By the end of this step, you will be able to identify the infrastructure required for enabling co-treatment at the STP/ SPS locations.

5.1 Direct addition method

As faecal sludge is directly added to the inflow of sewage, no elaborate treatment of faecal sludge is required. However, the quantity of faecal sludge added should match the rate of sewage inflow, to ensure that the resultant concentrations of the inflow into the STP do not exceed the design loading capacity. This is done by having a feeding/equalization tank at the receiving point for faecal sludge. Prior to the equalization tank, a screening system must be provided to remove the trash in faecal sludge. A flow control valve/pump arrangement must be used to equalise the flow of FS from the equalisation tank into the headworks of the STP or where it gets mixed with sewage. Figure 4 illustrates a typical process flow for this approach of co-treatment. The Table 15: Checklist of infrastructure for disposal of faecal sludge in SPS mentions the list of infrastructure that is required for the dilution method of co-treatment. A separate receiving station with screening, holding tank and pumps with flow regulation should be added for the direct addition method.

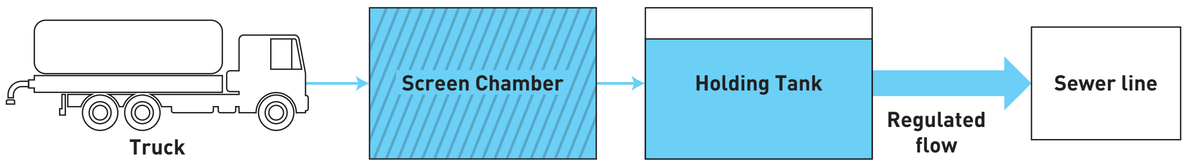


Figure 4: Illustration of process flow for direct addition of faecal sludge

5.1.1 Direct addition of faecal sludge at sewage pumping station

Table 15: Checklist of infrastructure for disposal of faecal sludge in SPS

S.NO	FACILITY	DESIGN CONSIDERATIONS	YES/NO
1	Receiving and parking for truck	5 m wide road to the sludge disposal point at the SPS (near to headworks – pump well) with easy turnaround and parking facility.	
2	Screening system	Inlet faecal sludge or septage to be screened using a mesh of not less than 25 mm opening	
3	Holding tank	1. Volume of the holding tank = Capacity of faecal sludge addition in a day ("H" m^3 per day) 2. Mixing arrangement to be provided inside the holding tank.	
4	Flow control arrangement	Pump or valve to regulate flow from holding tank into SPS	

The flow from the sludge holding tank into the SPS should be regulated at the rate determined by

$$= \frac{\text{Volume of the holding tank (H)}}{8 \ (m^3 \text{ per hour})}$$

given that the addition of this flow does not exceed the designed flow rate through the downstream sewer network.

Name and location of the SPS	
Quantity of FS that can be added (Step 4 - $P1.1_{feasible}$)	
S.No	Description of infrastructure that has to be added at the SPS for FS disposal

Reference for design of additional infrastructure:

Chapter 4 of the Manual on Sewerage and Sewage Treatment Systems - 2013, CPHEEO 2013 can be referred for design of screen system.

5.2.2 Direct addition of faecal sludge at sewage treatment plant

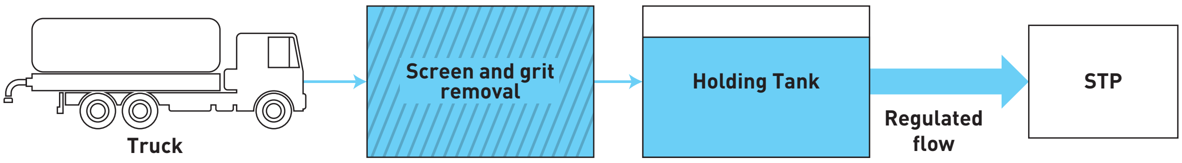


Figure 5: Process flow for direct addition of FS in STP

Use the Table 16: Checklist of infrastructure requirement for co-treatment at STP using direct addition method for identifying infrastructure requirements at the STP for co-treatment using direct addition.

Table 16: Checklist of infrastructure requirement for co-treatment at STP using direct addition method

S.NO	FACILITY	DESIGN CONSIDERATIONS	YES/NO
1	Receiving and parking for truck	5 m wide road to the sludge disposal point at the STP (near to headworks – pump well, Screening systems) with easy turnaround and parking facility.	
2	Screen and grit chamber	1. Inlet faecal sludge or septage to be screened using a mesh of not less than 25 mm opening 2. Grit chamber to remove silt in faecal sludge or septage	
3	Holding tank	1. Volume of the holding tank = Capacity of faecal sludge addition in a day ("E" m3 per day) 2. Mixing arrangement to be provided inside the holding tank.	
4	Flow control arrangement	Pump or valve to regulate flow from holding tank into STP.	
5	Sludge handling facility	The sewage treatment plant must have excess capacity in its sludge handling unit for additional sludge arising from faecal sludge and septage addition.	
6	Optional: Other approved sludge management facility	A scientific and approved sludge handling, treatment and management facility exists for the excess sludge from faecal sludge and septage addition	

The flow from the sludge holding tank into the SPS should be regulated at the rate determined by = Volume of the holding tank (H)/8 (m3 per hour), given that the addition of this flow does not exceed the designed flow rate through the downstream sewer network.

While a separate receiving station, screening, and holding tank with flow regulation (pumps and valves) have to be implemented for direct addition, other components missing at the STP should be added.

Name and location of the STP	
Quantity of FS that can be added (Step 4 – P1)	
S.No	Description of infrastructure that has to be added at the STP for co-treatment

Reference for design of additional infrastructure:

- Chapter 5 of the Manual on Sewerage and Sewage Treatment Systems - 2013, CPHEEO 2013 can be referred for the design of screen and grit system.
- Chapter 6 of the Manual on Sewerage and Sewage Treatment Systems - 2013, CPHEEO 2013 can be referred for the design of sludge handling and management facilities.

5.2 Solid-liquid separation method

In this case, the faecal sludge needs to be screened for removing trash followed by solid-liquid separation. Solid-liquid separation systems must be designed to increase the TSS content in solids to at least 10% and above. Various mechanisms exist for the solid-liquid separation process depending on the extent of dewatering that is being aimed. This is in turn dependent on the downstream solid handling processes. The supernatant (liquid fraction) from the solid-liquid separation is diverted to the headworks of the STP where it is treated along with sewage inflows. Since the characteristics and the quantity of supernatant is not so significant, hence it does not require any separate arrangement or design. The separated solids are sent for further processing at the solid management facility in the STP.

The output of solid-liquid separation should match the characteristics required for the downstream modules for treatment of supernatant and the solids. Annexure 3 and 4 provide a schematic layout for solid-liquid separation based co-treatment infrastructure.

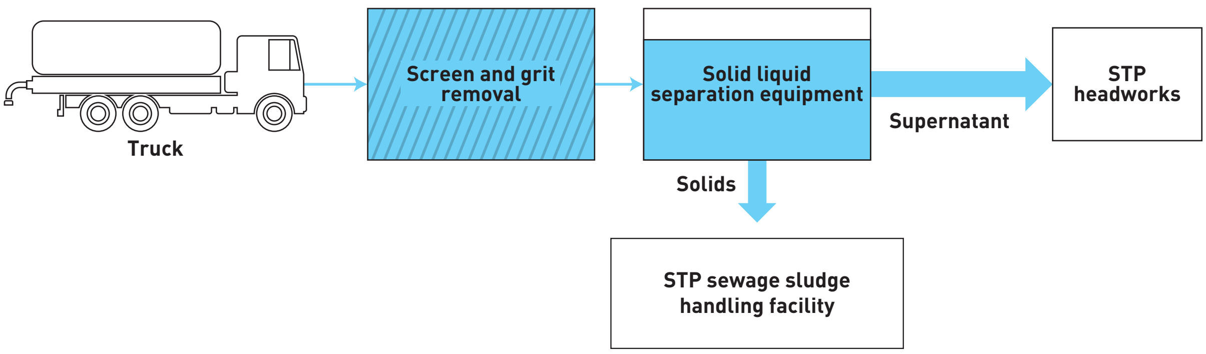
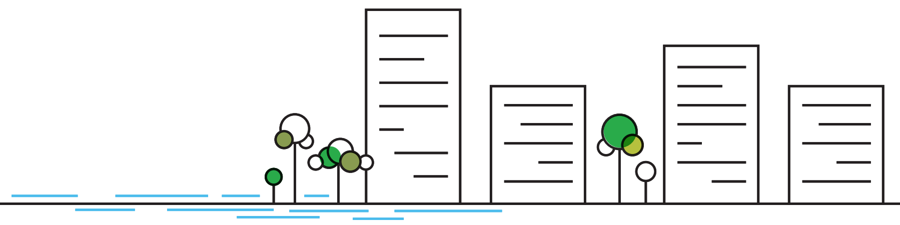


Figure 6: Process flow of solid-liquid separation method of co-treatment at a STP



5.2.1 Solid-liquid separation at the STP

Use the checklist in Table 17: Checklist of infrastructure for solid-liquid separation approach of co-treatment to identify infrastructure requirements

Table 17: Checklist of infrastructure for solid-liquid separation approach of co-treatment

S.NO	FACILITY	DESIGN CONSIDERATIONS	YES/NO
1	Receiving and parking for truck	5 m wide road to the sludge disposal point at the STP (near to solid/liquid separation unit) with easy turnaround and parking facility.	
2	Screen and grit chamber	1. Inlet faecal sludge or septage to be screened using a mesh of not less than 25 mm opening 2. Grit chamber to remove silt in faecal sludge or septage	
3	Options 1: Thickening tank	1. Settling tank designed for retaining solids in faecal sludge or septage for G m^3 per day. (Step 4.2) 2. Sludge pumps for evacuating faecal sludge/septage	
4	Option 2: Feeding tank and solid dewatering	1. Feeding tank to receive the faecal sludge or septage and feed it systematically into the solid dewatering unit such as belt press, centrifuge or any other mechanical dewatering device 2. Mechanical dewatering device to be calibrated for faecal sludge/septage (achieving a moisture content in output ← 85%). It should have capacity to dewater G m^3 per day of faecal sludge/septage. 3. Filtrate from dewatering device to be diverted into STP headworks	
5	Sludge handling facility	The sewage treatment plant must have excess capacity in its sludge handling (dewatering/drying, digestion, pathogen reduction and storage) unit for additional sludge arising from faecal sludge and septage addition.	
6	Optional: Other approved sludge management facility	A scientific and approved sludge handling, treatment and management facility exists for the excess sludge from faecal sludge and septage addition	
7	Land availability	5 - 10 m^2 per KL of FS ("G" x 5 m^2)	

A separate receiving station with screening arrangement has to be implemented for solid-liquid separation method. In case any of the items are not present in the current STP, the same has to be designed for the other components as per the CPHEEO Manual on Sewerage and Sewage Treatment Systems - 2013. All the items in the above checklist must be available to proceed with co-treatment.

Refer to Annexure 3 for solid-liquid separation options.

Reference for design (thickening tank, mechanical dewatering and drying beds):

- Chapter 6 of *Manual on Sewerage and Sewage Treatment Systems – 2013, CPHEEO* can be referred to for the design of sludge handling and management facilities.

Name and location of the STP	
Quantity of FS that can be added (Step 4 – P2)	
S.No	Description of infrastructure that has to be added at the STP for co-treatment

Step 6: Prepare for Commissioning, Monitoring and Operations

Once the infrastructure for co-treatment is implemented, it has to be tested by adding faecal sludge gradually, starting from 25% of the co-treatment potential to 100% in a few days. This gives time to record and monitor any deviations or process abnormalities in the STP. During such trial runs, the system must be monitored by a competent engineer.

By the end of this step, the upgraded/modified sewage treatment plant is commissioned and operational for co-treatment.

6.1 Checklist for readiness to commissioning

The checklist in Table 18: Checklist for readiness to commissioning of the infrastructure for co-treatment is to be used for the purpose of commissioning of the newly installed co-treatment infrastructure. Co-treatment should be enabled after all the parameters in the checklist are satisfied.

Table 18: Checklist for readiness to commissioning of the infrastructure for co-treatment

S.NO	CHECKLIST	YES/NO
1	Organisation and persons engaged to manage the co-treatment infrastructure.	
2	Responsible persons (engaged for management of co-treatment facilities) are trained on operations	
3	Operations manual of the STP is updated, operators trained on the updated version	
4	Hydraulic testing of all new modules and equipment carried out successfully	
5	All modules and equipment are tested to operate with the faecal sludge at designed capacity and are observed to be operating satisfactorily.	

Step 7: Operations, maintenance and Monitoring Management

Depending on the infrastructure modifications, a detailed O&M manual, including newer monitoring protocols for existing STP units, has to be developed for each module. These O&M plan and procedures must also be disseminated to all operators of the co-treatment facility and the STP through trainings. CPHEEO Manual on Sewerage and Sewage Treatment Systems, 2013 -- Part B – Operations and Maintenance can also be referred to O&M protocols and requirements for the newly added modules.

Annexure 4 has a list of common operational problems encountered by the STPs during co-treatment and its corresponding solutions. Operators can include this in their monitoring and recourse plan. For existing STPs/SPSs whose O&M is outsourced, their contracts have to be amended to include O&M of co-treatment systems.

By the end of this step, the user shall be introduced to parameters for effective operations and monitoring of co-treatment facility

7.1 Checklist for operational procedure of co-treatment facility

The checklist in Table 19: Checklist for operations related to co-treatment should be adopted during co-treatment operations

Table 19: Checklist for operations related to co-treatment

S.NO	CHECKLIST	YES/NO
1	**Truck arrival and disposal at the STP**	
1a	Truck receiving hours at the STP shall be between 8 am – 7 pm	
1b	Record of collection, transportation and disposal of faecal sludge to be maintained at the STP	
1c	Connect the truck outlet to the screen chamber (receiving unit)	
1d	Regular cleaning of screen chamber and grit chamber	
1e	Regular cleaning of the faecal sludge receiving area	
1f	In case of spillage, immediate cleaning and spraying of bleaching powder	
2	**Direct addition – Holding tank**	
2a	Mixing of sludge in the holding tank prior to disposal into the STP	
2b	Removal of settled sludge from the holding tank (once in a month)	
2c	Regulated additional of sludge from holding tank into STP, by regulating the flow through pump/valve	
2d	Regular preventive maintenance of pumps, valves and agitation equipment	
3	**Solid-liquid separation**	
3a	Thickening tank – periodic removal of scum, accumulated sludge from the bottom through gravity/pumping	
3b	Mechanical dewatering – Feeding of sludge from holding tank, additional of coagulants and preventive maintenance of equipment	

7.2 Monitoring STP for co-treatment

The below parameters have to be monitored to ensure effectiveness of the co-treatment and minimise the rate of failure of the STP due to addition of faecal sludge.

Table 20: List of parameters to monitor co-treatment

	PARAMETER	FREQUENCY
1.	Faecal sludge sample to be collected at the point of disposal and analysed for parameters mentioned in Table 2	One sample daily
2.	Sample of sewage and faecal sludge mixture entering into primary treatment stage of the STP for parameters mentioned in Table 2	One sample daily
3.	Treated water samples	Twice in a day or as per prescription of the SOP/State Pollution control board requirements
4.	Treated Biosolid samples	As per prescription of the SOP/State Pollution control board requirements

The below checklist to be filled daily:

Table 21: Checklist for monitoring

S.NO	PARAMETER	EXPECTED VALUE	COMPLIANCE
1	Faecal sludge sample to be collected at the point of disposal and analysed for parameters mentioned in Table 2	Table 4	Yes/No
2	Sample of sewage and faecal sludge mixture entering into primary treatment stage of the STP for parameters mentioned in Table 2	As per inflow design of the STP	Yes/No
3	Treated water samples	As per State/Central Pollution control board norms	Yes/No
4	Treated Biosolid samples	As per State/Central Pollution control board norms, if any	Yes/No

Annexure 1: Direct Addition Method

In this method, faecal sludge is added to the headworks of the STP without any pre-treatment. It is assumed that though the faecal sludge is much more concentrated with pollutants and solids as compared to sewage, the addition shall create a mixture which is diluted and on par with the design inflow requirements of the STP. It is believed that there is excess unutilised capacity at the STP which allows for this addition, thereby, ensuring that the overall solid and pollution (BOD, COD and nutrient) load to the STP is below or equal to its operational capacity.

Therefore, under this method, the STP has to be analysed thoroughly to identify the operational capacity (at times, due to non-availability of certain equipment, process controls, maximum operational capacity may be less than design capacity). Once done, the STP is then assessed to operate under the inflow of a mixture of faecal sludge and sewage. The maximum quantity of faecal sludge that can be added (co-treated) is determined by the ability of the STP to treat the mixture.

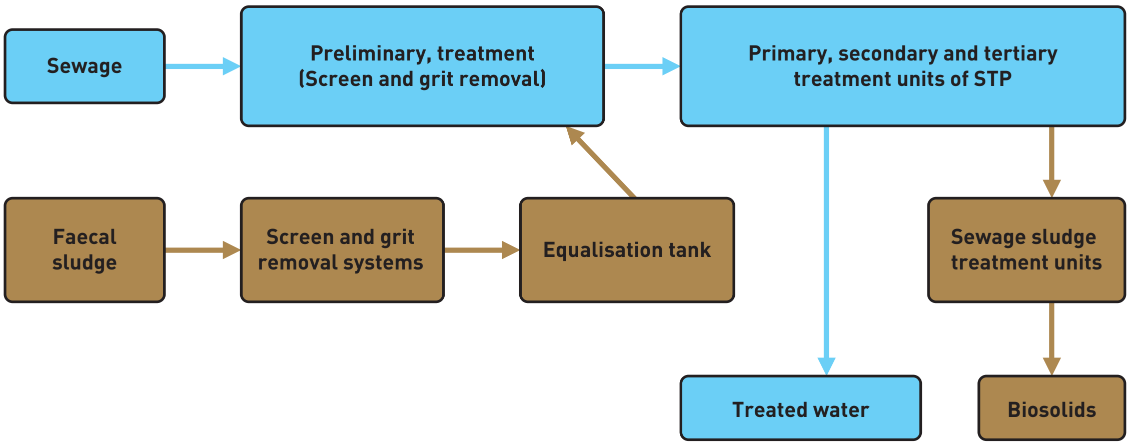


Figure 7: Illustration of a typical process flow for direct addition of faecal sludge in a STP

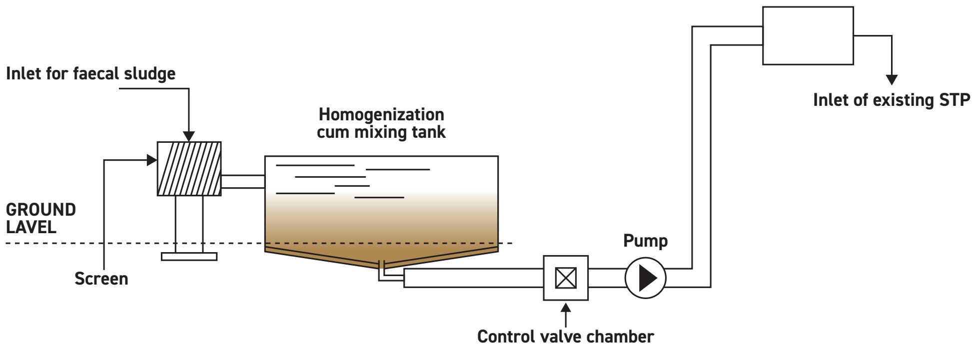
Faecal sludge is much more concentrated than sewage, therefore, the treatment approach involves reducing this concentration to make it compatible with the sewage treatment facility. This is done in two ways:

In sewage treatment, the quality of the mixture must be on par with the design loading capacity. Therefore, the faecal sludge should be mixed with sewage in a consistent manner, preferably through the peak flow period.

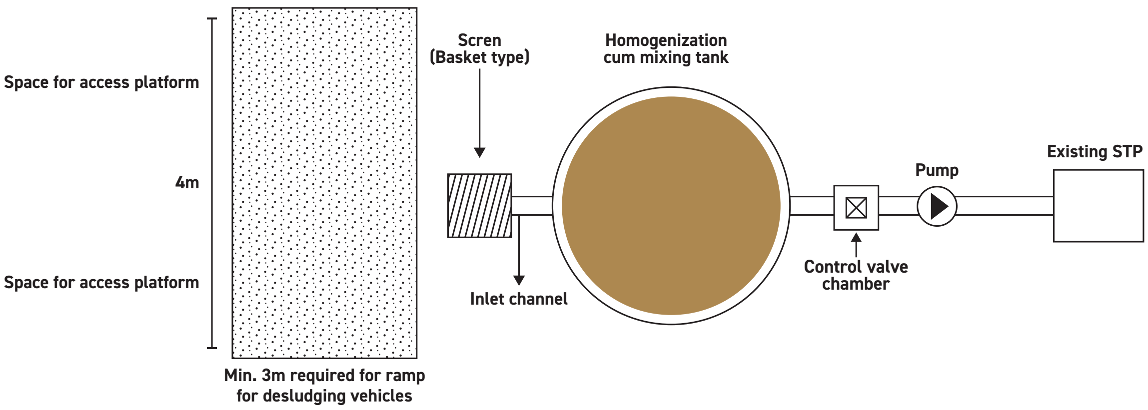
As the arrival of the faecal sludge is intermittent and not predictable, a holding tank is required to receive the sludge and doze it into the sewer network to enable a consistent mixing. The holding tank acts as a buffer for the faecal sludge (enabling quick turnaround of desludging vehicles) and also regulates the mixing process to ensure that the final product does not exceed the quality which STP can treat. The design of the holding tank should also ensure that the solids in the sludge do not settle during the retention period. A regulation mechanism such as a pump with flow control or a valve must be provided to empty the faecal sludge into the sewage network (or STP headworks). A tentative layout of such design is depicted in Figure 8.

The principle is that STP has additional capacity to treat BOD and TSS present in faecal sludge. Going forward, the STP can also be assessed for parameters such as COP, TkN, TP to evaluate the limiting conditions.

CROSS-SECTION



PLAN



Suitability of this approach

Direct addition method involves the least amount of infrastructure set up, therefore, the effort to operationalise co-treatment is minimal and can be initiated quickly. However, a thorough analysis of the STP has to be carried out to check if there exists an excess capacity for the treatment of additional pollution (organic and nutrient) and solid load due to the faecal sludge. Moreover, STPs which do not have a well-maintained biosolids management should not be considered for co-treatment at all, as additional solids will only add to more problems at the STP.

Dilution method, though easy to implement, can lead to many issues in operations. This may vary across technologies employed for sewage treatment. Therefore, continuous process monitoring is important during co-treatment to ensure that there are no process disruptions which can affect the entire treatment plant.

This method can be considered as an early check to assess co-treatment feasibility, or as an interim measure. In cases where the potential of faecal sludge which can be treated does not fulfil the generation at that location/ULB, the other approach of solid-liquid separation should be considered.

Figure 9 is an illustrative example of the infrastructure arrangements (equalisation and flow control) made for co-treatment of faecal sludge in an STP at Tirupati, using the direct addition method.

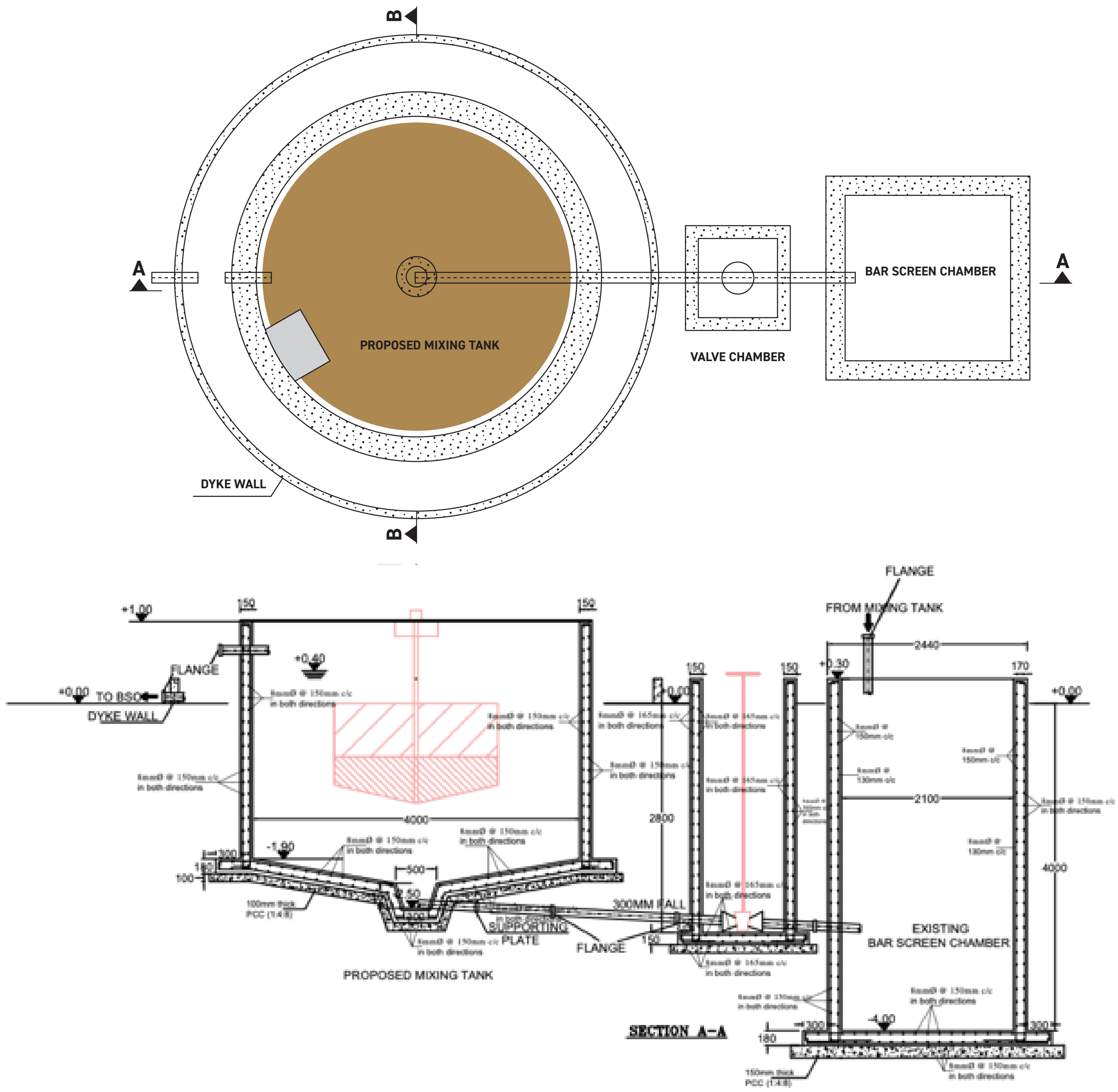


Figure 9: Plan and section of equalisation tank and flow control systems established for direct addition of faecal sludge in a STP at Tirupati. Source - ASCI

Annexure 2: Solid-liquid separation method

In this method, the faecal sludge instead of being directly added into the STP, is treated for solid-liquid separation and then treated as separate streams using the processes in the STP. Faecal sludge, after pre-treatment (i.e. removal of trash and grit) undergoes solid-liquid separation leading to separate solid and supernatant streams. The characteristics of the supernatant and sewage being comparable both can be treated together with the supernatant introduced at the inlet of the STP. The separated solids, based on the moisture content and degree of stabilisation, are further treated at the sewage sludge management facility in the STP. Solid-liquid separation of faecal sludge and its subsequent treatment is a much safer and reliable approach as compared to direct addition, as there are lesser chances of the core STP process getting affected. A typical flow of the solid-liquid separation type of co-treated is depicted

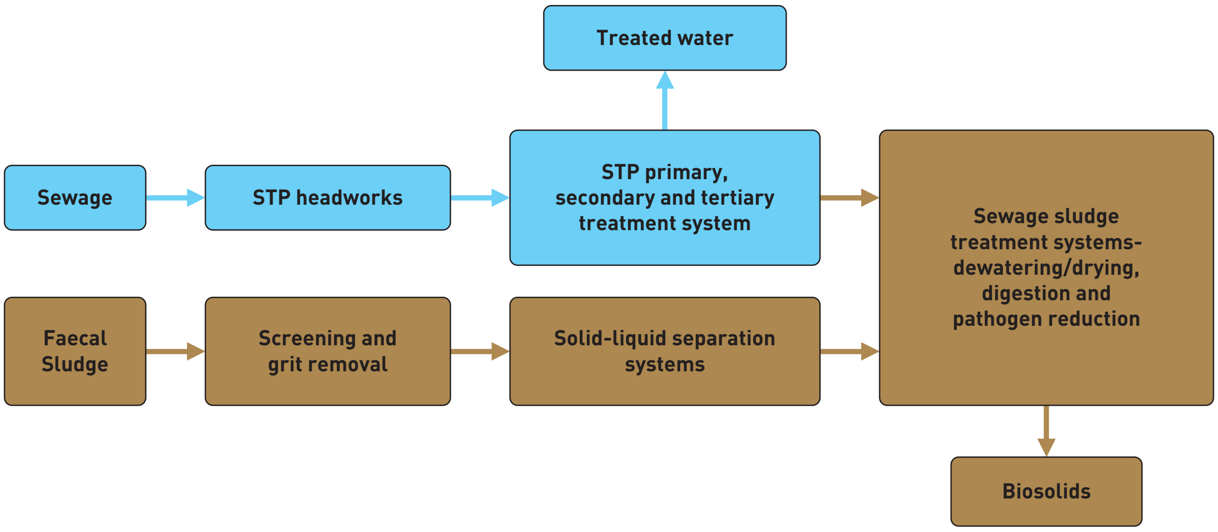
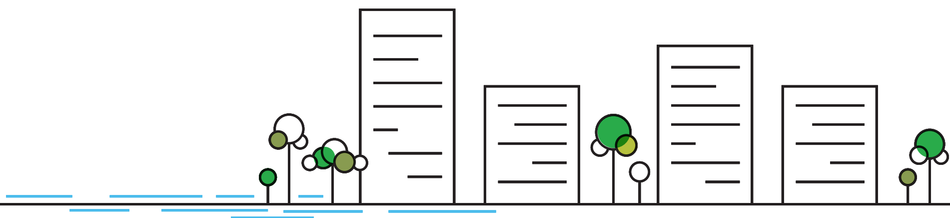


Figure 10: Illustration of a process flow for solid liquid separation method of co-treatment



Many technologies are available for solid-liquid separation, a few commonly used ones are listed in annexure 3.

Suitability of this approach

This should be the preferred approach for a green field STP with a mandate for co-treatment. While the direct addition approach is easier and quicker to implement, in the longer run to sustain co-treatment, STPs must plan to adopt solid-liquid separation. This is because the STPs, over a period, shall get increased inflow of sewage from their catchment area.

Figure 11 is an illustrative example of co-treatment using the solid-liquid separation method at an STP. The drawings depict the additional infrastructure (screen chamber, thickening tank, drying bed and equalisation collection tank) set up for co-treatment prior to treatment in an STP.

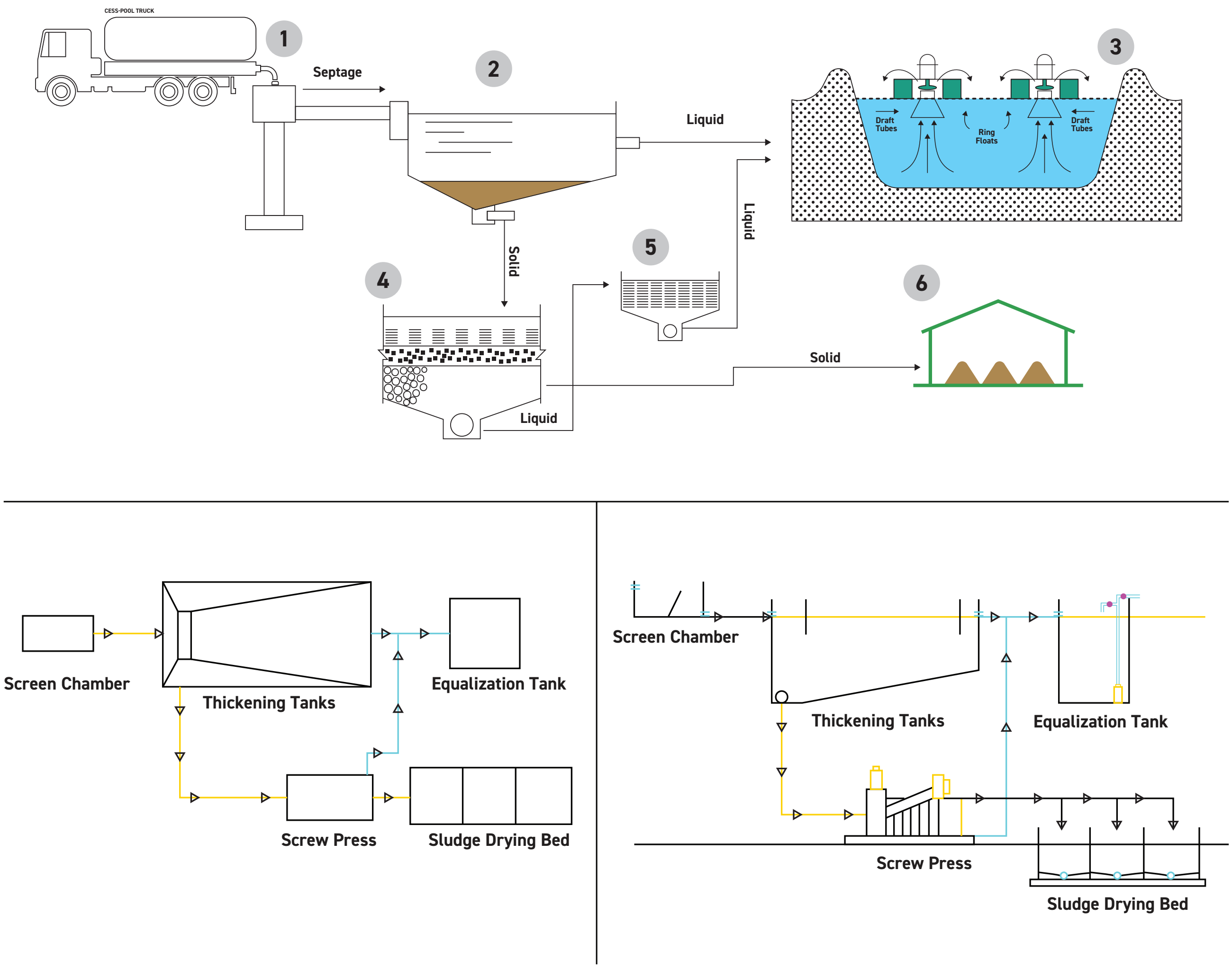


Figure 11: Illustration of co-treatment facility at Puri, India using solid-liquid separation method

Annexure 3: Solid-liquid separation options

1. Thickening tanks are passive systems which over a period of time and through gravity settling are able to perform solid-liquid separation. However, the efficiency of solid-liquid separation, when measured as final TSS in output sludge, would be in the range of 10-12%. This sludge needs further dewatering/drying before being used as an end product. Therefore, thickening tank must always be accompanied with either dewatering (volute press/centrifuge) or drying (drying beds, dryers) and pathogen reduction systems (storage, thermal based).

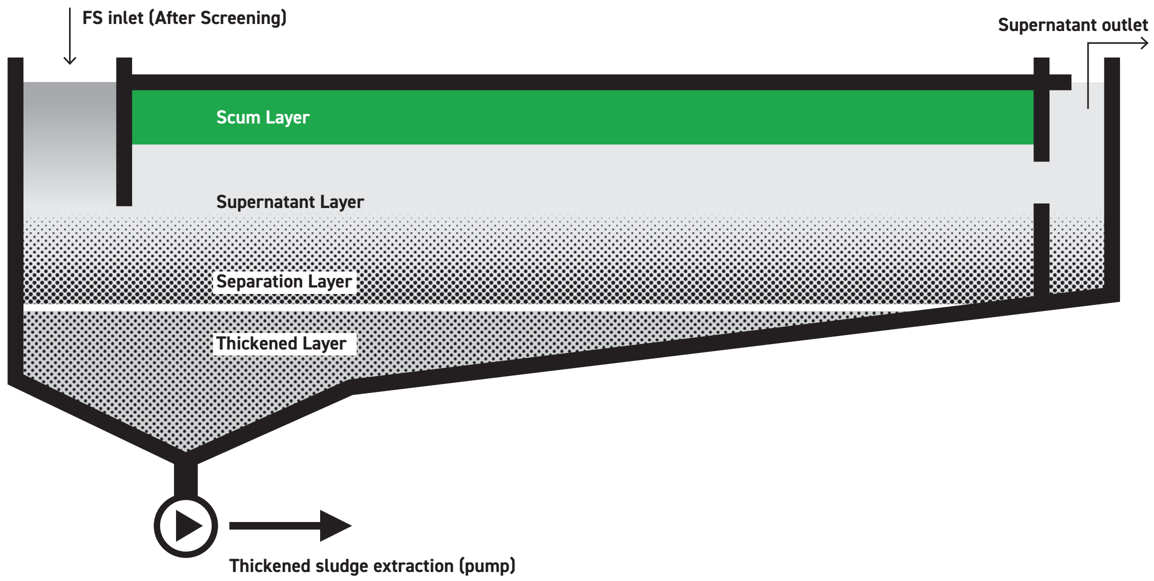


Figure 12: Cross-section of a typical thickening tank for solid-liquid separation of FS

2. Mechanical dewatering devices such as volute press, belt press and centrifuge can be used for solid-liquid separation. These devices can achieve a final TSS of around 18-22% in the output. However, this sludge requires further drying before being used as an end product. Therefore, mechanical dewatering systems should be accompanied by suitable drying systems (drying beds, dryers, etc.) to achieve an output solid content of 40% and greater. This sludge should also be further treated for pathogen reduction.

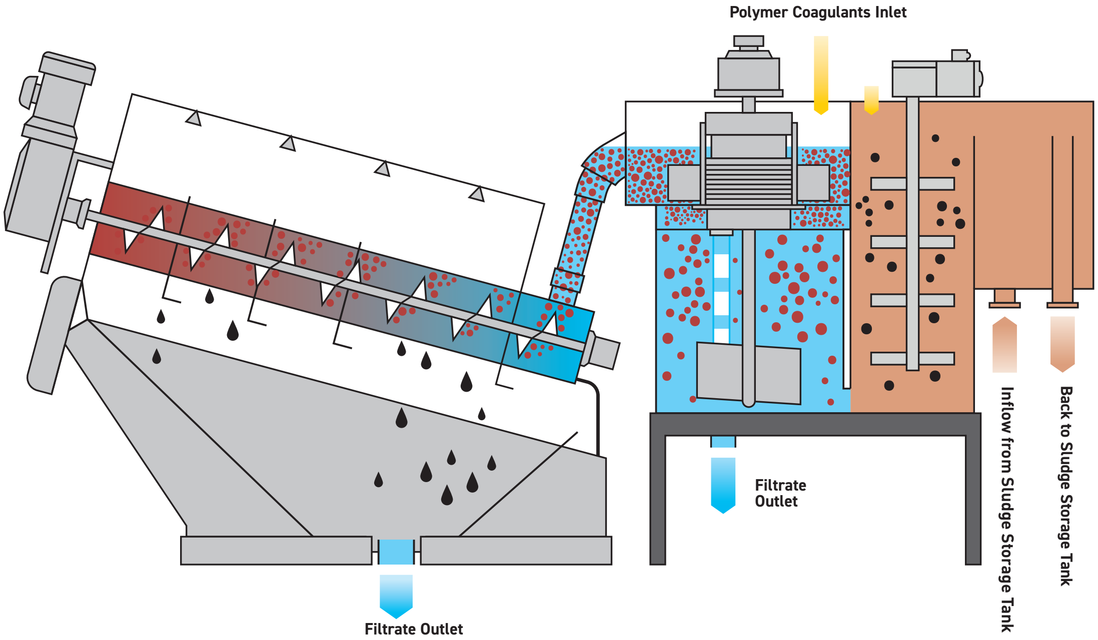


Figure 13: Cross-section of a mechanical dewatering device used for dewatering of FS

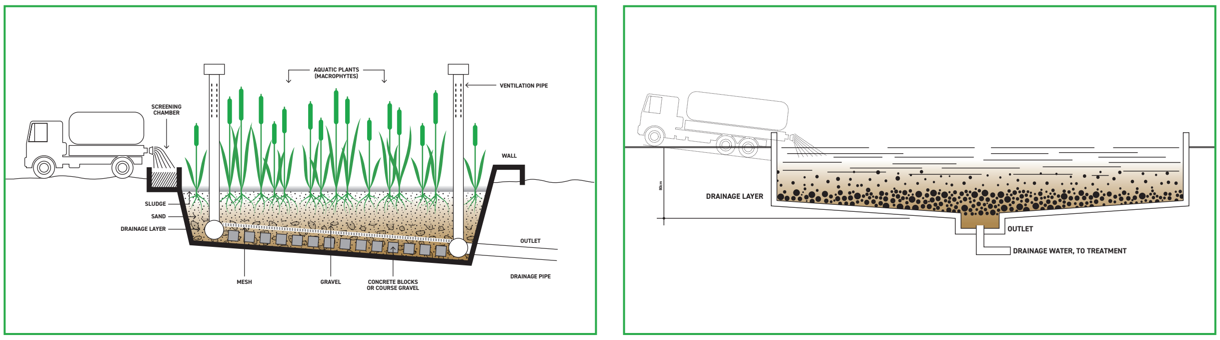
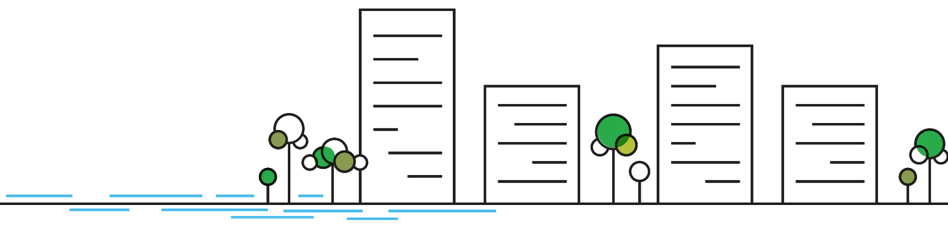


Figure 14: Cross-section of drying beds (left: planted and right: Unplanted) used for drying of FS

3. Drying beds such as unplanted drying beds and planted drying beds are passive systems which can perform both dewatering and drying of biosolids. The final solids from these beds can have TSS of around 50-60%.The sludge from drying beds should be further treated (as necessary) for pathogen reduction.

Annexure 4: Some common challenges encountered in O&M of the co-treatment facility

KEY IMPLICATIONS OR ISSUES	ISSUES	RESOLUTIONS
Industrial or other sludge delivered	It is important to monitor incoming sludge and ensure that it is human excreta based and does not consist of industrial or other wastes	Operators should be trained to check samples of incoming sludge for pH, conductivity (handheld instrument), colour, and odour. Further confirmation can be made by asking the desludging operator about the origin of the sludge to ensure only FS is accepted.
High concentrations of COD and TN in the aeration tank	When co-treating FS in an existing STP, the COD and TN concentrations in the aeration tank and at the outlet will increase proportionally. This is due to the quality and quantity of FS that is added, reducing the efficiency of the treatment process.	Presence of soluble non-biodegradable COD and TN will reduce the treated effluent quality because they cannot be removed or treated by either physio-chemical or biological processes. Hence, the quantity and quality of the FS need to be assessed closely in order to meet the required treatment standards. If problem persists, then suitable process interventions need to be adopted taking technical support from experts.
Increase in Oxygen demand at the STP aerobic reactors	Addition of FS into an existing STP can result in severe increase in the oxygen demand due to the high concentrations of biodegradable COD and TN. Oxygen requirement for COD removal is 1.2 kg oxygen per kg of COD and for Nitrification, 4.6 kg of oxygen per kg of Ammonia is required.	FS contains high concentrations of COD and TN. When the FS is co-treated, the oxygen demand of the STP will increase. Hence, organic concentrations of FS should be studied before undertaking co-treatment and the system needs to be retrofitted in order to meet the required treatment standards. If problem persists, then suitable process interventions need to be adopted taking technical support from experts.
Surplus sludge production	Due to high organics present in the FS, more biomass will be produced in the treatment reactor which will result in surplus solids. If the TSS exceeds the maximum limit, the treatment plant can experience serious operational problems ranging from the overloading of aeration and secondary settling tanks to considerable decrease in the oxygen transfer efficiency in the aeration tank.	Dilution of FS based on COD may most likely ensure the organic load as well as solids entering the STP would not exceed the design load. Limiting the rate at which FS is added into the system will be an appropriate measure to avoid excess sludge production.



KEY IMPLICATIONS OR ISSUES	ISSUES	RESOLUTIONS
Difference in sludge quality	The sludge handling units in STP are designed for handling sewage sludge from primary clarifier with solids concentration ranging from 2-4.5% and solids concentration in activated sludge ranging from 0.4 to 1.5%. Introducing the separated solids of FS will overload the sludge handling units and result in reduction of the efficiency. Hence additional sludge handling units at STP will be required for accommodating the solids from co-treatment infrastructure.	Based on the FSTP operations experience from Devanahalli, solids concentration after solid-liquid separation of FS would range from 5- 6% (50,000-60,000 mg/l). Hence due care should be taken while loading the solids fraction of FS into the sludge handling facility of STP.
Need for sludge handling facility	In India, it is acknowledged that solids handling is not an area of strength for the STPs. Due to space constraints, a lot of STPs are devoid of drying beds. Also, the existing equipment to handle solids are not properly operated and maintained leading to issues with handling and disposal of sludge.	Mechanical solids handling units like volute press or centrifuge can be explored as an option for the STPs, which will significantly reduce the area requirement for further drying. However, the capital and operational expenditures are likely to be higher for such systems.
Contractual Issues	Given that most of the STPs are operated under a contract through a private operator, the operator might not be interested in taking up the additional task of co-treatment. This is because of the complexities that are expected to be added to the process. Further, if a new service provider is appointed for the task, there may not be efficient coordination between the operators, which may affect the treatment efficiency of the plant.	Confidence building measures need to be taken up to convince the existing operators that through additional infrastructure and necessary control mechanisms, STPs will be able to safely treat FS also.

Annexure 5: Common Dos and Don'ts in co-treatment design

DO'S	Don'ts
Quantity of faecal sludge that can be co-treated in a STP must always be decided after a detailed investigation of the STP performance and its underutilised treatment capacity	Faecal sludge should not be disposed in STPs which do not have facilities for sewage sludge management
Faecal sludge must be disposed only in those SPS which are connected to STPs identified as feasible for co-treatment	Co-treatment using direct addition method should not be preferred for new STPs
Characteristics of Faecal sludge added to STPs should be continuously monitored and must always conform to the range provided in table 4	Co-treatment should not be implemented without updating the contractual arrangement with the O&M operator of the STP to reflect the additional management burden
The STP should be close enough for easy access by tankers transporting the sludge. At the same time, there should be sufficient buffer distance so that nuisances to neighbourhoods can be minimised. The tanker routes to the STP should also avoid residential areas.	Faecal sludge from trucks should not be directly disposed of into the STP without detailed feasibility study for co-treatment.

Annexure 6: Nature of on-site systems

There are three types of on-site systems prevalent in India, each of which are described below.

1. Septic tanks are watertight tanks with an outlet. As the toilet flush water passes through, the heavier solids settle and remain in the septic tank, eventually forming partially digested faecal sludge. Lighter particles are carried away by the effluent through the outlet. The sludge accumulates over the years reducing the time for heavier particles to settle thus increasing pollution in the effluent. However, there is no indication to the user about the level of sludge or degree of pollution in the effluent. Therefore, regular/periodic desludging of septic tanks is critical to maintain their efficiency. The interval for desludging depends on the size of the septic tanks and should be carefully determined in each town.

   Desludging at short intervals carries the risk of transporting water, as opposed to sludge, and is inefficient.

2. Single pits are permeable and allow water to leach out but retain solids. The solids are partially digested and form faecal sludge. Once full the single pit typically causes back flow into the toilet clearly indicating the need for desludging. When pits take very long to fill, the contents harden over time and become difficult to desludge, requiring addition of water along with stirring which may lead to unsafe practices. Therefore, a specific interval for desludging is recommended even for single pits.

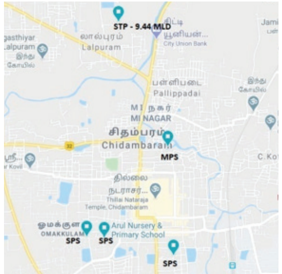
   Many single pits are erroneously identified as septic tanks by households. Single pits can be identified by lack of outlet pipe and long desludging intervals.

3. Holding tanks are watertight tanks without an outlet. These fill-up in a short time and require frequent emptying. Because of the short emptying intervals sludge is not formed, so the waste is closer to sewage in characteristics. Holding tank wastes, unless stored for more than 6 months may be considered as sewage.

   Holding tanks are typically seen in small multi-dwelling units that do not have access to storm drains in the outskirts of large towns and cities, though their prevalence is low. They are also found in slums.

4. Sewage sludge from small STPs – Many institutions and residential communities have small STPs which treat their sewage. In the process they generate sludge. This sludge, called sewage sludge, is expected to be handled at the STP itself. However, due to several reasons many small STPs dispose their sewage sludge rather than treat it themselves. This sewage sludge can be co-treated at an STP. However, it is different from faecal sludge and should be identified as sewage sludge and treated in that manner.

Annexure 7: Fact sheets on co-treatment in India



Co-Treatment at Nesapakkam STP, Chennai

Area: 426 km² | Population: 7.1 million | 12 STPs at 5 locations with a total installed capacity of 727 MLD

Notes: Greater Chennai Corporation (GCC) area is divided into five zones for sewage collection, conveyance, treatment and disposal. Co-treatment of septage at STPs began in the early 2000s, with three locations undertaking co-treatment at present.

STP Details

Spread over an area of 45 acres, Nesapakkam STP serves the south-western part of the GCC area. The site has **three treatment trains** with a combined installed capacity of **117 MLD** (23 MLD, 40 MLD and 54 MLD respectively) – all based on "**Activated Sludge Process" (ASP) Technology.** The combined waste water flow ranges from 95 to 100 MLD, with spare treatment capacity (of upto 17-22 MLD), enabling implementation of co-treatment. Treated wastewater is discharged into the Adyar River.

Co-treatment Story

- **Timeline:** Co-treatment of septage at Nesapakkam STP was initiated **in July 2006**, serving unsewered urbanized areas in the vicinity, with the aim of providing a facility for discharge of septage to private operators desludging septic tanks in these areas.
- **Scale of Operations:** Nesapakkam STP has **52 registered private desludging trucks,** each with a capacity of 9,000 Litres (9KL) and makes multiple trips every day. **With ~200 trips per day**, it is estimated that the plant provides treatment solution for between **180,000 to 600,000 households** with septic tanks.
- **Investment:** For creating a special decanting facility for discharge of septage, the STP had **to incur capital expenditure of about INR 20 million**. **No additional retrofits** or modifications required capital investment. **O&M cost has increased slightly** due to the higher aeration requirement.

Process & Performance

- **Technology:** With (ASP) technology - the facility receives about 200 truckloads of septage on a daily basis of about 1.8 MLD of septage, which is blended with ~100 MLD of sewage (which is ~ 2 percent of the sewage flows).
- **Operational Challenges:** Septage addition and co-treatment has not resulted in any operational challenges at the STP, and there has **not been any adverse impact** on the treated water quality.
- **Outcomes:** The treated water **has BOD, TSS and faecal coliform levels well within the prescribed levels i.e.,** BOD ← 20 mg/l , TSS ← 30 mg/l and faecal coliform ←100 MPN/100 ML

Co – Treatment at Chidambaram STP, Tamilnadu

Area: 4.82 km² | Population: 62,153

Notes: The area of the STP is 10 acres. It will cover 10,000 HSCs of 33 wards of the city and presently covers 5196.

STP Details

The installed capacity of STP is 9.4 MLD and the Treatment Technology is Conventional Activated Sludge process. The present average daily flow received at the STP is 2.4 MLD. The treated water discharged into Pasimuthan stream.

- Timeline: Chidambaram Municiplaity initiated co-treatment in 2020 by allowing decanting of septage at pumping stations to counter illegal dumping of septage by private desludging operators

Co-treatment Story

- **Scale of Operations:** From pumping station decanting, and about 10 decanting trips daily **(~6 m 3 litres each, so a total of 0.06 MLD per day),** the co-treatment facility can serve **6,250-18,750 households** with septic tanks.
- **Institutional Arrangement:** Collaboration between TWAD Board (planning and construction) Chidambaram municipality (service providers), private desludging operators and Tamil Nadu Pollution Control Board (monitoring
- **Investment:** The co-treatment facility was created at **no additional (capital and O&M) cost**

Process & Performance

- **Technology:** The (ASP) technology consists of a screen (mechanical), Grit Chamber and Primary Sedimentation followed by aeration and secondary settlement. Sludge drying bed is used for sludge handling.
- **Operational Challenges:** A screen arrangement should be established in pump house to streamline co-treatment.
- **Outcomes:** The discharge BOD, COD and TSS are within the limits.

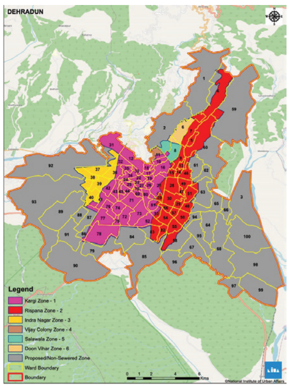
Future Plan

- Additional decanting facilities to receive FS from cluster ULBs is planned.

Co-treatment at Raipur and Banjaralwala STP, Dehradun

Area: 4.82 km^2 | Population: 62,153

Notes: With 6 sewerage zones, it currently has **8 STPs** and two more STPs are being designed at Banjaralwala and Raipur, with a combined installed capacity of **~35 MLD.**



STP Details

The two upcoming plants in Banjaralwala and Raipur have DPRs ready for sewage treatment and the study suggests design augmentations towards enabling co-treatment of septage at the bidding stage. Septage handling capacity of **75m^3 and ~40 m^3** at Banjaralwala and Raipur STPs respectively will be available.

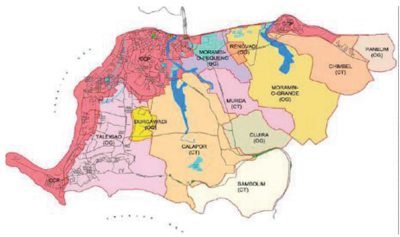
Co-treatment Story

- **Timeline:** The project designed has taken a co-treatment utilization period of 15 years between 2021-2036, assuming that the STP will be functioning at a **utilization of ~70% by 2036.**
- **Scale of Operations:** With a combined septage treatment of **~115 m^3**, the co-treatment facilities can serve ~142,500 people at current population levels. In future, it will be able to serve **200,000 more people (40,000 households) dependent on septic tanks.**
- **Desludging Requirements:** Total vacuum tanker (4m^3 each) requirement will be **two at Banjaralwala STP and four at Raipur STP**
- **Investment:** Co-treatment can be enabled in the two plants at a combined additional cost of **~INR 88 lakhs**

Process & Performance

- **Technology:** Primary treatment of septage before mixing with sewage will be done using additional technology. Solid-liquid separation in **septage will be conducted through septage receiving stations retrofitted with screens, holding and homogenization tanks, a centrifugal STP dewatering unit and sludge drying beds.** The liquid portion with higher BOD can be treated with sewage.
- **Operational Challenges:** Primary treatment of septage before mixing with sewage in the main pumping station will ensure **no compromise in the STP functionality**
- **Outcomes:** Of the total 114 KLD septage expected to be generated by 2036, the two STPs will be able to **treat 50% of the city's expected septage generation**. Benefits will also percolate to nearby towns and villages.

Co-treatment at Tonca STP, Panaji



Panaji is divided into two sewer sheds and it has three STPs of total installed capacity of **~28 MLD.** One of the STPs is located at **Tonca, of capacity 12.5 MLD,** and it functions as a **regional facility** serving Panaji, Panaji Urban Agglomerate and North Goa.

STP Details

Only an STP at Tonca provides co-treatment and has an installed capacity of **12.5 MLD.** The STP is based on **Cyclic Activated Sludge Technology (C-Tech),** an advanced **Sequential Batch Reactor (SBR) technology**. The treated wastewater is discharged into St. Inez creek and thereafter drains into Mandovi estuary.

Co-treatment Story

- **Timeline:** • Timeline: The STP at Tonca was **commissioned in 2005** and has since been using excess hydraulic capacity **(2.5-3.5 MLD)** for co-treatment, with a view to curb illegal dumping of septage into storm water drains, waterways and open fields. Geological conditions of a low water able and saturated topsoil necessitate frequent desludging and hence, co-treatment is necessary.
- **Scale of Operations:** Through solely the decanting station at the STP, about 120 truckloads of septage are decanted daily **(~4-8 kL each, so a total of 0.48-0.96 MLD per day)**, and the co-treatment facility can serve 110,000-230,000 households using septic tanks
- **Investment:** Co-treatment has been enabled by developing a decanting station at the STP at a cost of **INR 140,000;** no retrofits to the treatment train and changes to O&M protocols have been required.

Process & Performance

- **Technology:** The (C-Tech) technology is based on the Activated Sludge Process Technology and it **involves a complete biological process involving aeration,** settlement and decanting. Each cycle is fixed for **180 minutes** and it is capable of automatically adjusting for variable flow and load conditions through a **PLC system**. This is more effective than the mechanical grit removal system.
- **Operational Challenges:** There have been **no operational** challenges at the current flow and load, however STP operators are concerned about the impact on the plant and effluent quality with increased load, given there is no equalization tank at the decanting station.
- **Outcomes:** Data on treatment efficacy shows that the quality of treated effluent is within the prescribed limit of 30 mg/l for BOD and 100 mg/l for SS. ~ 50 m3 of treated effluent is provided free of charge to the forest department for irrigation. Dewatered sludge is provided to farmers. The total current septage received is 4-8% of total wastewater inflow at the STP.

Future Plan

- Additional STP with the capacity of **33 MLD** is being set up at the same site to replace the defunct treatment train.

Co-treatment at Bhandewadi-2 STP, Nagpur

Area: 393 km². | Population: 2.75 million | 4 STPs with a total installed capacity of 340 MLD.

Notes: It is the first city in India to recycle more than 90% of the waste water generated for reuse in industry.

STP Details

Nagpur has four STPs, two of them i.e. at **Bhandewadi 1 – 130 MLD and Bhandewadi 2 - 200 MLD** are based on **Sequential Batch Reactor (SBR) technology, and other two of 5 MLD** each are based on Moving **Bed Biofilm Reactor(MBBR) technology**. STPs serve 90% of properties. Co-treatment of septage is being undertaken at **Bhanderwadi 2 STP**, which has the spare capacity to treat sewage flow, thus enabling co-treatment. The treated waste water is **reused for thermal plants.**

Co-treatment Story

- **Timeline:** Co-treatment of septage with existing STP has been a common practice. Co-treatment of septage from **Nine ULBs** was initiated in December 2018 through an MoU between Nagpur MC and the ULBs to end the practice of dumping of septage in open areas/ drains
- **Scale of Operations:** Septage collection service is provided by Nagpur Municipal Corporation (NMC) within the city area. NMC has eight trucks of 3KL (kilolitres) capacity each. Total 20 KLD of **septage collected from the NMC** area and about **55 KLD of septage load** is received from nearby nine cities. Septage load is discharged to Hiwari sewerage pumping station (SPS). It is estimated that the co-treatment provides treatment solution for **60,000 properties of NMC and 99,600 properties from nearby nine ULBs that are dependent on septic tanks.**
- **Investment: No additional retrofits or modifications requiring capital investment** have been made at the STP to enable co-treatment. Further, no additional infrastructure has been created at the decanting stations

Process & Performance

- **Technology:** Septage from Nagpur and other sending cities is received at Hiwari sewage pumping station. Based on **Sequential Batch Reactor (SBR) technology at the Bhandewadi-2 STP**, the septage mixes with the waste water being received by the STP through the transmission lines from the Hiwari pumping station. Sludge is further treated through sludge digestor, dewatered using filter belt press for further reuse.
- **Operational Challenges:** Co-treatment has not resulted in operational challenges at STP or any adverse impact on the quality of treated water
- **Outcomes:** The treated water meets NGT prescribed standards for various parameters such as **BOD, COD, TSS, faecal coliform levels etc.**

Co-Treatment at Indira Nagar STP, Dehradun – Case Study (Ganga Towns in Uttarakhand)

Area: 393 km². | Population: 2.75 million | 4 STPs with a total installed capacity of 340 MLD.

Notes: It is the first city in India to recycle more than 90% of the waste water generated for reuse in industry.

STP Details

The STP was commissioned in **April 2014.** It was designed for an average flow of **18 MLD and a peak flow of 48.6 MLD.**

Process & Performance

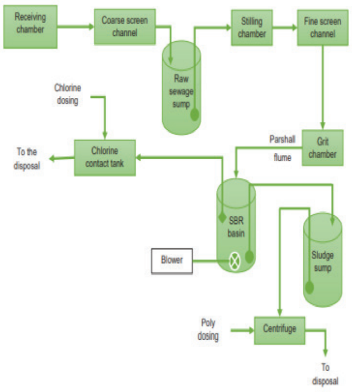
The STP is based on the **Sequencing Batch Reactor (SBR)** process. It comprises receiving chamber, coarse screen (manual and mechanical), raw sewage sump, pump house, stilling chamber, fine screen (manual and mechanical), grit chamber, Parshall flume, SBR basin, chlorine contact tank, sludge sump and centrifuge

Co-treatment Story

The observed average flow was 350 m3 /h or 8.4 MLD, and peak flow was 588 m3/h with a peak factor of 1.68 on 8-9th July 2019, which is lower than the design peak factor. The higher flow was observed due to rainwater infiltration in the domestic sewer

Flow Variation

- The **minimum and maximum COD** in raw sewage varied from 87 mg/L to 201 mg/L with a composite value of 132 mg/L
- The **minimum and maximum BOD** in the raw sewage varied from 43 mg/L to 126 mg/L with a composite value of 71 mg/L
- The **minimum and maximum TSS** in the raw sewage varied from 91 mg/L to 191 mg/L with a composite value of 139 mg/L.



Loading condition and Disposing Criteria

Considering COD	Considering BOD	Considering TSS
Safe COD loading = 75 kg/h S	Safe BOD loading = 42 kg/h	Safe TSS loading = 67 kg/h
Septage Tanker load = 90 kg COD/Tanker	Septage Tanker load = 60 kg BOD/Tanker	Septage Tanker Load= 90 kg TSS/Tanker
Average actual COD loading = 32 kg/h	Average actual BOD loading = 18 kg/h	Average actual TSS loading = 38 kg/h
75 kg/h – 32 kg/h= 43 kg COD/h or 0.5 truck/h can be disposed	Average actual BOD loading = 18 kg/h	67 kg/h -38 kg/h= 29 kg/h or 0.3 truck/h can be disposed

Reference Materials

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