पेयजल एवं स्वच्छता विभाग
जल शक्ति मंत्रालय
भारत सरकार
DEPARTMENT OF DRINKING WATER AND SANITATION
MINISTRY OF JAL SHAKTI
GOVERNMENT OF INDIA

स्वच्छ भारत
एक कदम स्वच्छता की ओर


# Manual: Faecal Sludge Management

July 2021

TREATMENT PLANT
TREATMENT PLANT

# Manual: Faecal Sludge Management

# Contents



# Preface

The Government of India, in February 2020, approved Phase-II of the Swachh Bharat Mission (Grameen) (SBM [G]) with a total outlay of Rs. 1,40,881 crores to focus on the sustainability of Open Defecation Free (ODF) status and Solid and Liquid Waste Management (SLWM). SBM (G) Phase-II is planned to be a novel model of convergence between different verticals of financing and various schemes of Central and State Governments. Apart from budgetary allocations from Department of Drinking Water and Sanitation (DDWS) and the corresponding state share, remaining funds will be dovetailed from 15th Finance Commission (FC) grants to rural local bodies, Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS), Corporate Social Responsibility (CSR) funds, and revenue generation models, etc., particularly for SLWM.

SBM (G) Phase-II has been uniquely designed to leverage the capacity of individuals and communities in rural India to create a people's movement to ensure that the ODF status of rural areas is sustained, people continue to practice safe hygienic behaviour and that all villages have solid and liquid waste management arrangements.

This manual has been developed to support rural local bodies implement ODF Plus initiatives effectively and efficiently in their settings. It provides detailed information on various technologies, estimated cost, Operation and Maintenance (O&M) arrangements, etc. This manual should be able to provide comprehensive guidance to achieve effective solid and liquid waste management in rural areas.

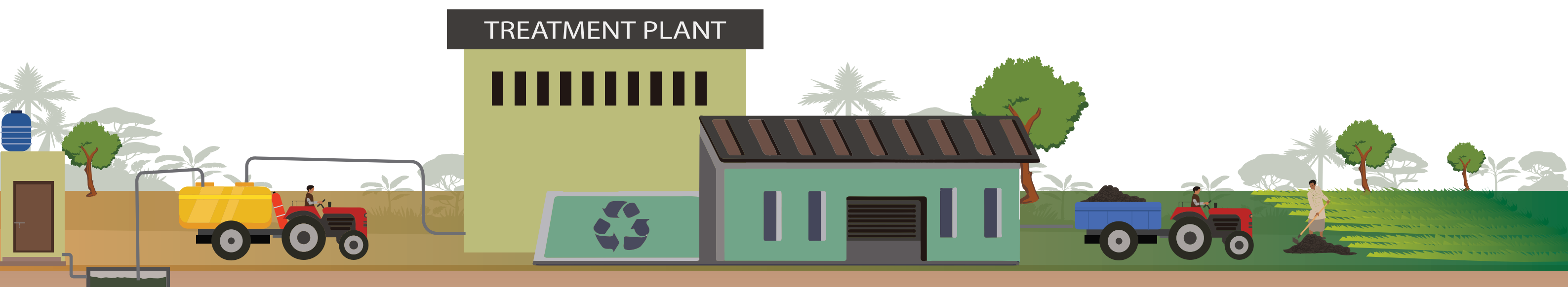
It is hoped that all implementers of Swachh Bharat Mission Phase-II would find this manual useful and a good guide for achieving ODF Plus objectives in their villages.

Department of Drinking Water and Sanitation
June, 2021

# Glossary

| | |
|---|---|
| ***Faecal Sludge*** | Faecal sludge comprises all liquid and semi-liquid contents of pits and vaults accumulating in on-site sanitation installations (Tilley et al, 2014). |
| ***Septage*** | Septage refers to the 'liquid and solid material pumped from a septic tank, cesspool or other primary treatment source' (Tilley et al, 2014). |
| ***Desludging*** | The process of removing sludge from a tank, pit, or other storage unit (Tilley et al, 2014). |
| ***Septic Tank*** | A watertight chamber made of concrete, fiberglass, PVC or plastic, through which blackwater and greywater flow for primary treatment. Settling and anaerobic processes reduce solids and organics, but the treatment is only moderate (Tilley et al, 2014). |
| ***Single Pit*** | It is one of the most widely used sanitation technologies. Excreta, along with anal cleansing waste (water or solids) are deposited into a pit. Lining the pit prevents it from collapsing and provides support to the superstructure. Twin pit technology consists of two alternating pits connected to a pour flush toilet. The blackwater (and in some cases greywater) is collected in the pits and allowed to slowly infiltrate into the surrounding soil. Over time, the solids are sufficiently dewatered and can be manually removed with a shovel (Tilley et al, 2014). |
| ***Twin Pit*** | Twin pit technology consists of two alternating pits connected to a pour flush toilet. The blackwater (and in some cases greywater) is collected in the pits and allowed to slowly infiltrate into the surrounding soil. Over time, the solids are sufficiently dewatered and can be manually removed with a shovel (Tilley et al, 2014). |
| ***Soak Well*** | A soak well, also known as a soak away or leach pit, is a covered, porous-walled chamber that allows water to slowly soak into the ground. Pre-settled effluents from a collection and storage/treatment system or (semi-) centralized treatment system is discharged to the underground chamber from which it infiltrates into the surrounding soil (Tilley et al, 2014). |

| | |
|---|---|
| ***Wastewater*** | Used water from any combination of domestic, industrial, commercial or agricultural activities, surface run-off/stormwater, and any sewer inflow/infiltration (Tilley et al, 2014). |
| ***Blackwater*** | Mixture of urine, faeces and flush water along with anal cleansing water (if anal cleansing is practised) and/or dry cleansing material (e.g. toilet paper). Blackwater has all of the pathogens of faeces and all of the nutrients of urine, but diluted in flush water (Tilley et al, 2014). |
| ***Greywater*** | Total volume of water generated from washing food, clothes and dishware as well as from bathing. It may contain traces of excreta and therefore will also contain pathogens. Greywater accounts for approximately 60 per cent of the wastewater produced in households with flush toilets. It contains few pathogens and its flow of nitrogen is only 10–20 per cent of that in blackwater (Tilley et al, 2014). |



Chapter 1

# Introduction

The Government of India launched Swacch Bharat Mission (Grameen) Phase-II to sustain the gains that SBM had made during the previous five years. The aim was to achieve sustainability of ODF status and creation of solid and liquid waste management services in rural areas. Faecal Sludge Management (FSM) is one of the key components to be implemented under SBM (G) Phase-II. FSM is critical for delivering safe sanitation in rural areas due to the considerable number of toilets linked to on-site sanitation, such as septic tanks and single pits. The overflow from filled-up septic tanks and indiscriminate disposal of emptied faecal sludge to open areas, water bodies, irrigation fields, open drains, areas outside the village, etc. has a negative impact on public health and the environment.

This manual has been developed to guide implementers, mainly engineers, planners and other key officials from the districts who are responsible for implementing FSM. The manual provides technical information on the selected technology based on the FSM implementation approach as outlined in the SBM (G) Phase-II guidelines. It also provides design and engineering for the technologies specified in the guidelines. This manual will help district officials in the preparation of Detailed Project Reports (DPRs), construction of Faecal Sludge Treatment Plants (FSTPs) and their Operation and Maintainenance.

## 1.1 Planning for Treatment of Faecal Sludge

Treatment of faecal sludge should be planned for clusters of villages, where the district must quantify the faecal sludge generated, identify suitable land, and decide which technical approach to choose. These steps are detailed in Annexure 3 which helps produce the integrated district FSM plan. Once these steps have been completed and the district FSM plan is ready, this manual helps to develop the technical DPR for the various activities to be undertaken. The key data that should be based on specific inputs from the integrated district

FSM plan before using this manual are:

- Toilets identified for retrofitting
- Estimation of faecal sludge quantity generated in each village based on toilet type
- Factors to be considered when choosing clusters for FSM including:
  a. Capacity of FSTP – The Annexure 4 provides details on assessing the quantity of faecal sludge, which helps in determining the design capacity of the treatment facility
  b. Site selection – An appropriate site needs to be selected for setting up the FSTP after taking into account factors such as maximum distance between the FSTP and the households (should be less than 15 km), easy road access to the FSTP site, safe distance from the nearest waterbodies and housing settlements, establishment of clear land tenancy, etc.
  c. Technology appropriate for each cluster – The relevant technology approach is selected with the help of the section of this manual

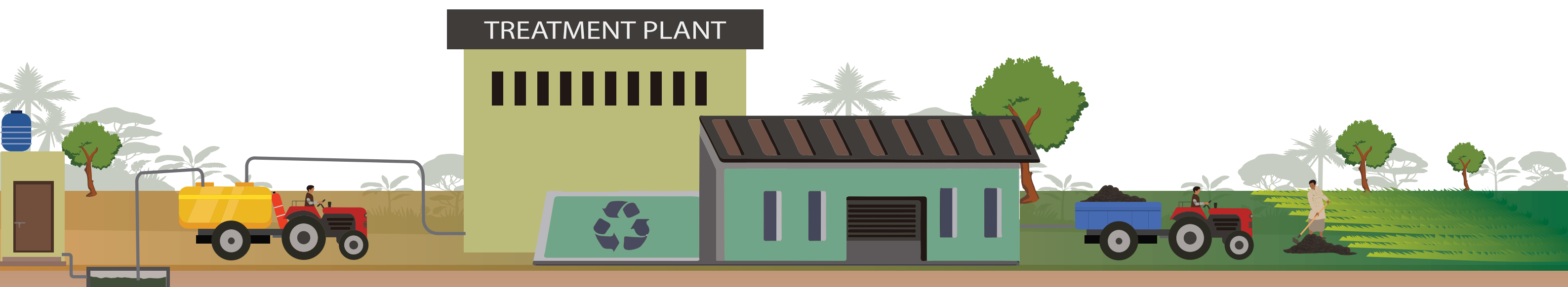
Once these key data are captured and all associated planning steps are complete, the integrated district FSM plan should be formulated showing clustering of villages for FSM. The final output is shown in Table 1.

**Table 1:** FSM Planning in Districts – Output of Clustering Activities

| Cluster number and name | Total FS generated in cluster (in kld) | Treatment approach for cluster (Existing/ New/Trenching) | Is land identified for cluster? (Yes/No/NA) | Extent of land identified (in Acres) | Location of land identified for cluster (Incl. lat/long) |
|---|---|---|---|---|---|
| Cluster 1 | | | | | |
| Cluster 2 | | | | | |
| Cluster 3 | | | | | |
| Cluster 4 | | | | | |
| … | | | | | |
| Cluster 'N' | | | | | |

The four types of treatment approaches are explained briefly here:

1. **In-situ Treatment:** SBM (G) promotes twin-pits toilets to ensure in-situ treatment requiring no mechanized emptying, transportation, or treatment. Twin-pit toilets convert the faecal slugde into manure which can be directly reused in agriculture. Retrofitting of toilets, particularly converting single pit toilets to twin-pit toilets should be encouraged as the first approach towards FSM implementation



2. **Existing STPs/FSTPs:** Faecal sludge from rural areas can be disposed of in nearby urban STPs/FSTPs, where technically feasible, in coordination with the municipality concerned

3. **New FSTP:** SBM (G) Phase-II identifies two primary technologies, i.e., planted drying beds and unplanted drying beds for FSTPs. It should be noted that these two technologies separate the solids from the sludge and treat the solids. The liquid part requires further treatment. This can be done using the technologies mentioned for greywater management. FSTPs can also be planned to be located along with greywater treatment systems such as Waste Stabilization Pond (WSP), Decentralized Wastewater Treatment System (DEWATS), etc. This will help in sharing the O&M costs

    a. **Planted drying beds-based FSTPs** are suitable in most geographical areas and can be suitably constructed with the help of this manual. Design calculations have been provided for 4 kld and 8 kld systems along with drawings for the 4 kld system

    b. **Unplanted drying beds-based FSTPs** should generally be chosen when the capacity requirement is larger, say 12 kld or more. They can be planned through the relevant section of this document. It should be noted that unplanted drying beds require relatively higher O&M effort and cost

4. **Trenching:** Deep row entrenchment should be considered for isolated villages that form very small clusters and where the need is for a low capacity treatment plant

## 1.2 Using this Manual

This manual will help users with the design and engineering aspects of FSM and to prepare technical DPRs for the implementation phase. Specifically, the manual helps with:

1. **Selection of new FSTP technology and engineering design:** Choosing treatment technology for a new FSTP, undertaking design calculations, detailing of engineering and operational aspects. For one specific size of Planted Drying Beds technology, it provides detailed drawings for a 4 kld system

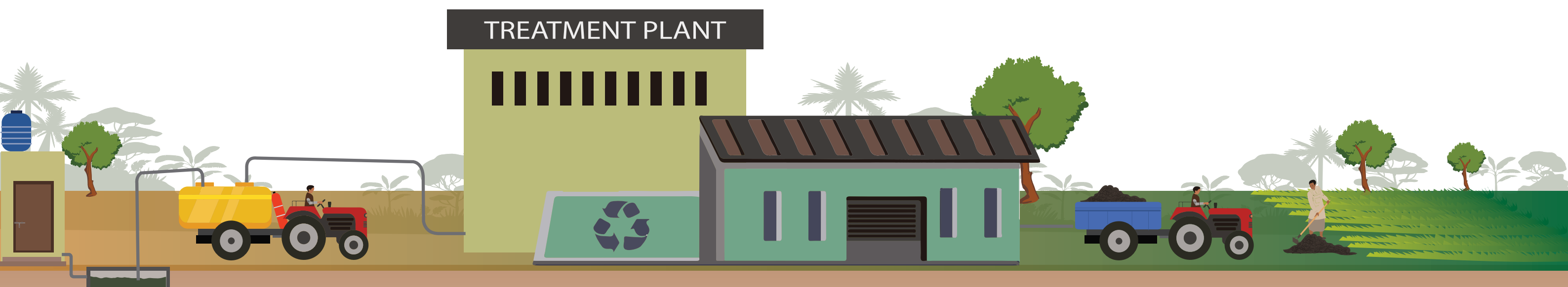
2. **Preparation of DPR:** Based on the capacity of the treatment system determined, technology options selected and the local site conditions at the project location, a detailed project report needs to be prepared. The DPR should mainly include detailed designs and drawings, technical specifications, bills of quantity, cost estimates and other necessary information as required by the district for preparation of tender documents and commencement of construction

3. **Construction and management of FSTPs:** After finalization of the scope of work a suitable agency needs to be hired for construction and management of the FSTP. Identification of agencies needs to be done based on the pre-approved criteria and as per standard procedures

For ease of reference, this manual has been organized into sections based on technical activities, as set out in Table 2.

**Table 2:** Section with Technology Details

| Item | Reference |
|---|---|
| In-situ treatment and retrofitting of toilets | Chapter 2 |
| Treatment at existing STPs/FSTPs | Chapter 3 |
| Deep row entrenchment | Chapter 4 |
| Planted drying bed | Chapter 5 |
| Unplanted drying bed | Chapter 6 |



Chapter 2

# In-situ treatment and retrofitting of toilets

The twin-pit toilet system provides the best form of FSM as it provides in-situ treatment, thus avoiding the need for the collection-transport-treatment method of waste management. It is therefore recommended that conversion of single pits to twin pits be prioritized where possible in all districts. Where twin-pit systems are not feasible, other similar options, such as toilet linked biogas plants and vermi composting toilets, can be adopted.

Retrofitting under the ODF-S initiative looks at a larger set of issues. A general set of criteria for choice of toilet technology is provided in Figures 1 and 2 below, from which technologies appropriate for the purpose of converting single pits to in-situ treatment methods may be explored for feasibility.

**Figure 1:** Selection Criteria for Type of Toilets

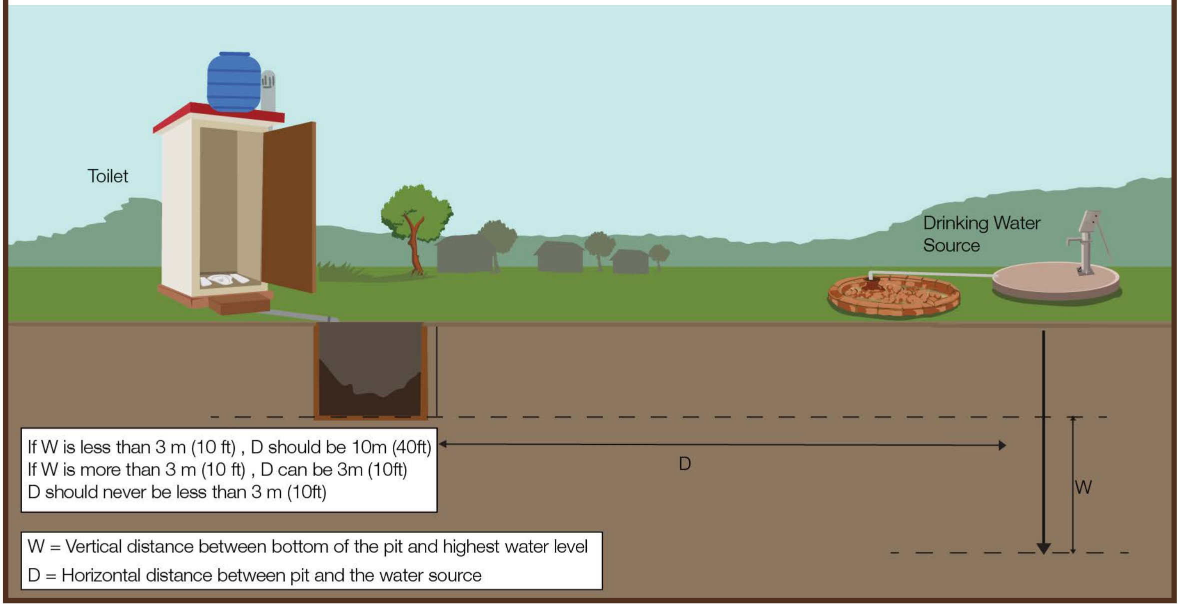
**Selection Criteria**

| Selection criterion | Condition | → Toilet type |
|---|---|---|
| **Soil Conditions** | Normal soil/ sandy soil, permeable soil | Twin pit toilet |
| | Semi-permeable soil | Modified twin pit toilets |
| | Impermeable soil | Ecosan toilet/biogas linked toilet/ vermiculture based toilet/ septic tank with proper treatment system |
| **Hard Strata** | Hard strata beyond 1.2 m depth | Twin pit toilet |
| | Hard strata beyond 0.75 M to 1.2 m depth | Modified twin pit toilets |
| | Hard strata before 0.75 m depth | Ecosan toilet/biogas linked toilet/ vermiculture based toilet/ septic tank with proper treatment system |
| **Groundwater Conditions** | Water table beyond 3m depth | Twin pit toilet |
| | Seasonal high water table | Modified twin-pit toilets |
| | Permanent high water table/water logged condition | Ecosan toilet/biogas linked toilet/ vermiculture based toilet/ septic tank with proper treatment system |

**Figure 2:** General Criteria For Siting Of Toilets

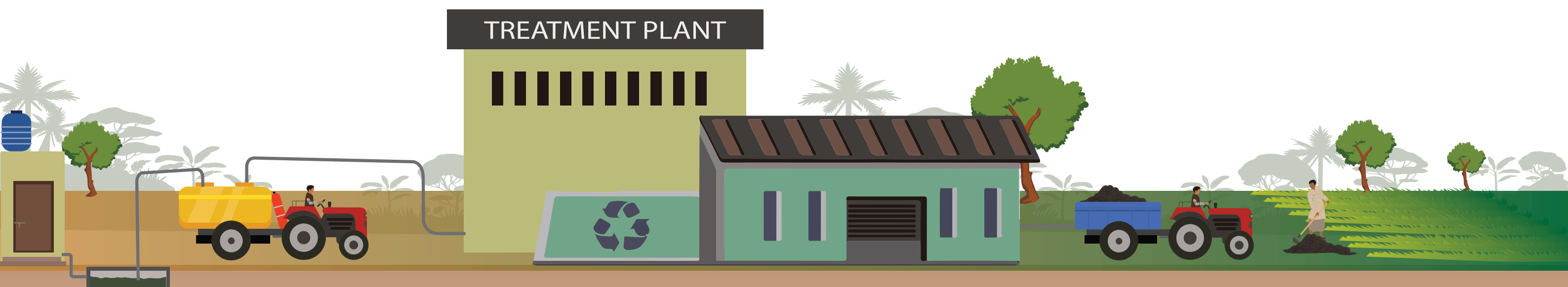
**Distance Between Toilet (Twin-Pit, Single-Pit, Septic Tank with Soak Pit) and Water Sources**

Maintaining a safe distance from a drinking source like a handpump, well, river, pond, etc. (except secured piped water supply) is very important. A minimum of 3 m (10 ft) distance should be maintained between a toilet and water source in any type of terrain, soil type, groundwater level, etc.




In rural areas, the two most common type of toilets, other than twin pit, are single pit and septic tank toilets. The following retrofitting interventions should be undertaken, as feasible:

- Converting single pit toilets to twin-pit toilet systems. Detailed feasibility analysis should be carried out with respect to space availability at each single pit toilet. The SLWM compendium provides the methodology and criteria to be used for this task. The Sujal and Swachh Gaon resource materials provide the necessary know-how
- Septic tanks partially treat wastewater, converting the solids into sludge which is settled in the septic tank, whereas the partially treated liquid fraction (also known as supernatant, effluent) is disposed of through the soak pit. Retrofitting of septic tanks should be considered where soak pits are not constructed with the septic tank
- In case a soak pit cannot be constructed due to constraints such as space or high-water table, the effluent should be managed in accordance with SBM Phase-II guidelines, SLWM compendium and the Greywater manual
- Retrofitting of single pit toilets into twin pit toilets will result in in-situ treatment, requiring no FSM i.e., emptying transportation, treatment. However, replacing septic tanks with soak pits through retrofitting only helps in the safe disposal of liquid (supernatant/effluent) coming out of the septic tank. For the solid matter, FSM still needs to be implemented



Chapter 3

# Treatment at Existing STP/FSTP

The possibility of treatment of faecal sludge at an existing STP/FSTP should be explored, before deciding that there is a need for a new FSTP. There are two options for using existing treatment infrastructure:

1. Co-treatment at existing STP
2. Disposal at existing FSTP

Such existing STPs/FSTPs in urban centres within a radius of 10 km or 30 minutes driving time (preferably) or up to 15-20 km or 45 minutes driving time (in extreme cases as an interim solution) should be identified.

The district, in coordination with the competent authority responsible for the O&M of the STP/FSTP, should consider the technical aspects of the existing facility in detail. This is a critical step to ensure its continued smooth functioning after accepting additional faecal sludge. Finally, an estimate of the quantity of faecal sludge that can be treated at the facility should be arrived at.

This estimate is to be used to form a cluster of villages around the existing STP/FSTP which generates that quantity of faecal sludge on average. This cluster should be mapped to the specific existing facility for disposal. The district may enter into a formal MoU/MoA to this effect with the urban centre.

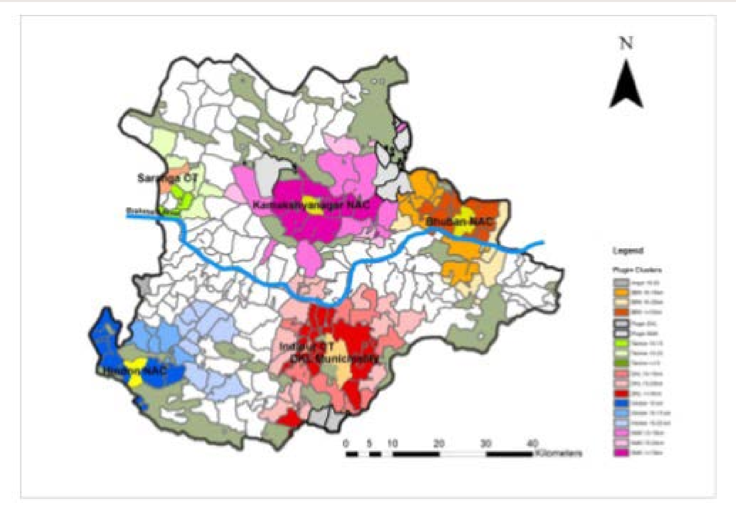
The district should further ensure that there is proper communication and coordination between respective authorities, and set up a monitoring system for proper and safe disposal of collected faecal sludge.

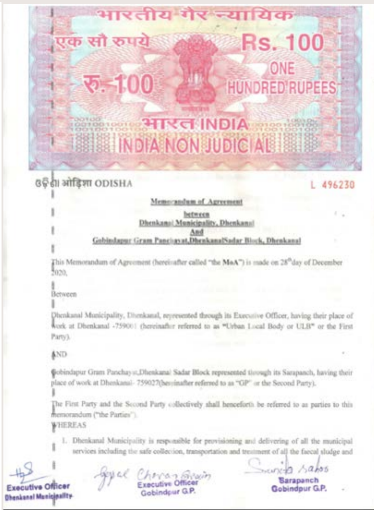
## Case Study – Managing Faecal Sludge through a District-Wide Approach in Dhenkanal

Dhenkanal district in Odisha has 2.7 lakh households and a population of 11.9 lakhs (Census of India, 2011). With the construction of nearly 2.4 lakh toilets under the first phase of the SBM (G), the rural areas of the district is declared Open Defecation Free. A district-wide sample survey in 2019–20, indicated that the on-site sanitation systems like septic tanks and leaching pits have increased manifold in rural areas. The Dhenkanal district administration, with support from UNICEF and the Centre for Policy Research (CPR), has developed a novel district-wide cum cluster-based strategy on FSM to manage the faecal sludge generated.  The strategy aims at providing rural communities with safely managed sanitation as defined by the Sustainable Development Goal 6.2.

### 1. Leveraging the existing and upcoming urban FSTPs to serve rural households by 'plugging-in' the neighbouring GPs

The Dhenkanal Municipality (M) had earlier emerged as one of the first small town in the country to implement a citywide system for FSM under the collaborative Project Nirmal (supported by the Bill and Melinda Gates Foundation, the Arghyam Foundation, CPR and Practical Action). In the municipality commissioned a nature-based FSTP capable of treating 27 kilolitres of faecal sludge per day (KLD). In 2019,  an assessment of spare capacity available based on operational data from two years of operation was done, and a cluster of 17 GPs (with 13,000 households situated in the vicinity of the Dhenkanal

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Memorandum of Agreement
between
Dhenkanal Municipality, Dhenkanal
And
Gobindapur Gram Panchayat,DhenkanalSadar Block, Dhenkanal

This Memorandum of Agreement (hereinafter called "the MoA") is made on 28th day of December 2020,

Between

Dhenkanal Municipality, Dhenkanal, represented through its Executive Officer, having their place of work at Dhenkanal -759001 (hereinafter referred to as "Urban Local Body or ULB" or the First Party).

AND

Gobindapur Gram Panchayat,Dhenkanal Sadar Block represented through its Sarapanch, having their place of work at Dhenkanal- 759027(hereinafter referred to as "GP" or the Second Party).

The First Party and the Second Party collectively shall henceforth be referred to as parties to this memorandum ("the Parties").

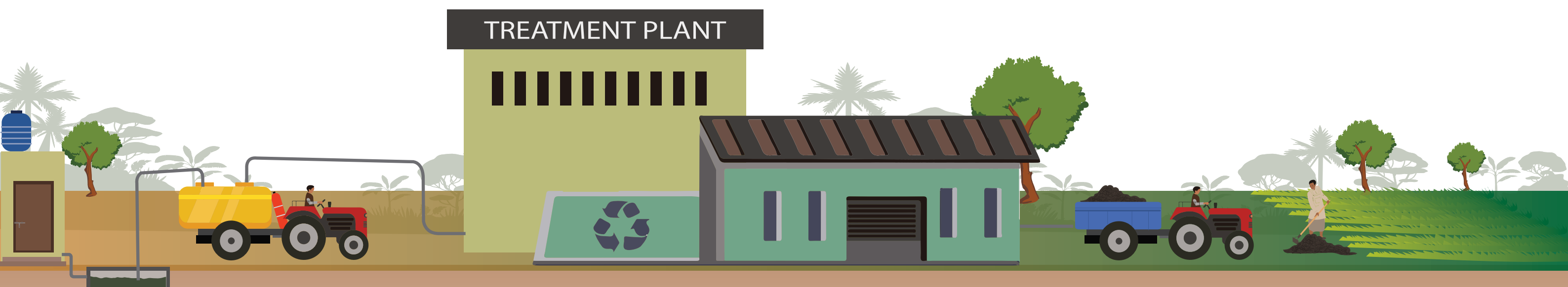
WHEREAS

1. Dhenkanal Municipality is responsible for provisioning and delivering of all the municipal services including the safe collection, transportation and treatment of all the faecal sludge and

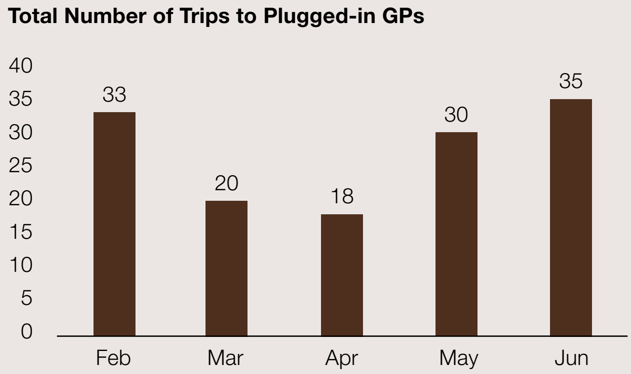
Executive Officer Dhenkanal Municipality

Executive Officer Gobindpur G.P.

Sarapanch Gobindpur G.P.

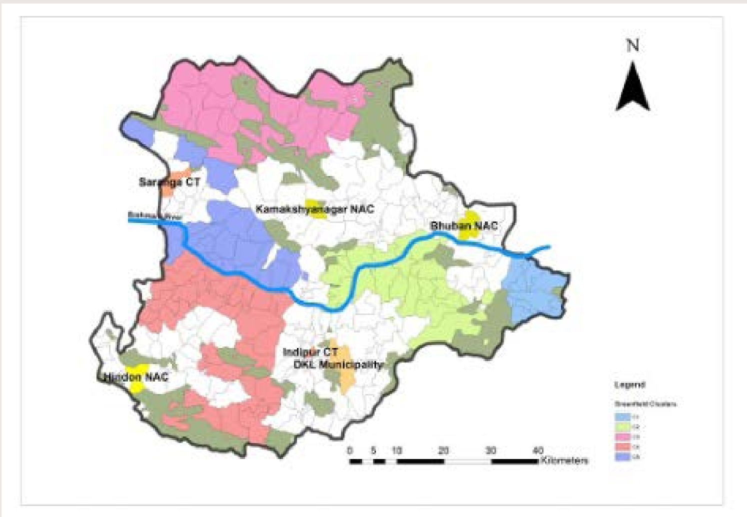


(M) has was identified to be 'plugged-in' to the urban FSTP. These 17 GPs signed a formal agreement, viz. Memorandum of Agreement, with the Dhenkanal (M) to enable systematic rural-urban convergence and coordination on aspects such as tariffs, financing, accountability, and monitoring. Since the operationalization of the plug-in model, 278 KL of faecal sludge from these GPs has been safely conveyed to and treated at the urban FSTP. It is now planned to roll-out out this approach of 'plugging-in' for the upcoming urban FSTPs in other ULBs in the district.




2. **Identifying clusters of GPs for development of greenfield rural FSM Systems (FSM-S) in the district**

The plug-in strategy, while suitable for GPs surrounding urban centres, is in MoM of the meeting held on 29.7.2021 between AS SBM MoJS-DDWS not a feasible solution for those GPs located at further distances form the existing FSTP or when the urban FSTP is running close to its designed capacity.




Both situations necessitate the development of cluster-based greenfield rural FSM-S (or, independent rural FSM-S for a cluster of GPs) for district-wide achievement of safely managed sanitation. After extensive mapping, five such clusters of GPs that cannot be plugged-in into either of the four existing or upcoming FSTPs in the district have been identified. Of these five, one cluster is now selected for the initial demonstration of a greenfield rural FSM-S with the support of the project partners.

Chapter 4

# Deep Row Entrenchment

Deep row entrenchment[2] is a controlled disposal method that consists of excavating deep trenches, filling them with faecal sludge/septage and covering them with soil. Additionally, plantation can be carried out on the top or side of the entrenchment for the plants to take-up the nutrients available in faecal sludge.

Source: https://niua.org/scbp/sites/default/files/Latest_Odisha_Phase_II_2_EP_.pdf

## 4.1 Feasibility

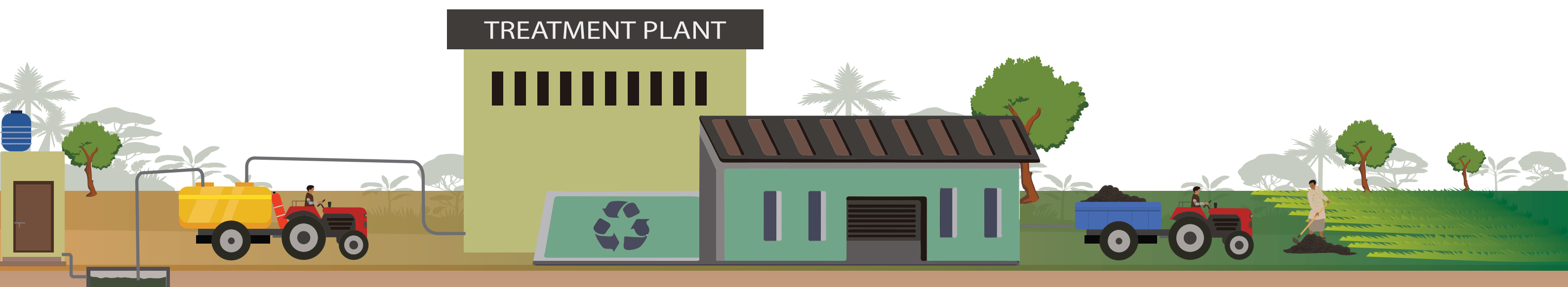
### Geographical Requirements

**a. Climatic conditions**

- Heavy rainfall in the project area may increase moisture content in the environment and may cause inconvenience in evacuating the biosolids
- It may also lead to local flooding of the project area, causing nuisance

**b. Soil and terrain**

- Soil with good permeability and high Infiltration capacity is required (if the soil is clayey or has a rocky stratum, the infiltration will be low, so more trenches and a larger area may be required)
- If constructed in black cotton soil, there may be cracks in the trenches which may expose the sludge and sludge movement to other areas. Necessary precautions should be taken in such areas to avoid sludge movement



- Trenching in loose soil may be difficult as the soil may fall during the excavation or during the course of filling the sludge
- To avoid any spillage/flow of wastewater to the downstream area, flat terrain is preferable

**c. Site selection**

- The site should not be in low lying areas or prone to localized flooding. Further, the groundwater table at the site selected should be at least 10 m deep and surface water bodies should be at least 50 m away
- Preference should be given to a flat site which is easily accessible to vehicles off loading sludge
- It should be at least 500 m away from human habitation
- The selected site should have all the required clearances from the concerned authorities like the state pollution control board, revenue department, etc. The required clearances include no objection certificates, consent for construction of FSTP, etc.

## Appropriateness of the Technology

### Advantages

- Simple and easy to construct
- Low investment required
- No expensive infrastructure or energy required
- Limited or low operation and maintenance
- Increase in green cover with benefits like extra $CO^2$ fixation, protection against erosion, or potential economic benefits from the produce

### Limitations

- Requirement of large amounts of land
- Support of local people regarding implementation is necessary
- Leaching from the trenches can pollute the groundwater and surface water bodies
- Possibility of contamination of soil or ground water by heavy metal, if present

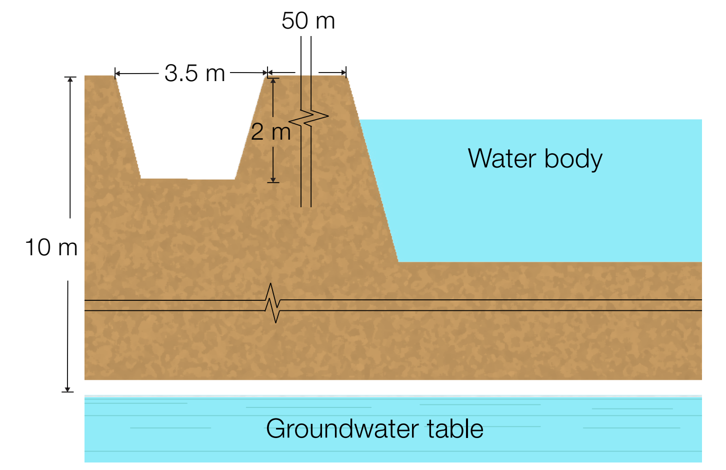
## 4.2 Technical Details and Layout Planning

Deep row entrenchment is a simple technique used for disposal of faecal sludge in an environmentally responsible manner. Deep row entrenchment involves pits that are usually not deeper than 2 m and are designed specifically for disposal of septage. The trench is filled with the sludge up to 0.3 m from the top of the surface and then backfilled with excavated soil. Aspects to be considered are a) distance from water sources: surface and groundwater; b) trench dimensions; c) method of filling.

The minimum distances necessary between a water source and the trenching site are given in Table 3:

**Table 3:** Distance between trench and water sources

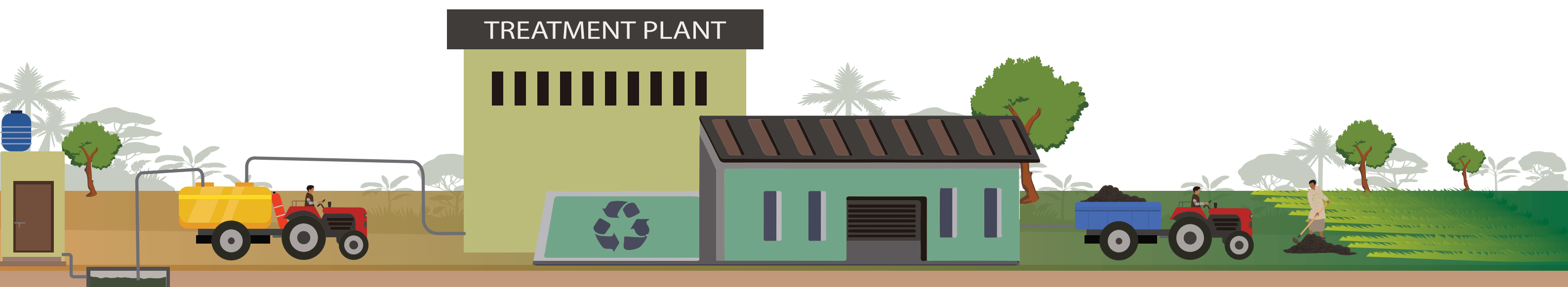
| Description | Min. distance |
|---|---|
| Horizontal distance between entrenchment site and any water source (well, intake structure, aquifer, etc.)[6] | 50 m |
| Vertical distance between bottom of the trenches and the groundwater table[6] | 10 m |




The technology has three variations depending upon the proximity to water bodies or ground water table. These are presented in Table 4:

**Table 4:** Types of Deep Row Entrenchment

| Sr. No | Name | Condition | Description |
|---|---|---|---|
| 1 | Normal deep trench | • Groundwater table is very deep<br>• There are no surface water sources such as streams/rivers, open ponds, wells, etc. near the trenching site | A normal deep trench of standard size is used |
| 2 | Deep trench with sand barrier | • Groundwater depth is almost equal or less than the vertical permissible limit<br>• There are no surface water sources such as streams/rivers, open ponds, wells, etc. near the trenching site | After excavation of the trench, a thick layer of sand (0.3 m/9–12 inches) is provided at the bottom to reduce leaching of solids and pathogens |



| Sr. No | Name | Condition | Description |
|---|---|---|---|
| 3 | Deep trench with sand barrier and plastic/Agri-film cover | • Both ground as well as surface water sources are almost equal to the permissible limits | The base of the trench is filled with 0.3 m thick layer of sand and the sides of the trenches are protected with plastic/agri-film. Providing plastic/agri-film cover for all four sides will prevent seepage through the sides of the trench and guide leaching of the content through the bottom sand layer. |

### Layout Planning for Trenching

Identified site should be divided into four parts, to be prepared quarterly considering year-wise cycle. The first section of the site should be developed considering the demand for the next three

The site should have clear demarcation for trench and accessibility of site. A clear distance of 3.5 m should be maintained between trenches

For vehicle movement, particularly in loose soil, 5 m should be provided to ensure accessibility

The area should be protected by barbed wire to prevent animals from entering. A typical layout plan has been shown for further clarity

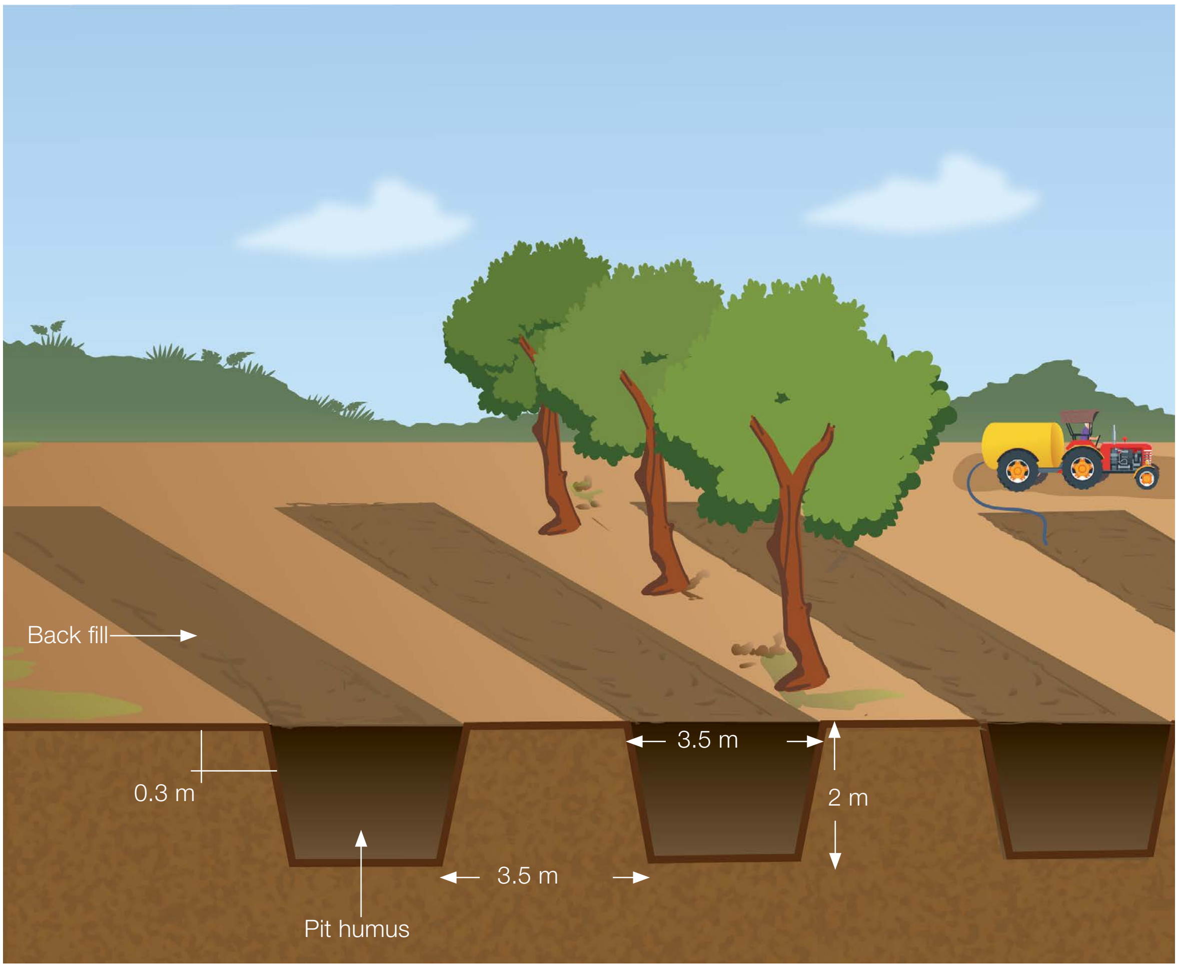
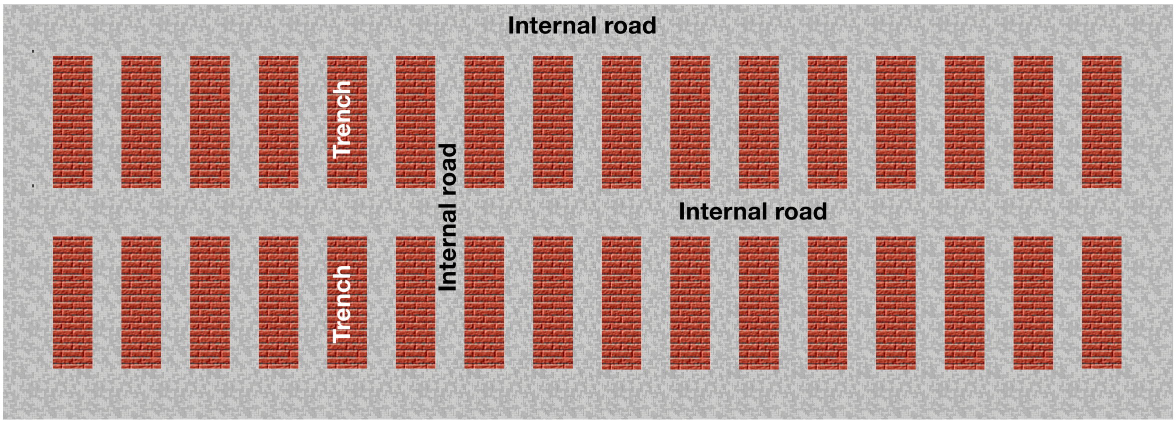
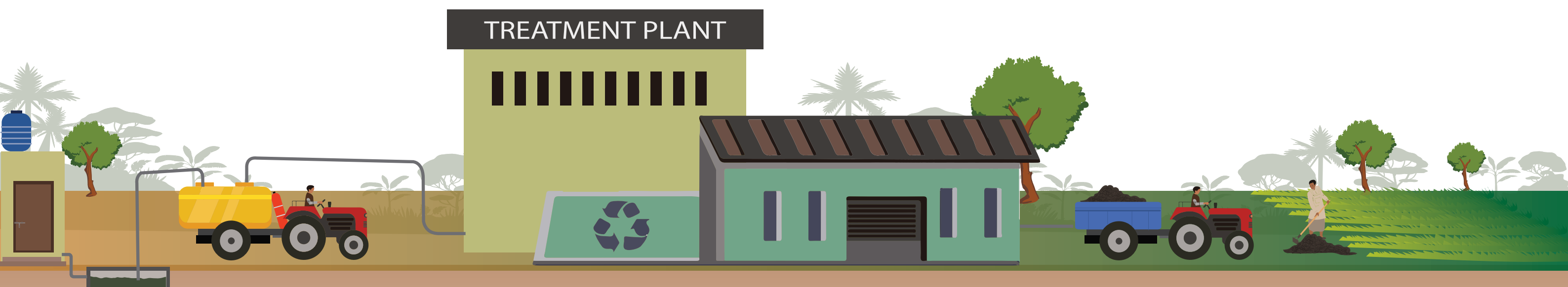


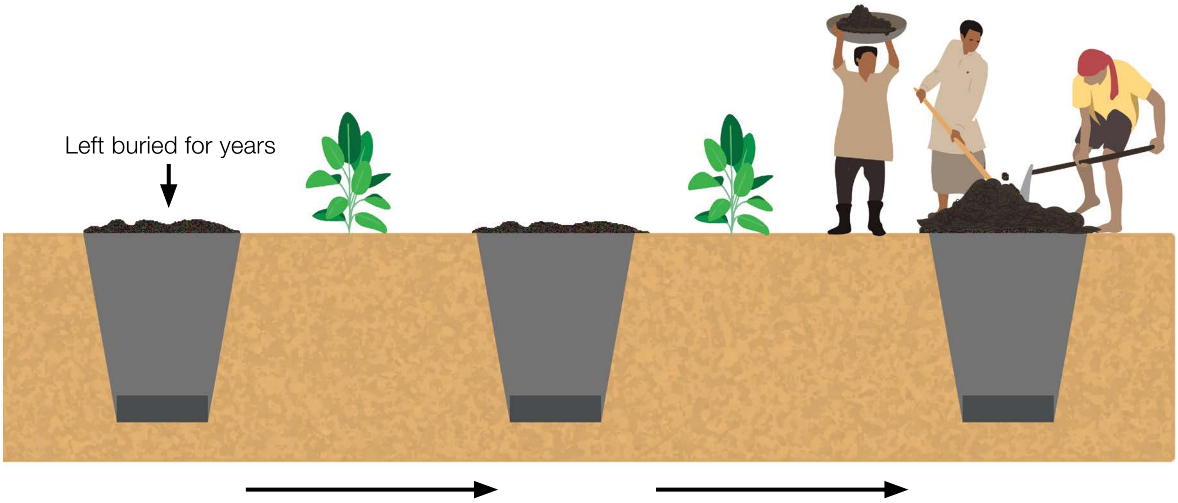

**Figure 3:** Typical Plan of a Trenching Site



### Operational Details

The practice of deep row entrenchment involves placement of faecal sludge into trenches and covering it with a thin layer of soil after each application. Once filled to the desired height, usually 0.3 m from the top, the trench should be covered with a soil layer to avoid odours and to maintain a favourable environment for digestion and dewatering. The filled-up area can be left open for future reuse or planted with particular species of plants (e.g., eucalyptus, acacia, poplar) that have high nutrient consumption rates. Storage of biosolids within the trench for longer duration results in transformation of biosolids into stable soil-like media with good nutrient value.




## 4.3 Financial Details

### Capital Cost

There is no requirement of any construction or equipment installation for this technology, however, the site needs to be protected from animals entering and trespassing. The capital investment required for application of this technology is primarily for a) land formation, b) excavation, c) fencing of the site, and d) construction of internal roads for manoeuvring of the trucks off-loading sludge, if required.

### Operational Cost

The technology does not require any consumables, any specific operation schedule, etc. Hence, the operational cost is also very low, including cost of excavation every three months. Expenses that need to be considered while estimating the operational costs are given in Table 5.

**Table 5:** Operational Costs for Deep Row Entrenchment

| Sr. No | Description | Frequency |
|---|---|---|
| 1 | Excavation of trenches | Trenches to be excavated once in a quarter/month |
| 2 | Backfilling of trenches with excavated material (0.3 m thickness) | Twice a month (Once a trench is filled) |
| 3 | Plantation on trench bunds | Once a month (Done at the same time as backfilling) |
| 4 | Removal of stabilized sludge from trenches | Once in two years (Manure can be auctioned) |

## Case Study – Trenching

**Land application of faecal sludge at the outskirts of Bengaluru, Karnataka[3]**

In Bengaluru, on site sanitation technologies like septic tanks are common in conurbation and rural areas, where a sewerage network does not exist. Due to the lack of regulations and resources, the authorities are unable to meet the demand of septage collection or management. This is where the private service providers and farmers in Bengaluru stepped in to provide an economical model for septage management.

A private mechanized truck for emptying septic tanks charges around Rs.1500 per trip and can do five trips a day. One truck can service a population of 20,000 assuming a two year pit emptying cycle. Farmers in Bengaluru provide land (compost pits dug by them) to these private trucks for disposal, and in lieu get free compost.

**Deep row entrenchment – An interim solution in Odisha[7]**

In Odisha, deep row entrenchment is being promoted as a temporary solution for safe disposal of faecal sludge. For towns with available land and a need for temporary disposal of faecal sludge, deep row entrenchment has proven to be a viable solution.

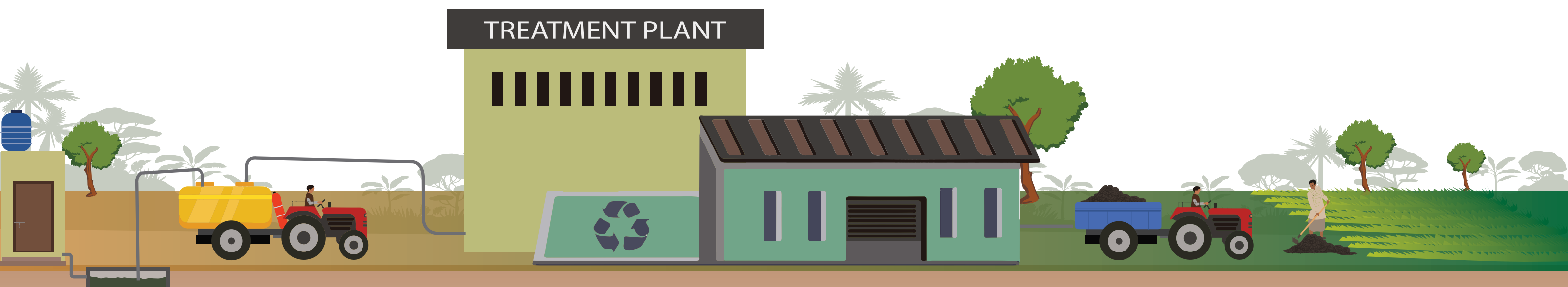


**Figure 4:** Filling of a Trench by Vacuum Truck (L) and a Partially Filled Trench (R)

Eighty-four towns in Odisha have functional deep row entrenchment sites and several other towns are in the process of adopting this intervention as an interim measure before moving to faecal sludge treatment plants.

Prior to implementation of deep row entrenchment in Odisha, no interim solutions were used for safe disposal of faecal sludge. This waste was disposed of in agriculture fields and had a negative impact on health due to the contamination of crops.

The following steps were undertaken for implementation of deep row entrenchment in Odisha:

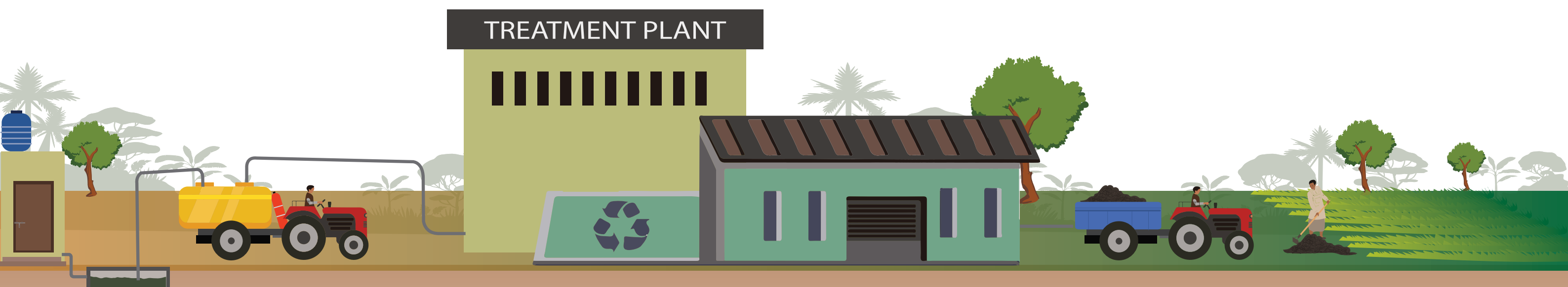
- Quantification of septage generated
- Estimation of cost of implementation and upkeep
- Development of guidelines for site selection
- Development of model design for deep row entrenchment
- Monitoring mechanism to ensure disposal at designated site

Chapter 5

# Unplanted Sludge Drying Beds (UPDB)

The unplanted sludge drying bed is a simple open tank filled with graded gravel and having sand on top, which when loaded with sludge collects the percolate at the bottom of the tank and allows the sludge to dry by evaporation at the top. The percolates are collected at the bottom of the tank through underdrain pipes/channels. The solids in the sludge are retained on the surface of the filter media along with 20–50 per cent of the liquid, whereas about 50–80 per cent of the liquid drains through filter media as percolate water. The dried sludge and the percolate collected are further treated to meet the required discharge standards prior to disposal or reuse.

Source: https://cddindia.org/wp-content/uploads/FSTP-guidance-document-2021.pdf



# 5.1 Feasibility

## Geographical Requirements

### a. Climatic conditions

- Higher temperature (mesophilic range) helps to digest and dry the sludge faster
- Higher temperature in combination with low humidity and high winds enhances drying through evaporation
- Heavy rainfall in the project area may increase the moisture content and cause inconvenience in removing the bio solids. A typical practice is to cover drying beds with a transparent roof to avoid rainwater intrusion and ensure drying
- Heavy rainfall may also cause flooding of the project area, which may be a nuisance. The selected area should not be prone to waterlogging

### b. Site selection

- Adequate land should be made available based on the expected quantity of faecal sludge. The minimum area required for construction of a treatment facility is approximately 80 to 120 sqm/cm
- The location of the treatment site should be at least 200 m away from habitations and, preferably, a minimum of 100 m away from nearby water bodies
- The FSTP plant should not be in an area that is prone to waterlogging or flooding. It is prescribed that the ground formation level of the treatment plant be kept above the recorded flood level
- The treatment site should be easily accessible from the main road via a pucca road
- The movement of vehicles offloading contents of cesspools should not cause a nuisance in the neighborhood
- The selected site should have all the required clearances for land and establishment of the system from the concerned authorities, including the State Pollution Control Board and revenue department

## Appropriateness of the Technology

### Advantages

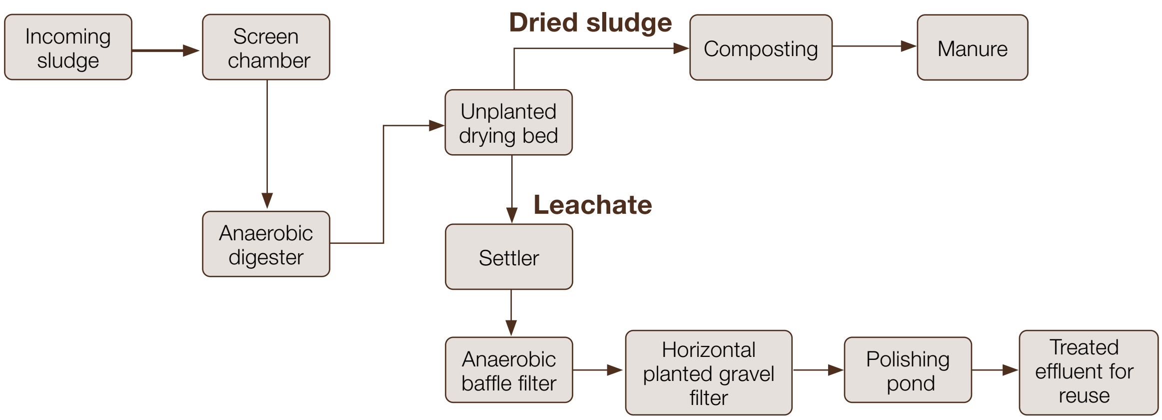
- Simple and easy to construct with locally available material
- Low capital and operational cost
- Does not require any electromechanical equipment for the treatment
- Simple operations and maintenance

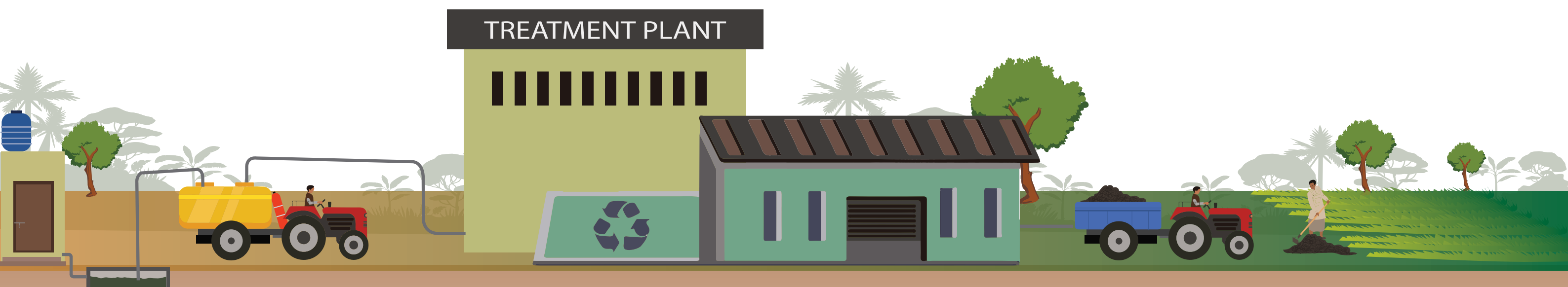
### Limitations

- Needs labour for regular removal of dried sludge prior to application of fresh sludge
- Both incoming and dried sludge are pathogenic and hence require adoption of safety measures during handling
- Dried sludge as well as effluent collected from the filter bed require further treatment prior to disposal/reuse
- Odors and flies may be noticeable
- Requires expert design and construction

# 5.2 Technical Details and Layout Planning

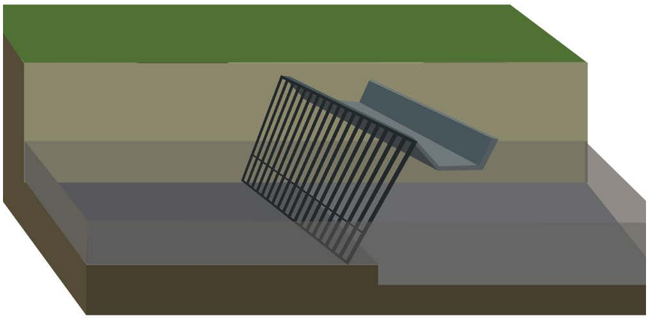
**Figure 5:** Typical process diagram of FSTP based on unplanted sludge drying bed



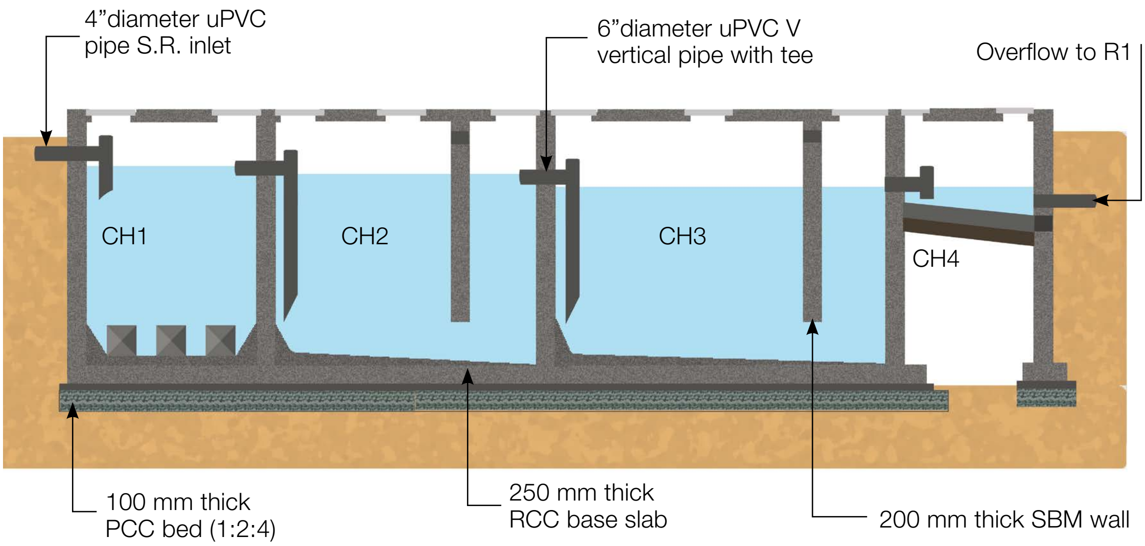
Based on existing FSTPs in India, a model treatment for leachate has been demonstrated in Figure 5. Any other technology or a combination of technologies can be adopted from SBM Phase-II guidelines or Greywater Manual. The FSTP may be co-located either with a greywater treatment system or with a plastic waste management unit to share the expenditure on O&M.  If co-located with the greywater treatment system, treatment of leachate with greywater can be considered (considering the necessary design parameters).

### a. Screen chamber



This is a physical method of separating solid waste and inorganic solids such as plastic, cloth, sand, slit, etc. from faecal sludge to prevent clogging of subsequent treatment modules. It also enhances the value of the treated end products. A screen chamber uses a series of vertical screen bars made from mild steel and coated with anti-corrosive paint for this purpose. The trash is collected by manually scraping the screen bars with a rake or similar arrangement.

### b. Anaerobic digester




The liquid sludge (mixture of liquid and solids in slurry form) from the screen chamber is further conveyed to an anaerobic digester, also called, sludge stabilization reactor, for treatment. The main objective of this treatment system is separation of degradable organic substances and for improving its dewatering ability.

The tank has four chambers. The first chamber of the stabilization reactor acts as a homogenization reactor, where the organics are mixed thoroughly. The second and third chambers provide a digestion zone for anaerobic treatment of organics present in the faecal sludge. The fourth chamber is designed to collect and retain digested sludge for one day and pump it to the unplanted sludge drying bed.

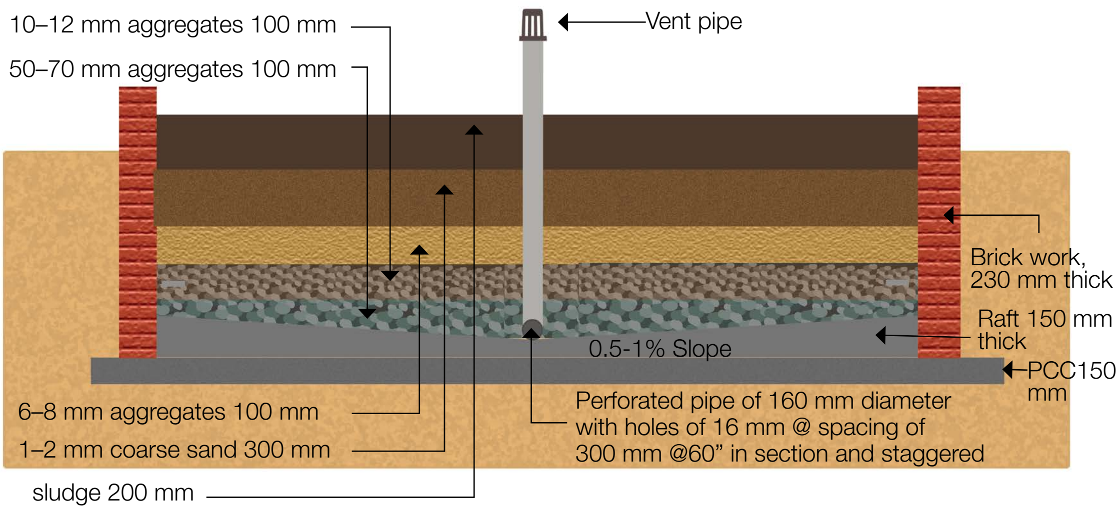
- Number of chambers: 3–4
- Sludge depth: 2–2.5 m
- Sludge retention time: 7–10 days

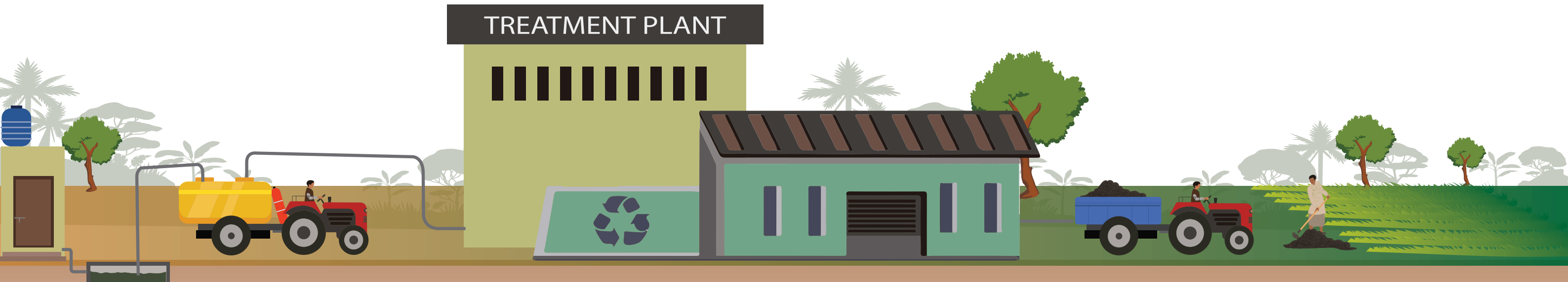
### c. Unplanted sludge drying bed

A sludge drying bed allows water to percolate so that the solids remain at the top, where they dry by evaporation. The percolate water is collected at the bottom of the beds through perforated pipes (underdrain). The sludge should be applied in layers that are a maximum of 30 cm, or the sludge will not dry effectively. The sludge drying area (area of each bed x number of beds) required will depend on the depth of sludge loading and days taken to dry. The drying period should be determined based on the local climatic conditions and requisite soild/moisture content.

- Number of beds: 10–12 beds
- Sludge thickness: 20–30 cm
- Desludging period: 12–15 days

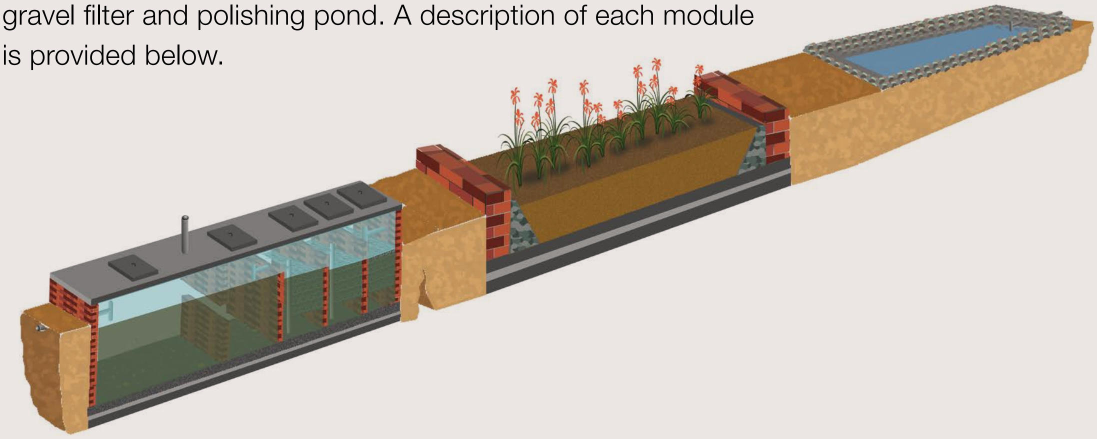
**Figure 6:** Section for Unplanted Sludge Drying Bed



**Percolate treatment**

Liquid percolated from the bottom of the sludge drying bed undergoes treatment through a series of treatment units – settler, anaerobic filter, horizontal planted gravel filter and polishing pond. A description of each module is provided below.



**Integrated settler and aerobic filter**

### d. Settler

The settler is made as a sub soil, watertight constructed tank with two chambers. Here, two main treatment processes take place – sedimentation and sludge stabilization through a biological treatment process. The digestion process ensures that the accumulated sludge is reduced and stabilized. The design parameters commonly adopted are as follows:

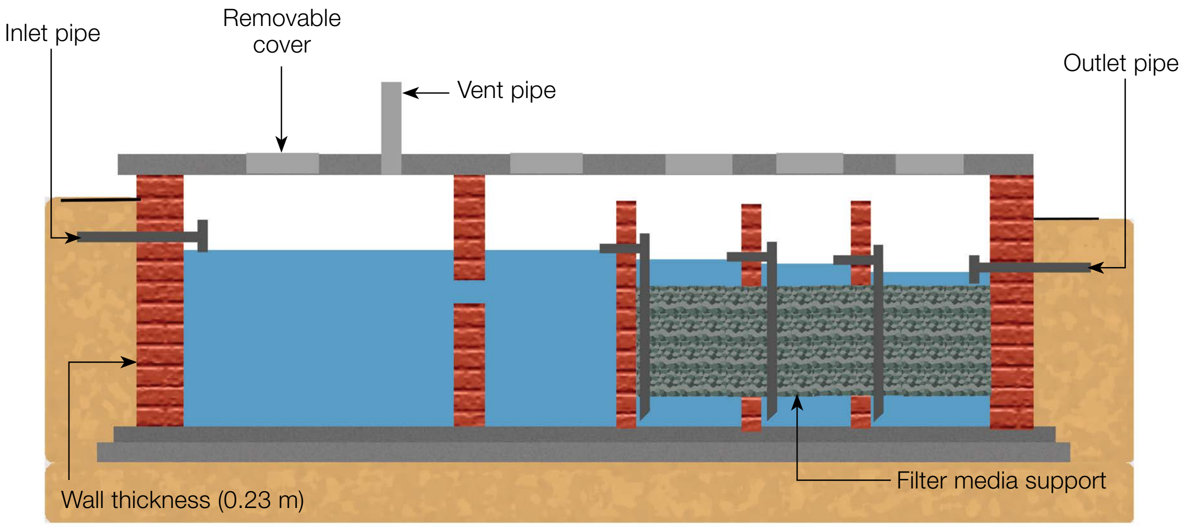
- Hydraulic retention time (HRT): 1.5–2 hours
- Dimensions: water depth – 1.5–2.0 m, length and width ratio to be 2:1 to 3:1 to ensure effective settling of suspended solids
- Treatment efficiency – 20–30 per cent of BOD removal
- Desludging period – 18–24 months

### e. Anaerobic filter (AF)

Based on the influent organic concentration from the settler, as well as to ensure better effluent standards for final disposal, the settler is integrated with a fixed bed anaerobic filter (AF), which consists of a series of chambers in which filter media are provided. As the water flows up-stream through the filter media in the chambers, it comes in contact with the active bacterial mass which grows on the filter media (carrier). The anaerobic bacteria present in the filter media, make use of the pollutants for their metabolism, degrading the organic material present in the leachete. The design parameters commonly adopted are as follows:

- Hydraulic retention time (HRT): 1–2 days
- Dimensions: Water depth – 1.8–2.0 m
- Treatment efficiency: 70–90 per cent of BOD removal
- Desludging period: 18–24 months

**Figure 7:** Section of Anaerobic Baffle Reactor




### f. Horizontal planted gravel filter (HPGF)

The working of a horizontal planted gravel filter is similar to that of a constructed wetland. It is a shallow tank filled with graded gravel or pebbles as filter media, and planted with emergent plants. The main removal mechanisms are biological conversion, physical filtration and chemical adsorption. Plants commonly used are *canna indica, reed juncus, phragmites,* etc. The plants help in the uptake of the nutrients from the leachate. The following criteria are applied to the design of the HPGF

- Organic loading for cross-sectional area: 150 g/m$^2$ of BOD
- Organic loading for surface area: 10 g/m$^2$ of BOD
- Hydraulic retention time (HRT): 2–3 days
- Filter height: 0.5–0.6 m
- Treatment efficiency: 70–90 per cent of BOD removal and 80–90 per cent removal of pathogens

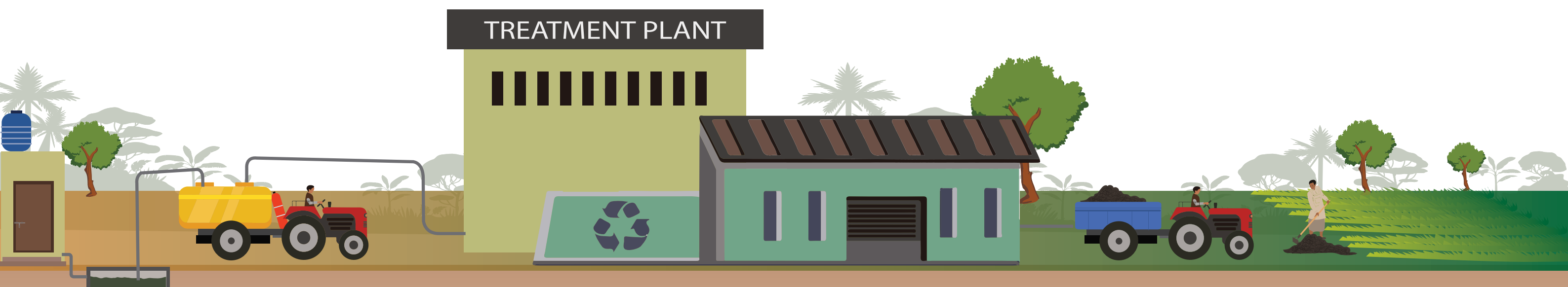
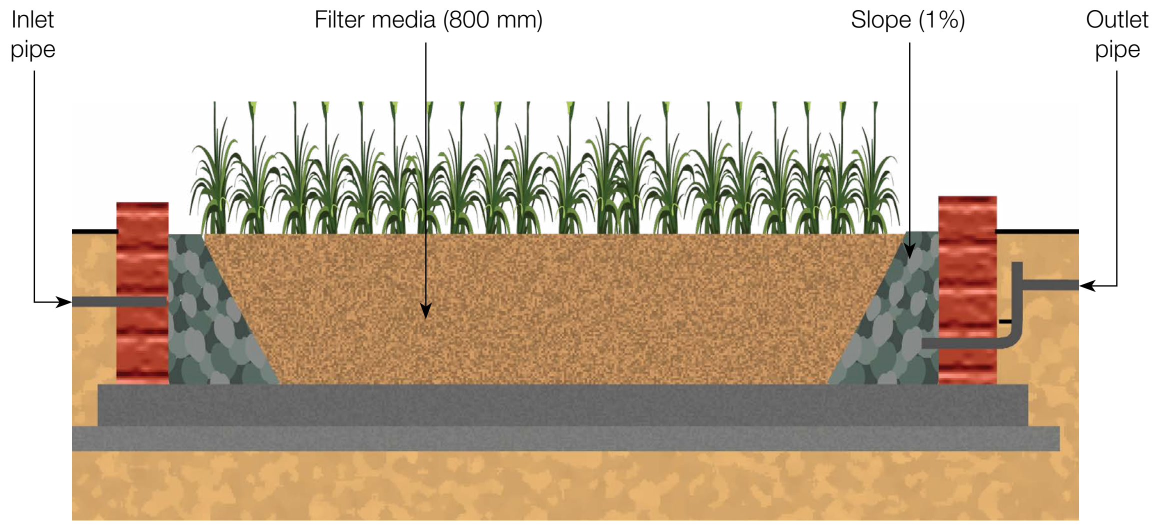


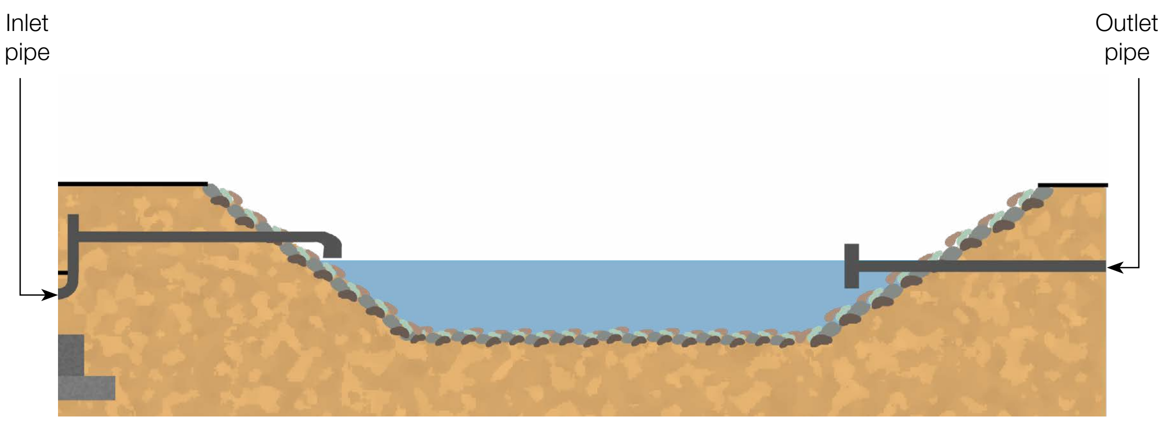
**Figure 8:** Section of Horizontal Planted Gravel Filter




### g. Polishing pond

A polishing pond is a shallow pond where the microbial action takes place in the presence of oxygen and sunlight. Its primary function is to remove pathogens and odour. Retention time provided for a polishing pond is usually 1–3 days and the depth of the pond is restricted to 0.5–1 m.

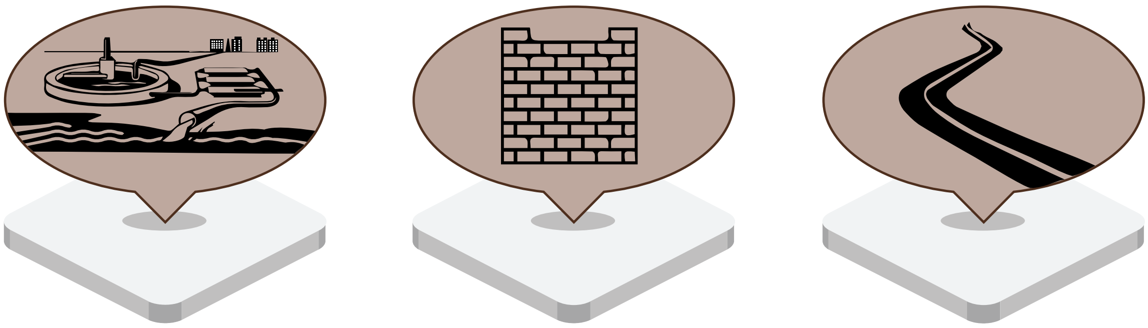
**Figure 9:** Section of Polishing Pond




## Layout Planning

1. Layout planning is site specific, which ensures optimized use of land. Contouring of the site should be carried out before fixing of the layout. A detailed topographical survey should be be carried out before the layout is fixed

**Three Important Components of the FSTP that should be Identified by Layout Planning**



**Treatment units:** Treatment includes the screen chamber, anaerobic digester, unplanted drying beds, settler, anaerobic filter, horizontal planted gravel filter and polishing pond

**Civil structure:** Road, storm water, boundary/protection wall, office building, sludge storage area

**Other infrastructure:** Access road/external road

2. The placement of treatment modules should follow the ground slope of the site to ensure gravity flow of sludge across the treatment modules. The proposed hydraulic flow is as follows: screen chamber -> anaerobic digester -> unplanted drying beds-> settler-> anaerobic filter -> horizontal planted gravel filter -> polishing pond
3. The vacuum truck (both tractor/truck based) should have access up to the screen chamber for disposing of the sludge
4. As the beds rely on evaporation, the site should be planned so as to keep any shadows from covering the beds
5. Circulation space should be provided across the unplanted drying beds to make the emptying of beds easier. It should be noted that emptying will take place every 12–15 days, depending on local climatic factors
6. Inspection chambers/registers should be provided across the drainage channel/pipe from the beds to the leachate treatment facility
7. An overflow arrangement from the polishing pond should be provided for disposal of excess water. An alternate arrangement should be provided to use the water for landscaping on site

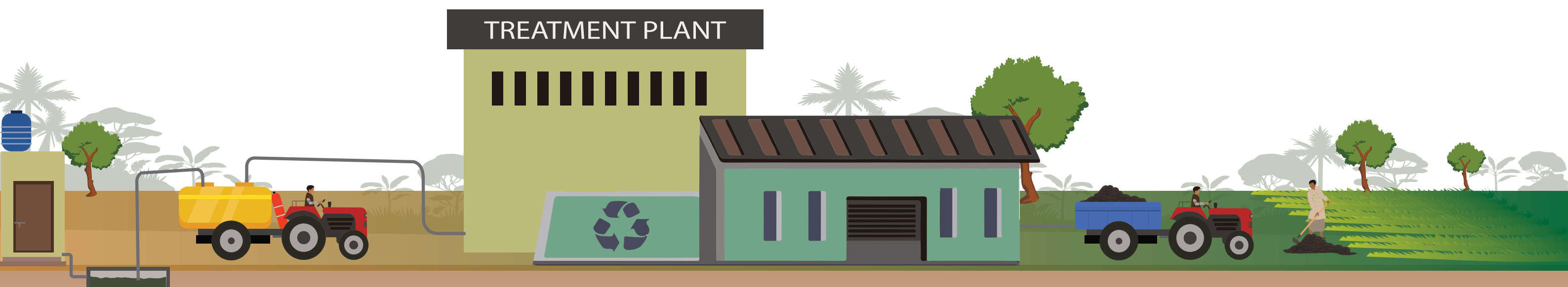
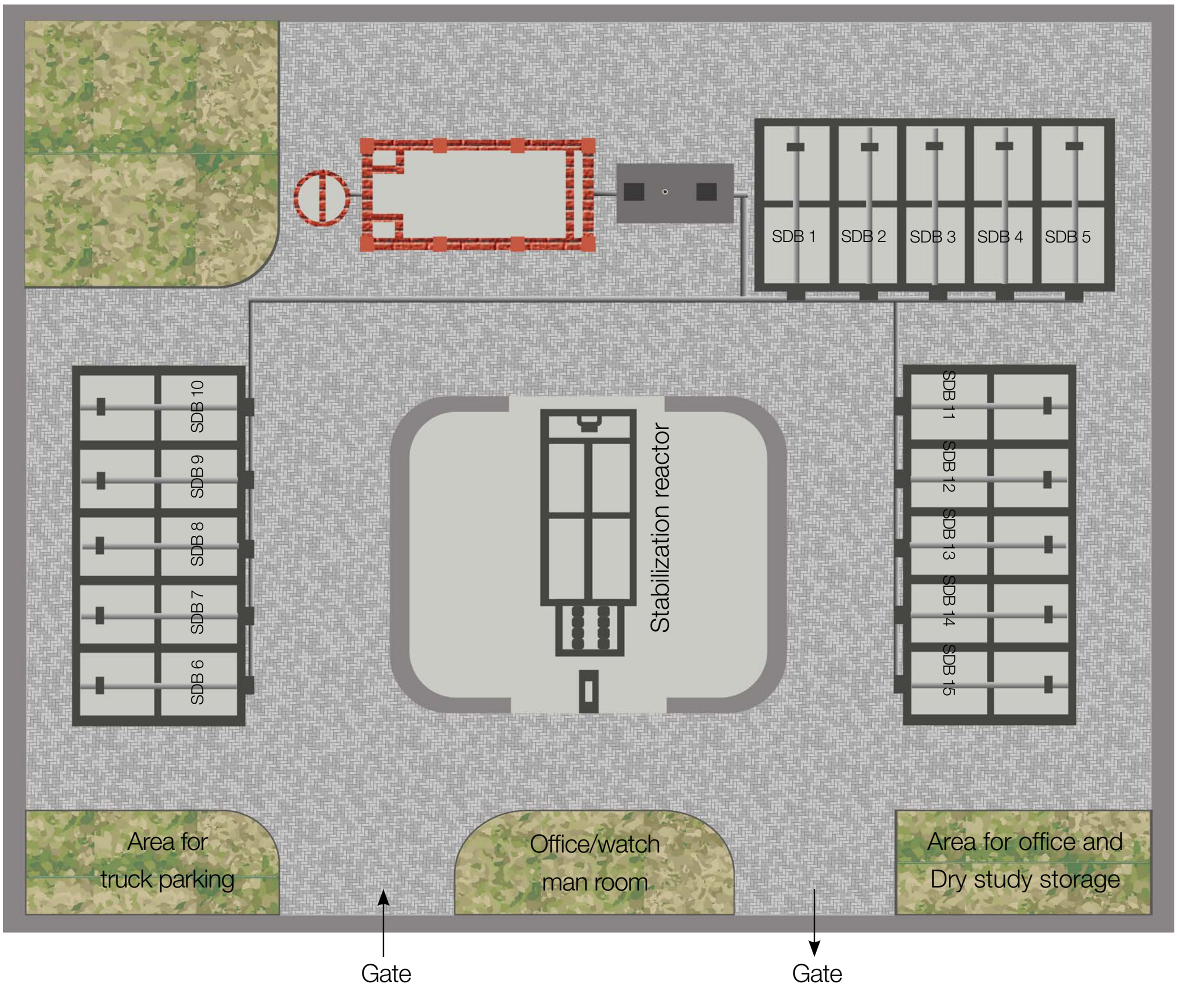


**Figure 10:** Layout for FSTP Based on Unplanted Drying Beds




## Operational Details

An unplanted sludge drying bed is one of the simplest and oldest techniques for dewatering sludge. It is a simple open tank filled with graded gravel and topped with sand, which when loaded with sludge collects the percolated water at the bottom of the tank and allows the sludge to dry by evaporation from the top. The percolates are collected at the bottom of the tank through underdrain pipes/channels. The solids in the sludge are retained on the top surface of the filter media along with 20–50 per cent of liquid, whereas about 50–80 per cent of the liquid drains through the filter media as percolated water. The dried sludge requires further treatment (sun drying/co-composting/storage). The percolate collected must also be subjected to further treatment to meet the required discharge standards, prior to its disposal or reuse.

Considering the working principles of unplanted drying beds (regular emptying of dried sludge), this technology is mostly preferred and adopted for treatment of higher volumes of faecal

sludge. In the rural context, this system can be proposed for a cluster of villages producing more than 3–4 truckloads of faecal sludge per day, i.e. more than 12 cum.

## 5.3 Financial Details

The construction costs required for the FSTP need to be arrived at based on site specific designs and construction specifications adopted. The capital cost per kld varies from 4–5 lakh for treatment units. Additional requirements need to be considered for civil structures such as a boundary wall, internal road, storm drainage within the site. The O&M costs are based on the size of the plant and per capita costs usually vary between Rs. 15–25/capita/annum.

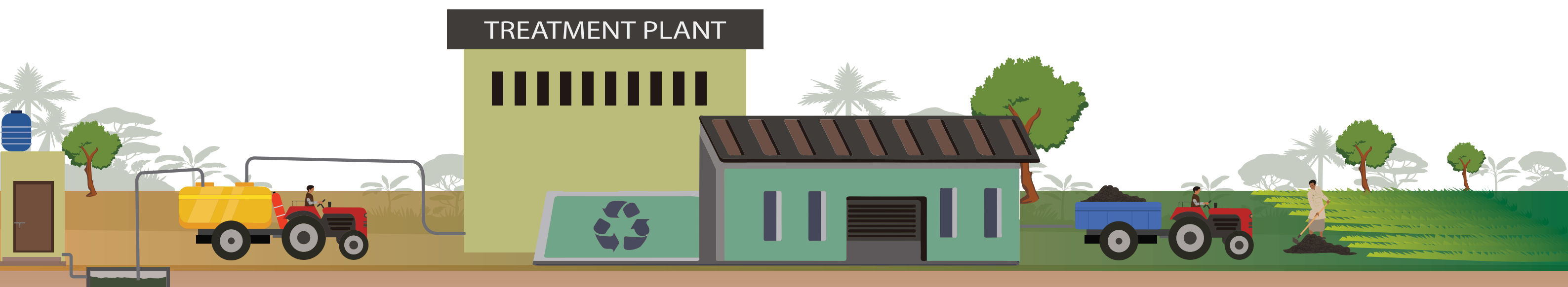
### Case Study – Faecal Sludge Treatment in Karunguzhi

Karunguzhi is a town panchayat in Kancheepuram District. In order to demonstrate the principles and operational requirements of septage management, a plant to treat faecal sludge was constructed in the town. The details of the town and the treatment plant are as given below:

- Quantity of septage to be treated – 23 kld
- Area of plant – 6070 $m^2$
- No. of loads per day – 6–7 loads of 3 $m^3$ each
- Expected no. of households dependent on the plant – 10,000

The plant is designed to treat the septage generated in Karunguzhi TP and Madhuranthagam Municipality. The DPR was prepared by the Directorate of Town Panchayats (DTP) and submitted to the Tamil Nadu Urban Finance and Infrastructure Development Corporation (TUFIDCO) appraisal committee. The Tamil Nadu Water Supply and Drainage Board (TWAD) provided technical review and approval and was also responsible for the implementation of the project. TWAD was also responsible for the O&M of the plant for a year from the date of its commencement.

The FSTP is built on land measuring 6070 $m^2$ and is expected to treat septage collected from about **3,000 households** in Karunguzhi, and about **7,000 households** in Madhuranthagam. The cost of the FSTP is Rs. 490 lakh.



Desludging trucks empty raw septage into the drying beds through an inlet chamber. The inlet chamber is fixed with a screen, so that grit and other coarse particles are removed. There are 20 sludge drying beds within the site. The dried sludge is removed and stored in the sludge storage yard. The leachates (liquid percolated from the sludge) passes through stoneware pipes to the horizontal planted gravel filter. This filter is filled with graded gravel and pebbles as filter media. Canna Indica and coral reeds are planted over the filter media. The effluent is later sent to a maturation pond for tertiary treatment. The treated effluents are then stored in a filtrate sump and used for gardening. A resource recovery park has been set up in Karunguzhi, where the dried sludge from the FSTP is being co-composted using the windrow composting method with the solid waste from the TP. There are plans to sell this as agricultural fertilizer. A schematic along with unit sizes adopted in the treatment plant is given in Figure 10.

Chapter 6

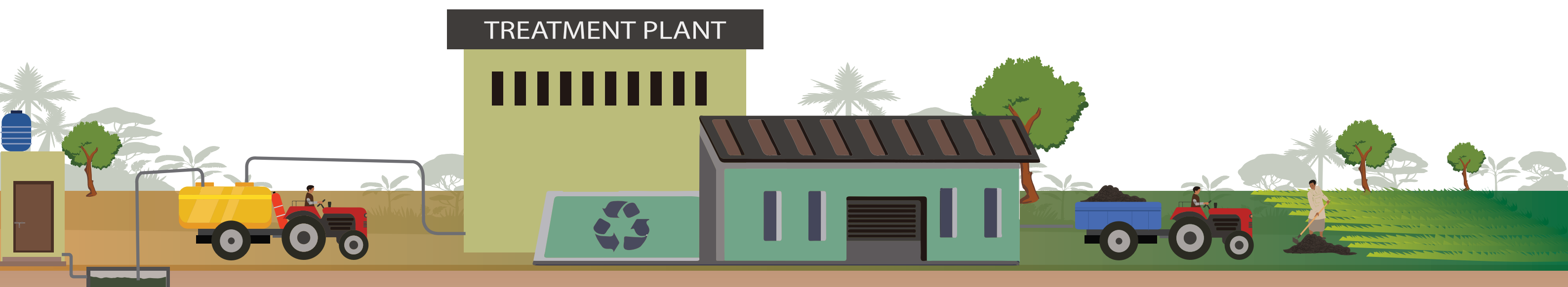
# Planted Drying Beds

A planted drying bed (PDB) is a simple drying bed filled with layers of gravel having a sand layer on top (graded filter media) and suitable plants (emergent microphytes). The sludge is put on the top sand layer, allowing water to percolate through the media with the solids being retained at the top. The bed is loaded repeatedly at fixed intervals, e.g., once a week, allowing dewatered solids to accumulate over a period of time. The solids are allowed to dry through evaporation and evapotranspiration (from the plants) and get stabilized in the process through multiple physical and biological mechanisms. The percolated water collects at the bottom of the bed through an underdrain.

PDBs are designed with multiple (6–10) beds that are loaded sequentially with layers of sludge once in 6–10 days depending on local climatic conditions. The in-between period is known as a resting period, which ensures adequate drying of sludge with sufficient crack formation necessary for percolation of liquid from the next loading. The faecal sludge is loaded upto 10–15 cm depth per load onto a PDB bed, where it accumulates for several years (2–3 years) depending on the loading rate, the capacity of the system and mineralization rates. Meanwhile the percolate is treated separately in a liquid treatment facility, for e.g. DEWATS.

The volume of sludge on the PDB declines continuously (through moisture loss and degradation), and the plants roots maintain porosity within the sludge layer, thereby significantly reducing the need for regular sludge removal compared to unplanted drying beds (which require sludge removal every 12 to 15 days).


Source: https://cddindia.org/wp-content/uploads/FSTP-guidance-document-2021.pdf



A PDB is one of the most preferred options due to the simplicity of its operation and maintenance requirements as well as its efficient performance. Mostly, the PDB option is adopted for treatment of small volumes of well or partially digested faecal sludge which is 4–6 kld. Also, this system is mostly preferred where sludge coming into the treatment facility is not regular.

## 6.1 Feasibility

### Geographical Considerations

#### a. Climate conditions

- Higher temperatures (mesophilic range) helps to digest and dry the sludge faster
- Higher temperatures in combination with low humidity and high winds enhance drying through evaporation
- Heavy rainfall in the project area may increase the moisture content in the bed, resulting in the requirement of a higher volume of leachate treatment. PDBs can be covered with a transparent roof to avoid rainwater intrusion, if required
- Heavy rainfall may also cause flooding of the project area which may create a nuisance. The treatment location should not be prone to waterlogging

#### b. Site identification

- Adequate land should be made available based on the per day discharge volume. The land required for construction of a treatment facility is approximately 70–100 sqm/cum
- The location of the project site should be at least 200 m away from the nearest habitation, preferably near a forest area or agricultural fields and a minimum of 100 m away from any nearby water sources
- The FSTP plant should not be in areas that are prone to waterlogging or flooding. It is prescribed that the formation level of the plant be kept above the recorded flood level
- The treatment site should be easily accessible from the main road via a pucca road
- The movement of vehicles emptying sludge into the PDB should not cause a nuisance for the neighborhood

The selected site should have all the required clearances for land and establishment of the system from the authorities concerned, including the State Pollution Control Board, Revenue Department, Drainage Department, etc.

## Appropriateness of the Technology

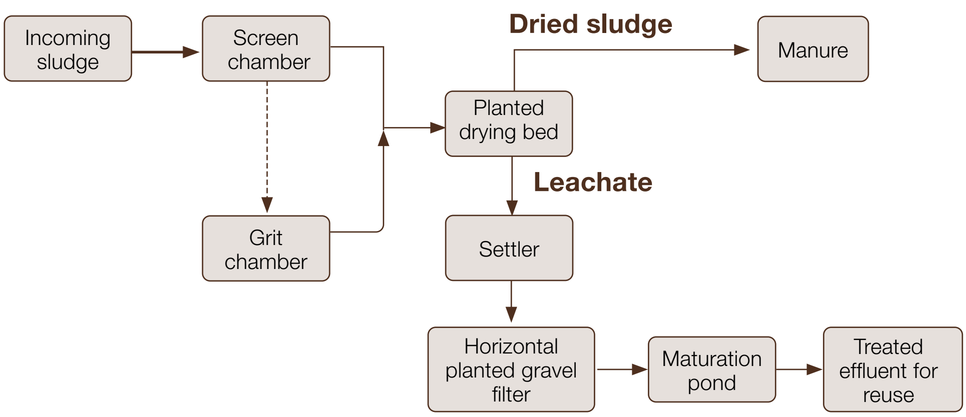
### Advantages

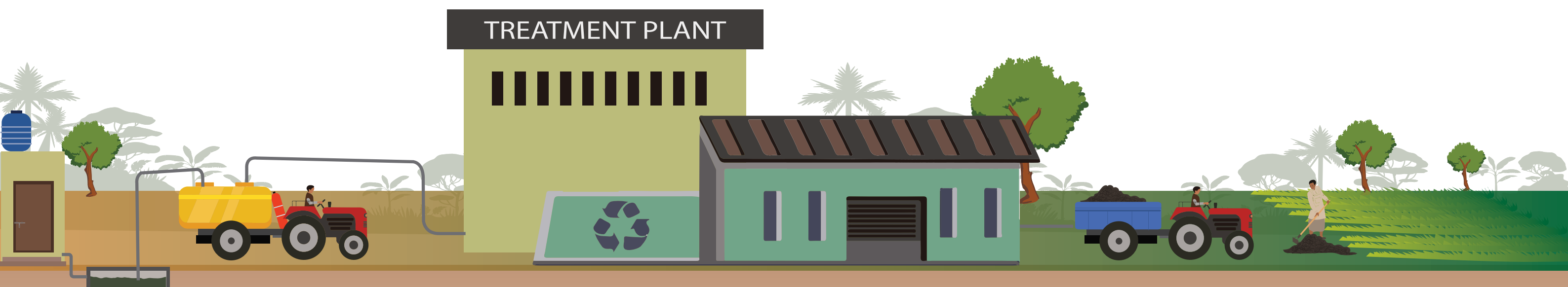
- Least area required in comparison to UPDB and DRE
- Simple and easy to construct with locally available material
- Low capital and operational cost
- Does not require any electromechanical equipment for the treatment
- Simple O&M
- Can handle variable organic and hydraulic loading as compared to unplanted sludge drying beds
- Does not need to be desludged after each feeding cycle, hence fresh sludge can be applied over the previous layer
- Plants maintain the porosity of the filters through their rooting system to ensure easy percolation of liquid through filter media

### Limitations

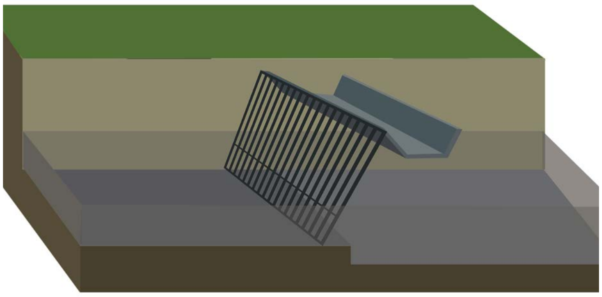
- Dried sludge as well as effluent collected from the filter bed requires further treatment prior to disposal/reuse
- Odours and flies may be noticeable
- Plant growth is affected in dry climatic regions due to moisture stress and high concentration of salts resulting from application of sludge
- Requires expert inputs for design and construction
- Requires proper resting time for single beds after each loading

# 6.2 Technical Details



### a. Screen Chamber

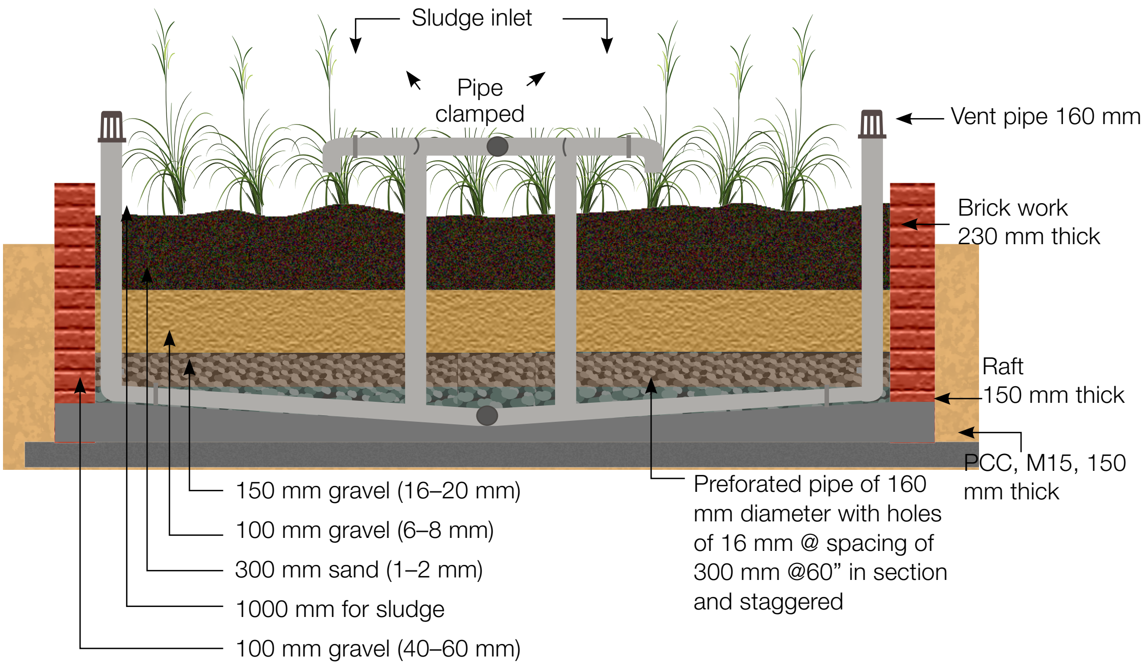


This is a physical method of separating solid waste and inorganic solids such as plastic, cloth, sand, slit, etc. from faecal sludge to prevent clogging of subsequent treatment modules. It also enhances the value of the treated end products. A screen chamber uses a series of vertical screen bars made from mild steel and coated with anti-corrosive paint for this purpose. The trash is collected by manually scraping the screen bars with a rake or similar arrangement.

### b. Planted sludge drying bed

Faecal sludge is applied on to planted drying beds (PDBs), which are beds of porous media (e.g., sand and gravel) that are planted with plants (emergent macrophytes). Faecal sludge is repeatedly loaded onto PDBs, with up to 10–15 cm of faecal sludge per loading where it accumulates for several years depending on the loading rate, the capacity of the system and mineralization rates. The percolated water, needs further treatment.

- Resting period: 6–10 days
- Number of beds: 6–10
- Sludge depth per loading: 10–15 cm
- Dimensions: sludge depth: 0.75–1.5 m
- Desludging period: 2–3 years

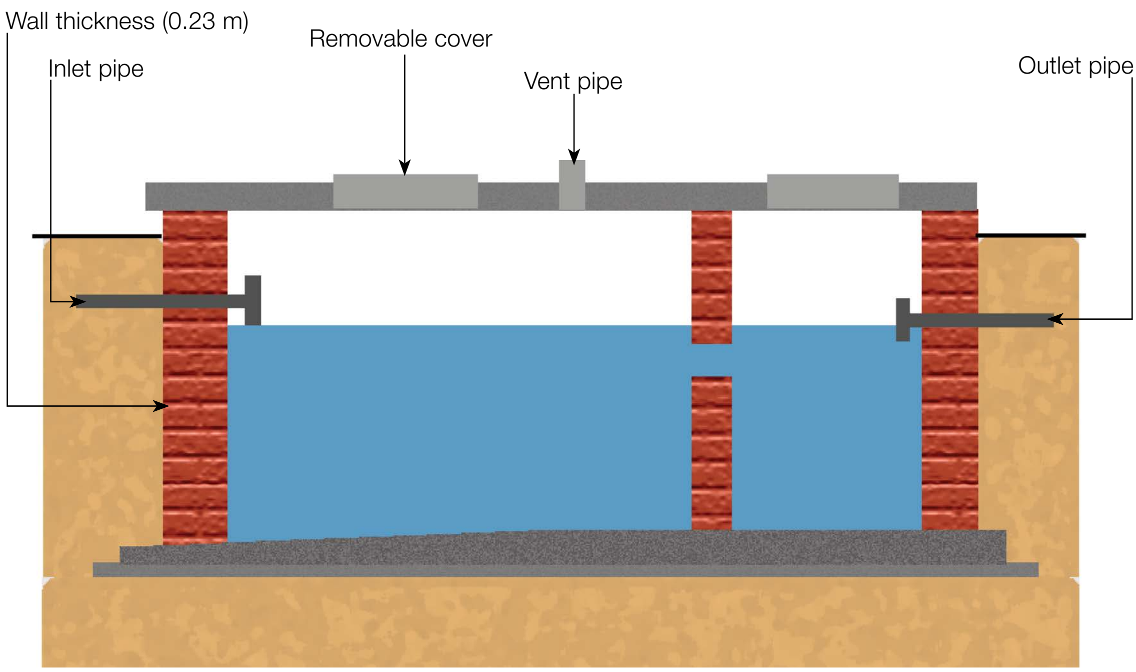



### c. Settler

The settler is made as a sub-soil watertight constructed tank with two chambers. Here, two main treatment processes take place, which are, sedimentation and sludge stabilization with biological treatment process. The digestion process ensures that the accumulated sludge is reduced and stabilized. The design parameters commonly adopted are as follows:

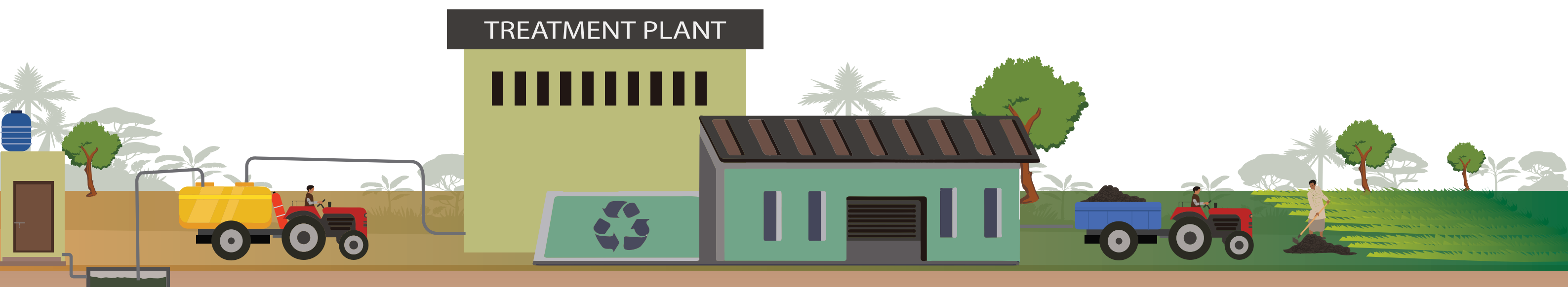
- Hydraulic retention time (HRT): 1.5–2 hours
- Dimensions: Water depth – 1.5–2.0 m, length and width ratio to be 2:1 to 3:1 to ensure effective settling of suspended solids
- Treatment efficiency: 20–30 per cent of BOD removal
- Desludging period: 18–24 months

**Figure 11:** Section of Settler



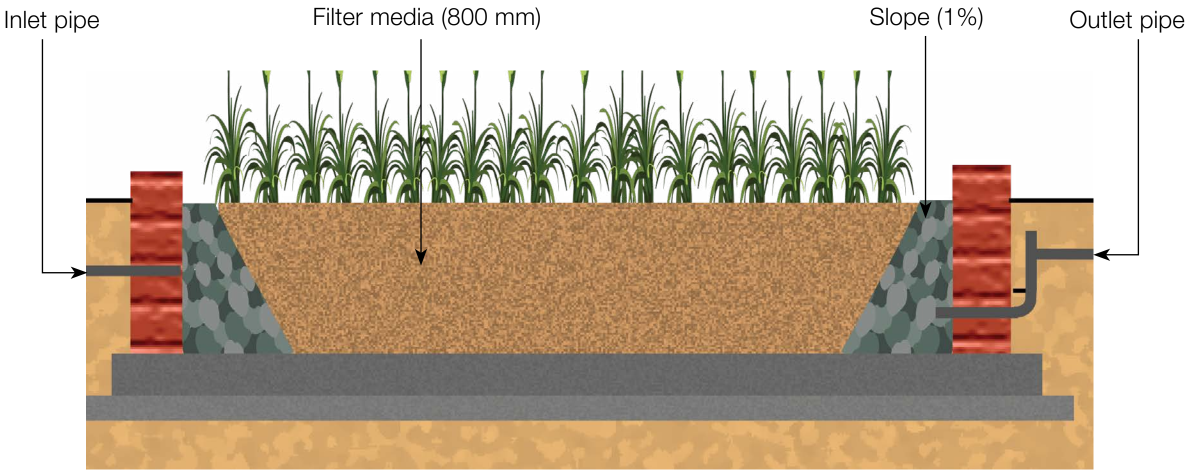

### d. Horizontal planted gravel filter (HPGF)

Working of a horizontal planted gravel filter is similar to that of a constructed wetland. It is a shallow tank filled with graded gravel or pebbles as filter media, and planted with emergent plants. The main removal mechanisms are biological conversion, physical filtration and chemical adsorption. Plants commonly used are canas indica, reed juncas, phragmites etc. Plantation helps in the uptake of the nutrients from the leachate. The following design criteria are applied to the design of an HPGF



- Organic loading for cross-sectional area: 150 g/m$^2$ of BOD
- Organic loading for surface area: 10 g/m$^2$ of BOD
- Hydraulic retention time (HRT): 2–3 days
- Filter height: 0.5–0.6 m
- Treatment efficiency: 70–90 per cent of BOD removal and 80–90 per cent removal of pathogens

**Figure 12:** Section of Horizontal Planted Gravel Filter

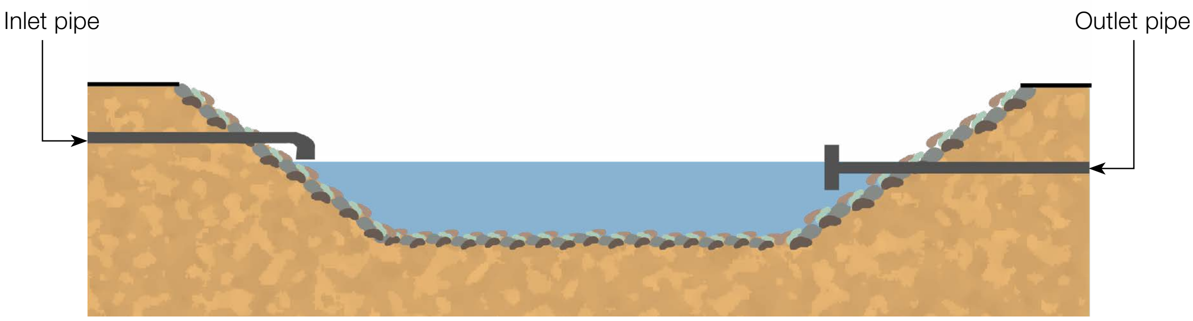



### e. Polishing pond

A polishing pond is a shallow pond where pathogen removal takes place. The main purpose of a pond is oxygen enrichment and elimination of pathogen germs through radiation from the sun. Floating aquatic plants can help to control algal growth and make it a pleasant landscape feature, if desired.

- Hydraulic retention time (HRT): 1–3 days
- Dimensions: water depth – 0.5–1 m

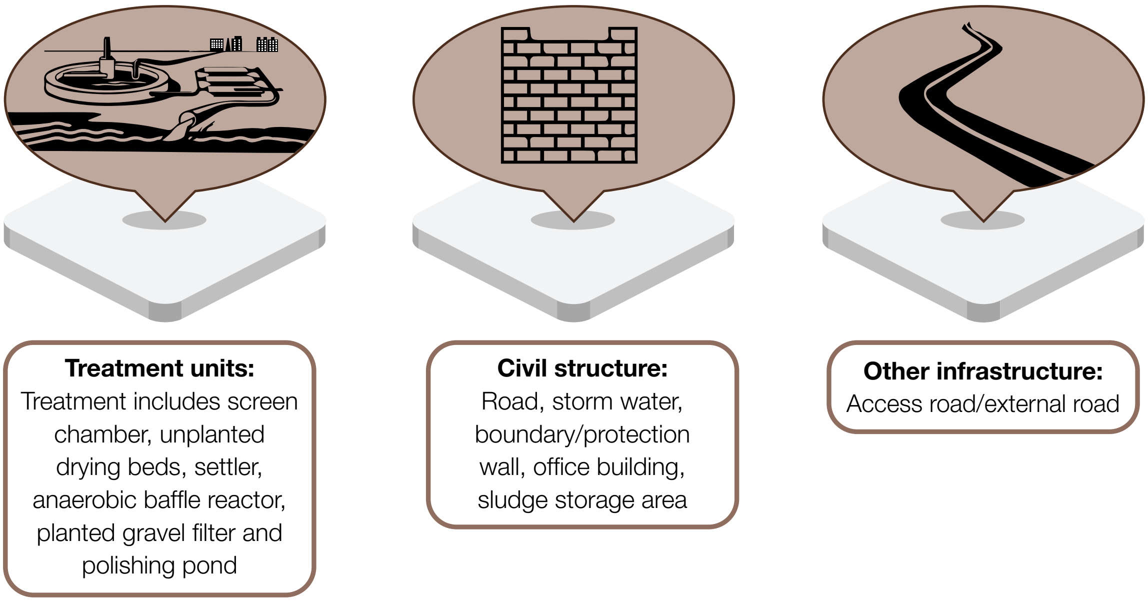
**Figure 13:** Section of Polishing Pond




## Layout Planning

1. Layout planning is site specific and is done to ensure the optimized use of land. Contouring of the site should be carried out before fixing of the layout. A detailed topographical survey should be carried out before the layout is fixed.

**Three Important Components of the FSTP that should be Identified while Layout Planning**




2. The placement of treatment modules should follow the ground slope of the site to ensure gravity flow of sludge across the treatment modules. The proposed hydraulic flow is as follows: screen chamber -> planted drying beds-> settler-> horizontal planted gravel filter -> polishing pond.
3. The vacuum truck (both tractor, truck based) should have access up to the screen chamber for disposing of the sludge.
4. As the beds rely on evaporation, the site should be planned so as to keep any shadows from covering the beds.
5. Circulation space should be provided across the planted drying beds to ease the emptying of beds. It should be noted that emptying will take place every 2–3 years, depending on local climatic factors.
6. Inspection chambers/registers should be provided across the drainage channel/pipe from the beds to the percolate treatment facility.
7. An overflow arrangement from the polishing pond should be provided for disposal of excess water. An alternate arrangement should be provided to use the water for landscaping on site.

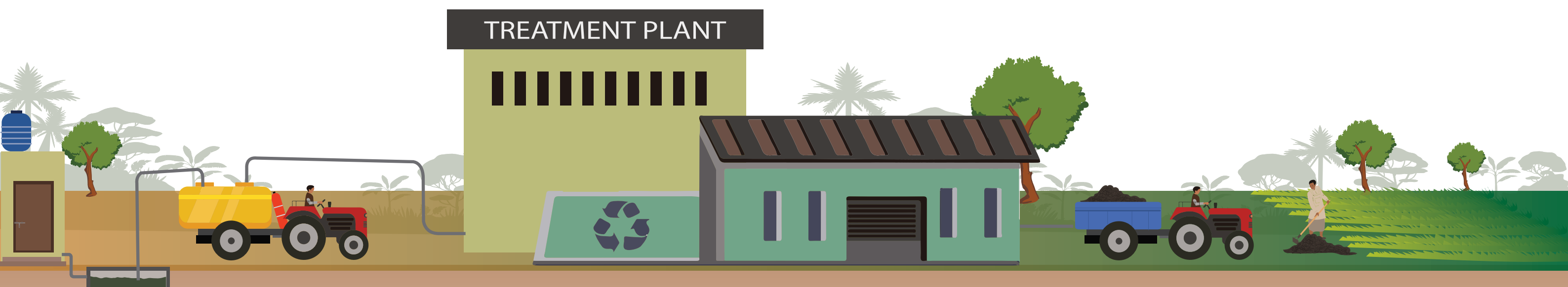
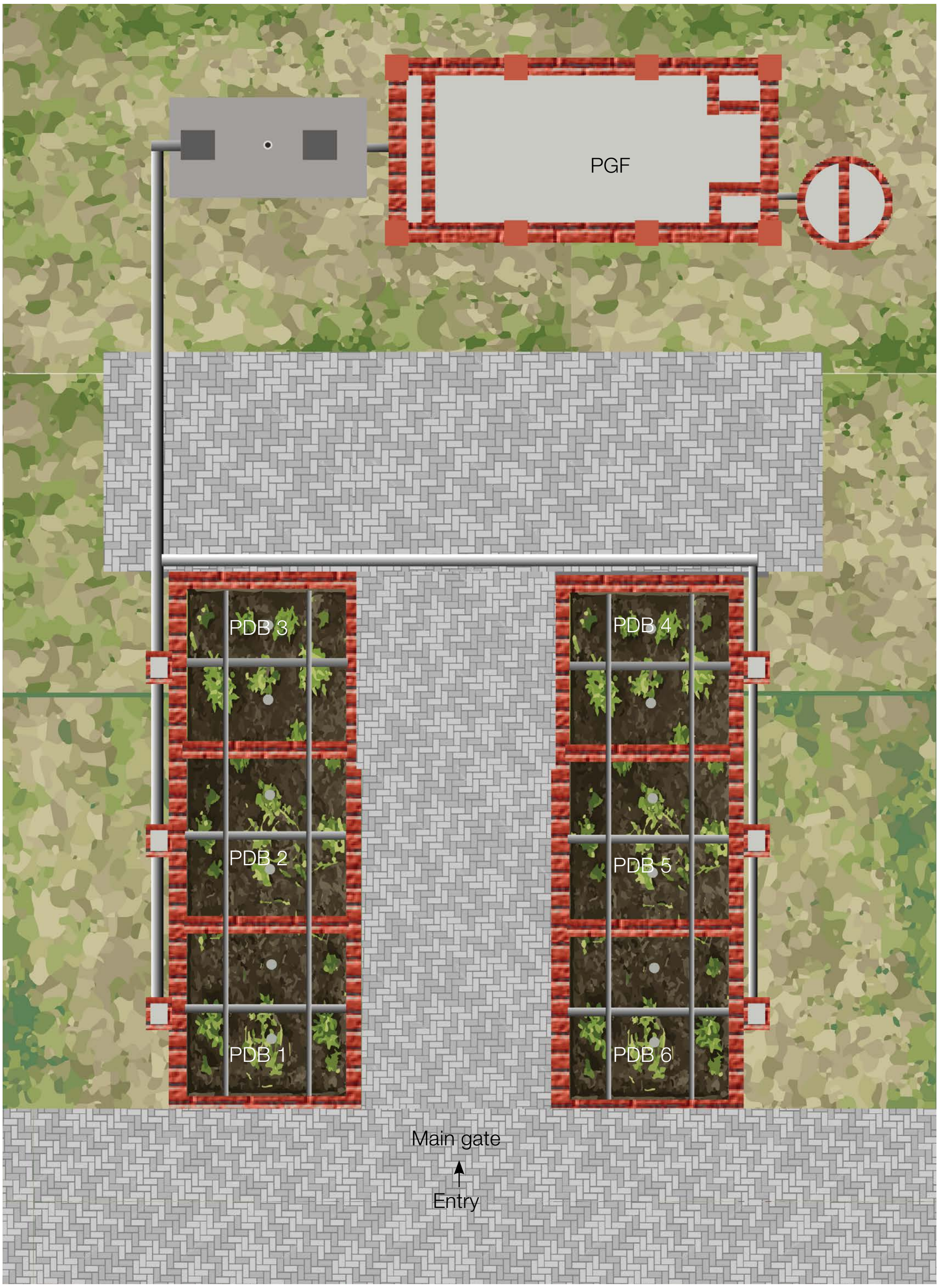


**Figure 14:** Layout for FSTP Based on Planted Drying Beds




**Master Plan**

## Operational details

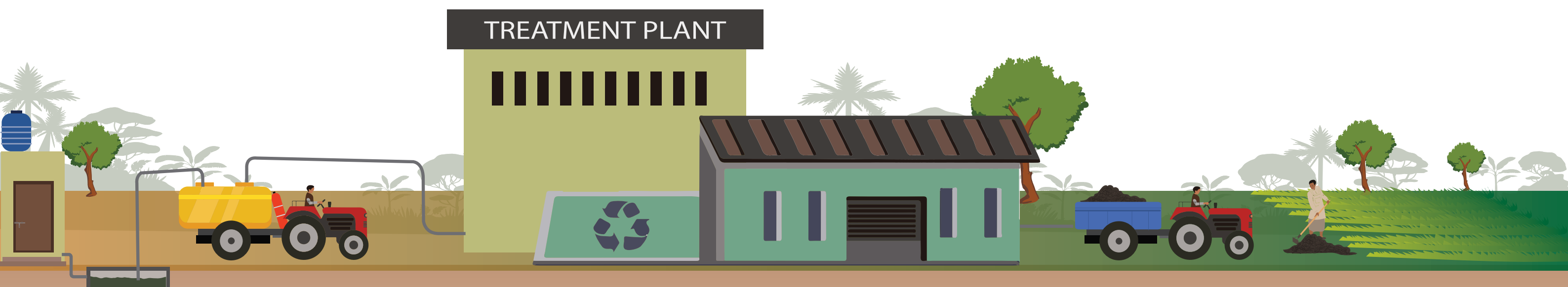
The sludge is disposed of through hose pipes to the PDB where liquid present in the sludge percolates through filter media, called leachate. The percolate collected is further treated in the liquid treatment part of the facility/module, in this case the settler, horizontal gravel filter and polishing pond. Water from the polishing pond can be reused for local landscaping and agriculture while the sludge from the drying beds needs to be emptied. The sludge will require further treatment (sun drying/composting/storage). For liquids any suitable technology can be used considering the organic and nutrient load of percolate produced by the PDB.

# 6.3 Financial Details

The construction costs required for the FSTP need to be arrived at based on site specific designs and construction specifications adopted. The capital expenditure for construction of a treatment unit varies from 3.5–5 lakh/kld. An additional requirement for the civil and other ancillary structure may be required. The O&M cost varies from 10–15 INR/capita/annum.

## Case Study – FSTP at Leh[16&17]

Leh, a high-altitude cold desert located at 12,000 feet in the union territory of Ladakh is a popular tourist destination with about 2,50,000 visitors annually. The city is building a sewerage system that in the near future will connect about 40 per cent of the city. Presently, households, hotels and guesthouses use septic tanks and soak pits for on-site containment of sewage. The Municipal Committee of Leh has ordered that septic tanks are to be made watertight to avoid contamination of groundwater and mandatorily desludged every year. An FSTP has been set up to treat and reuse the sludge safely. The plant was inaugurated in August 2017. The construction cost of the plant was Rs. 52 lakh and serves a population of 30,000.

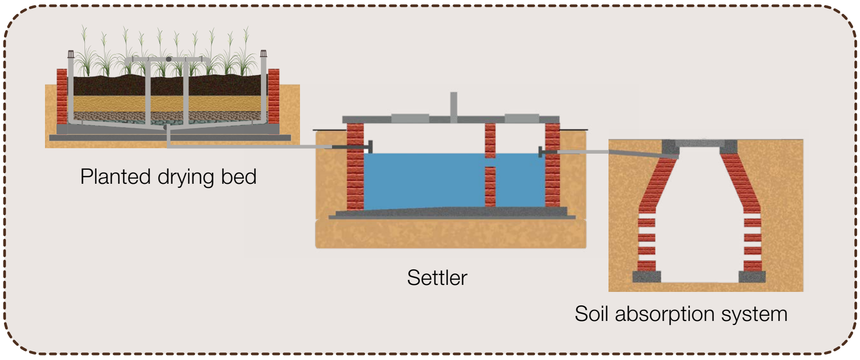



Planted sludge drying beds are used as primary treatment for the septage or faecal sludge delivered to the plant. The raw sludge from the tankers is emptied into the screening chamber for removal of grit and debris and then applied to the respective planted sludge drying beds. In order to maintain the efficiency of treatment, each day only one bed is filled with sludge and allowed to dry. The liquid fraction of the sludge that percolates through the filter media, flows into a horizontally planted gravity filter for further treatment. Later it flows into a polishing pond where it is digested and disinfected using direct sunlight. The sludge is applied to the drying beds till it reaches a height of about 0.9 m. It is then ready to be applied as an organic soil conditioner and can be removed from the drying beds.

Development of a plant nursery has been proposed on-site where the treated leachate and dried sludge would be used to grow plants and make Leh greener.

**Figure 15:** Discharging of faecal sludge at Leh FSTP

## Treatment plant facility for low density areas




### Planted drying beds

In PDB-based treatment facility, the number of planted drying beds can be reduced to four or less if the incoming sludge to the treatment facility is not regular. The provision of beds as per the loading rate is as follows:

| No of loads | Number of beds required | Effective resting period |
|---|---|---|
| 6 loads per week (<5,000 septic tanks) | 6 | 6 days |
| 4 loads per week ( 2,000-5,000 septic tanks) | 4 | |
| 2 loads per week (<2,000 septic tanks) | | |
| * Treatment facility should be adopted for cluster of villages considering distance of 15–20 km | | |

### Settler

Settler will ensure the reduction in the solid content in the leachate receive from the planted drying beds. The standard drawing of settler is provided in Annexure 3. Settler may be avoided for four loads per week and lesser.

### Soil absorption system

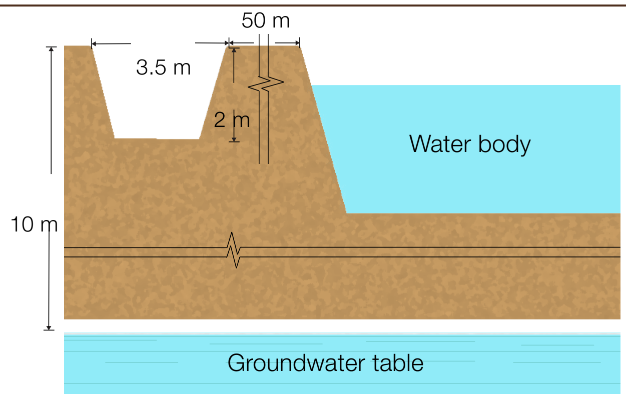
Soil absorption system, i.e., i) Seepage pit; or ii) Dispersion trench should be adopted.  IS 2470-2 provide relevant information regarding adoption of seepage arrangement.

### Cost of system

For two number of beds with the settler and seepage pit, the cost varies from 3–5 Lakhs.  A detailed estimate should be prepared based on the site. Further, treatment facility should be co-located with a plastic waste management unit/ solid waste unit/ greywater management unit or any other similar facility to ensure sharing of land along with optimizing capital and O&M expenditure. .  Refer Annexure 4 for drawings and preparation of detailed cost estimation for planted drying beds and settler.

### Suitability of plant site

| Description | Min. distance |
|---|---|
| Horizontal distance between entrenchment site and any water source (well, intake structure, aquifer, etc.)[6] | 50 m |
| Vertical distance between bottom of the trenches and the groundwater table[6] | 10 m |



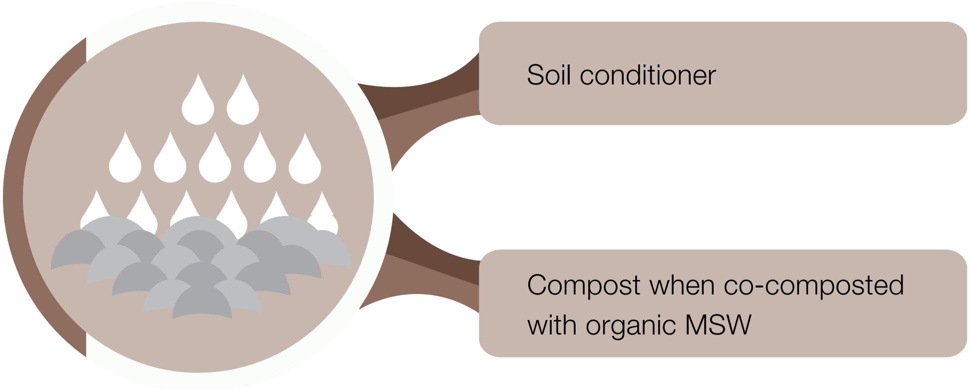

* In case these criterias do not fulfill, leachate treatment should be adopted, as per Annexure 3.

Chapter 7

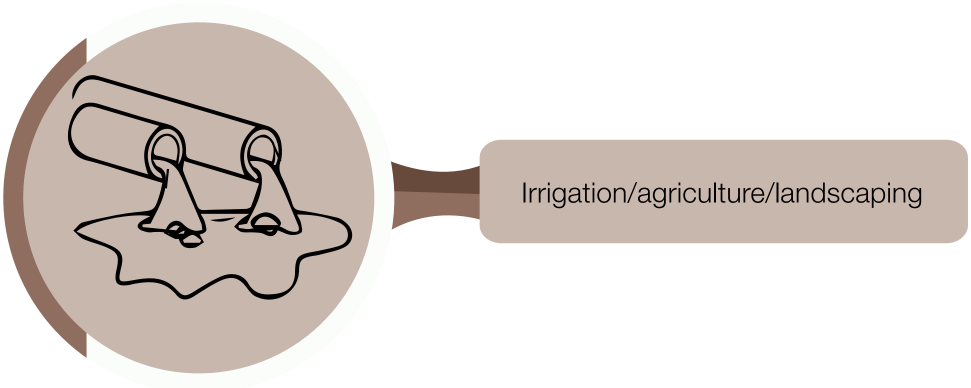
# Reuse of Treatment By-Products

FSM is not only a precondition for clean and healthy living, but it also provides a great opportunity for reusing sludge, particularly as manure. If adequate treatment is applied to faecal sludge, it generates mainly two treatment by-products which are a) treated wastewater (effluent) and b) biosolids.

**Reuse of Treated Sludge (Biosolids)**




**Reuse of Treated Wastewater**




Chapter 8

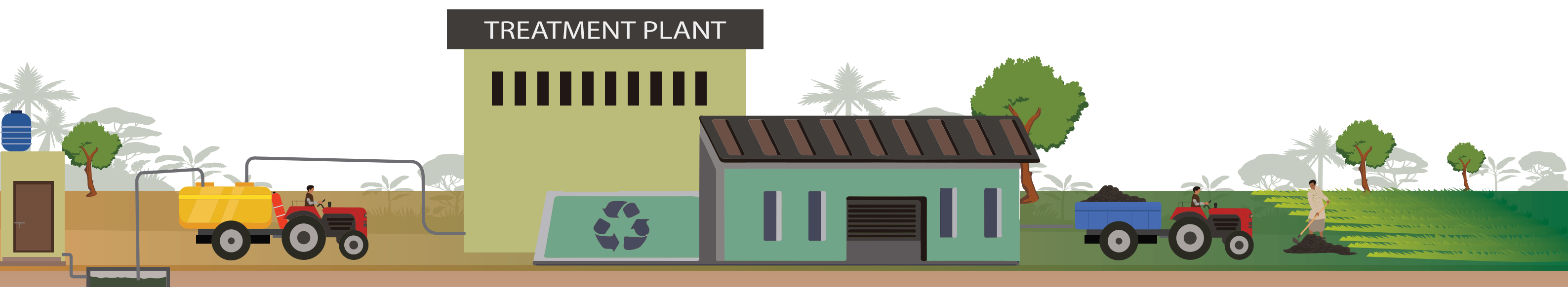
# Monitoring of FSTPs

**A. Deep row entrenchment**

- A record of incoming loads of faecal sludge, and other related data should be maintained meticulously
- Drinking water sources near the trenching site should be monitored closely and the chemical and bacteriological testing of water samples should be done as per the norm

**B. FSTP – Planted and unplanted drying beds**

- Treatment performance monitoring should be carried out periodically according to the parameters defined by the relevant statutory institution. Samples should be collected at the following points to assess the treatment efficiency for each of the treatment modules adopted:
    - Influent quality of sludge
    - Inlet and outlet of each of the treatment modules – if required
    - Final effluent quality (treated wastewater)
    - Final dried solid quality
- A record of incoming loads of faecal sludge, treatment process parameters and other plant related data should be maintained meticulously



Annexure 1

# Characterization of Faecal Sludge

The design of a new treatment plant or suitability of an existing treatment plant largely depends on the degree of treatment and the quality of treatment products and by-products required. The minimum and maximum values for each constituent, and hence the mean values, of the incoming faecal sludge are given in the section below. This section also details the standard requirements for safe disposal or reuse of the treatment by-products generated as a result of faecal sludge treatment.

## A. Characteristics of Faecal Sludge

The faecal sludge collected from the septic tanks and single pits is normally characterized by an offensive odour and large quantities of solid and organic contents, due to the accumulation of sludge and scum. The selection of treatment modules for faecal sludge and its design is based on the following design parameters.

Faecal sludge characteristics vary widely from one location to another due to various factors, which include the number of users, type of liquid/solid waste disposed of in the containment unit, size of the pit/tank, desludging frequency, climatic conditions and construction specifications of the pit/septic tank. The faecal sludge characteristics and its variability are critical in designing the treatment facility. Therefore, knowledge of faecal sludge characteristics, their variability, and dewaterability are important in determining acceptable treatment and disposal methods. Characteristics of faecal sludge are summarized in Table 1:

**Table 1:** Characteristics of Incoming Faecal Sludge from Various Sources

| Sr. No | Source | BOD | COD | TS | TKN | TP | Total coliform |
|---|---|---|---|---|---|---|---|
| | | MPN/100 ml | | | | | MPN/100 ml |
| 1 | FSM book- Septic tank- (Strande et. al., 2014) | 2,600 | 10,000 | 30,000 | 1,000 | 150 | |
| 2 | Chunar, Uttar Pradesh India–lab results, CSE, Delhi | 4,470 | 21,936 | 44,760 | 1,573 | 166 | |

| Sr. No | Source | BOD | COD | TS | TKN | TP | Total coliform |
|---|---|---|---|---|---|---|---|
| | | MPN/100 ml | | | | | MPN/100 ml |
| 3 | Devanahalli, Karnataka lab results, CDD Society | 3,750 | 23,900 | 34,560 | 19,665 | | |
| 4 | Tide technocrats, India (Kumar et. al, 2017) | 16,321 | 21,954 | 29,927 | 307 | 12 | |
| 5 | Bhubaneshwar, Orissa lab results CSE | 1,484 | 18,390 | 13,199 | 367 | 66 | 1,83,50,000 |
| 6 | Dhenkanal, Orissa lab results CSE | 2,344 | 34,658 | 21,043 | 901 | 171 | 46,50,000 |
| 7 | Jhansi, Uttar Pradesh lab results CSE | 1,743 | 50,917 | 42,888 | 1,348 | 169 | 62,25,000 |
| 8 | Leh, Ladakh, lab results CSE | 5,144 | 34,453 | 21,593 | 868 | 164 | 58,00,000 |
| **Indicative characteristics** | | **4,732** | **27,026** | **29,746** | **3,253** | **112** | |

The inlet characteristics of raw faecal sludge mentioned above are indicative. It is highly recommended to conduct a detailed quality analysis of faecal sludge from the project areas in order to establish the parameters mentioned above.

## B. Discharge Standards Adopted for Safe Disposal of Treatment By-Products

### a. Discharge standards for safe disposal of treated wastewater in India

The design adopted for treatment of faecal sludge should comply to the discharge standards specified by the statutory institution. The same have been set out in Table 2:

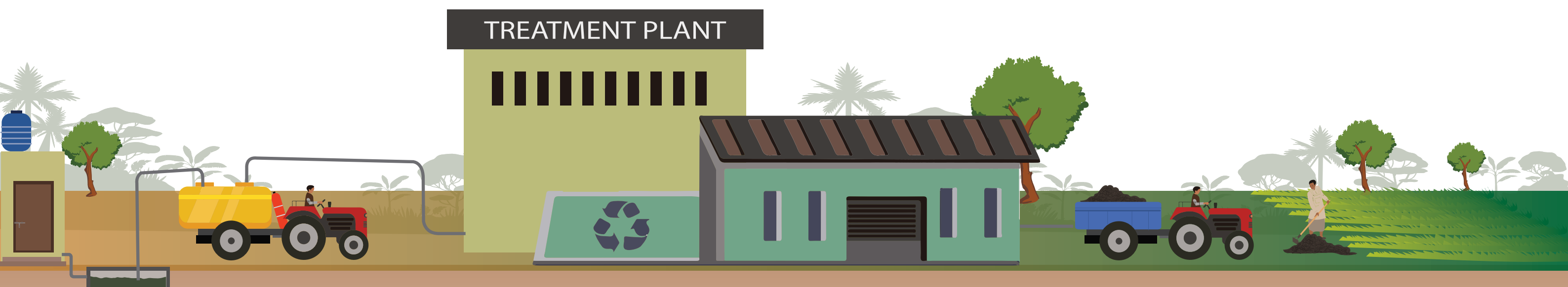


**Table 2:** Effluent Discharge Standards Specified under Environment (Protection) Rules 1986

| Sr. No | Parameters | Inland surface water | Public sewers | Land irrigation | Marine/ coastal areas |
|---|---|---|---|---|---|
| 1 | pH | 5.5 to 9.0 | 5.5 to 9.0 | 5.5 to 9.0 | 5.5 to 9.0 |
| 1 | BOD [mg/l] | 30 | 350 | 100 | 100 |
| 2 | COD [mg/l] | 250 | – | – | 250 |
| 3 | TSS [mg/l] | 100 | 600 | 200 | 100 |
| 4 | TKN [mg/l] | 100 | – | – | 100 |
| 5 | NH3-N [mg/l] | 50 | 50 | – | 50 |
| 6 | Dissolved phosphates as P [mg/l] | 5 | – | – | |
| 7 | Faecal coliform [MPN/100 ml] | – | – | – | |

Annexure 2

# Deep Row Entrenchment for a Population of 3000

## A. Design, Specifications and Construction

The following parameters should be considered for design, detailing and implementation of the trenching system for the selected location:

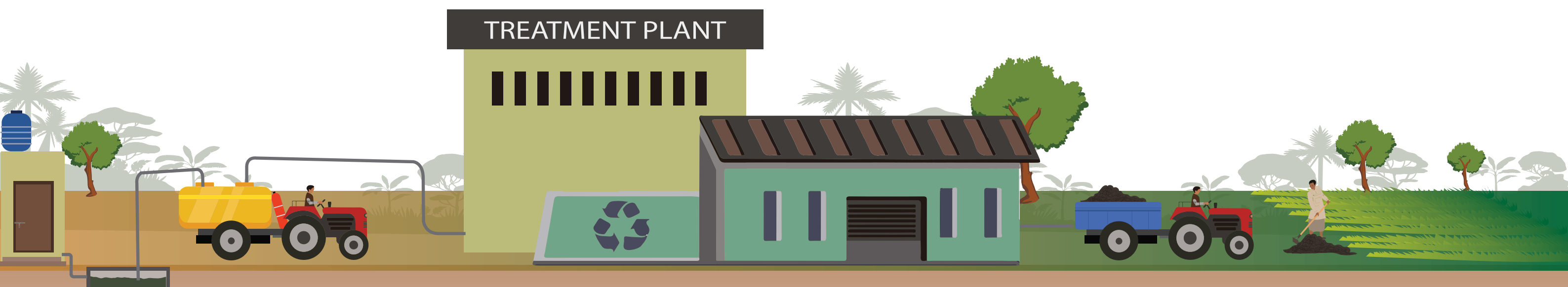
| Design aspects | Detail description |
|---|---|
| Sludge volume | Maximum volume of sludge: 1–3 $m^3$/day |
| Sludge digestion/dewatering/disinfection | • Minimum of 1–3 years<br>• Digestion and dewatering may be faster (within 6 months), however pathogens should be removed after 1–3 years |

### a. Design calculations

**Design calculation of a) total population served, b) total number of septic tank loads that can be disposed of in the proposed trenching site**

**Assumption**

- For the purpose of calculation, consider a trenching site in hard soil strata of around 1 acre
- Details of trench:
  - Length = 10 m
  - Top width = 3.5 m
  - Bottom width = 1.5 m
  - Depth = 2 m
  - Permissible sludge depth = 1.8 m
  - Side slope = 0.5:1 (H:V)



***Volume of sludge that can be disposed of as per the assumed details of the trench***

Sectional area of one trench = ½ x (sum of parallel sides) x (depth of trench) = 4.5 $m^2$

Volume of one trench = Sectional area of trench x Length of trench = 4.5 x 10 = 45 $m^3$

***Total volume of sludge that can be disposed of in the allocated 1 acre of site is as follows:***

Consider there are two rows of trenches in the site with 10 m length each and the intermediate distance of 5 m. Sixteen such trenches can be dug in each row along the length of the site.
A site plan is given in the figure below:

Total sludge volume that can be disposed of in the trenching site = Volume of single trench (considering 50 per cent reduction) x number of trenches = 67.5 x 32 = 2160 $m^3$

***Total number of septic tanks that can be served by this trenching site location:***

Assumed volume of sludge emptied from each septic tank = 4 $m^3$

Number of septic tanks served = Total sludge volume that can be disposed of/volume of sludge emptied from each septic tank

= 2160/4 = 540 Nos.

***Total number of households and population served by the trenching site:***

Total number of household septic tanks that can be served = 540 Nos.

Number of persons per household = 5

Total population served = 540 x 5 = 2700 people

*Summary: Totally 540 household septic tanks with 4 $m^3$ capacity serving a population of 2700 can be emptied in the proposed 1 acre trenching site*

**Note:**

- The above calculations are given considering simultaneous filling of trenches
- Special precautions should be taken during the monsoon. To avoid overflow of sludge in areas with high rainfall, it is advisable to fill the trench to only half of its depth
- There is a significant reduction in the volume of sludge after it is drained into the trench and hence a 50 per cent reduction in volume is estimated, however, it may differ due to the following factors:
    - Evaporation rate in the area (The rate of evaporation will be higher in dry seasons)
    - Permeability of soil
    - Frequency of disposal of sludge at the site
    - Rainfall in the area

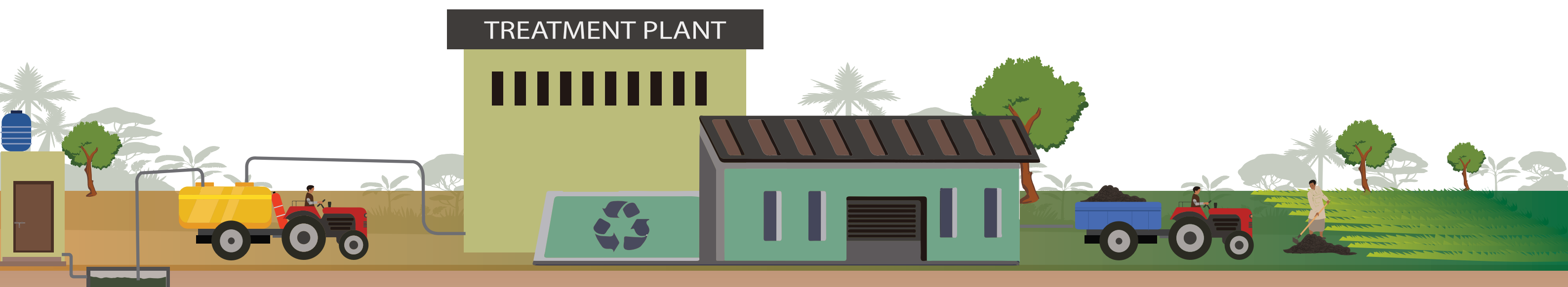
### b. Dimensions of trenches

The dimensions of the trenches are given in the table below; the same are illustrated in the drawings provided in the sections below.

| Sr. No. | Details | Measurements (m) |
|---|---|---|
| 1 | Top width of trench | 3.50–5.50 |
| 2 | Bottom width of trench | 1.50 |
| 3 | Depth of trench | 1.00–2.00 (in no circumstances shall exceed 2.00 m) |
| 4 | Length of trench | 10 |
| 5 | Distance between two trenches | 3.50 |
| 6 | Side slope (H:V) | 0.50: 1 (hard soil formations)<br>1:1 (loose soil formations) |

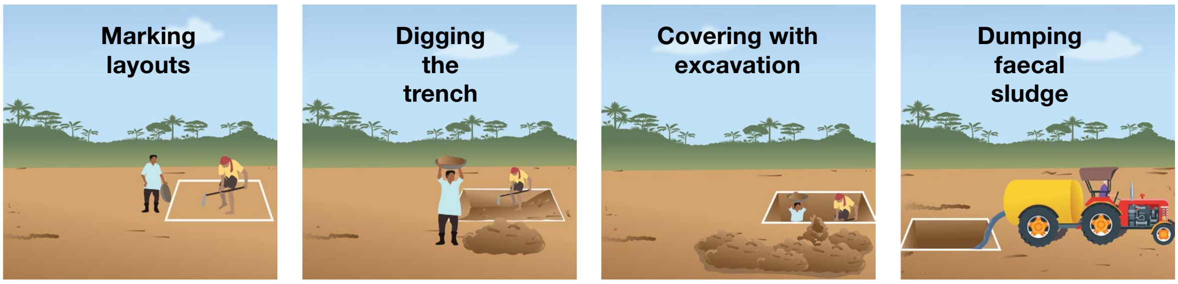
### c. Execution of work

- The site should be selected as per the requirements mentioned in Figure 2, Chapter 2. Required testing should be carried out to ensure the feasibility of the allocated site for trenching. A proper access road should be available to reach the trenching site
- The area requirement should be calculated based on the existing and projected number of septic tanks/single pit toilets in the village/cluster of villages that will depend on the facility being developed
- Dimensions of trenches should be arrived at based on the line diagram as well as design calculations provided above
- Based on the dimensions calculated for each trench, location and orientation of the trenches, the area and shape of allocated land required for the internal access roads should be decided
- Excavation, either manual or using an excavator machine, should be carried out for trenches as per the design specifications. The required amount of soil should be stored within the project site for filling of the top portion of the trenches and the balance quantity should be shifted out of the trenching area. Top soil, which is valuable, should be preserved carefully and reused at the time of filling of trenches
- Internal road formation should be carried out (if required) with proper technical specifications as per conditions at the local site



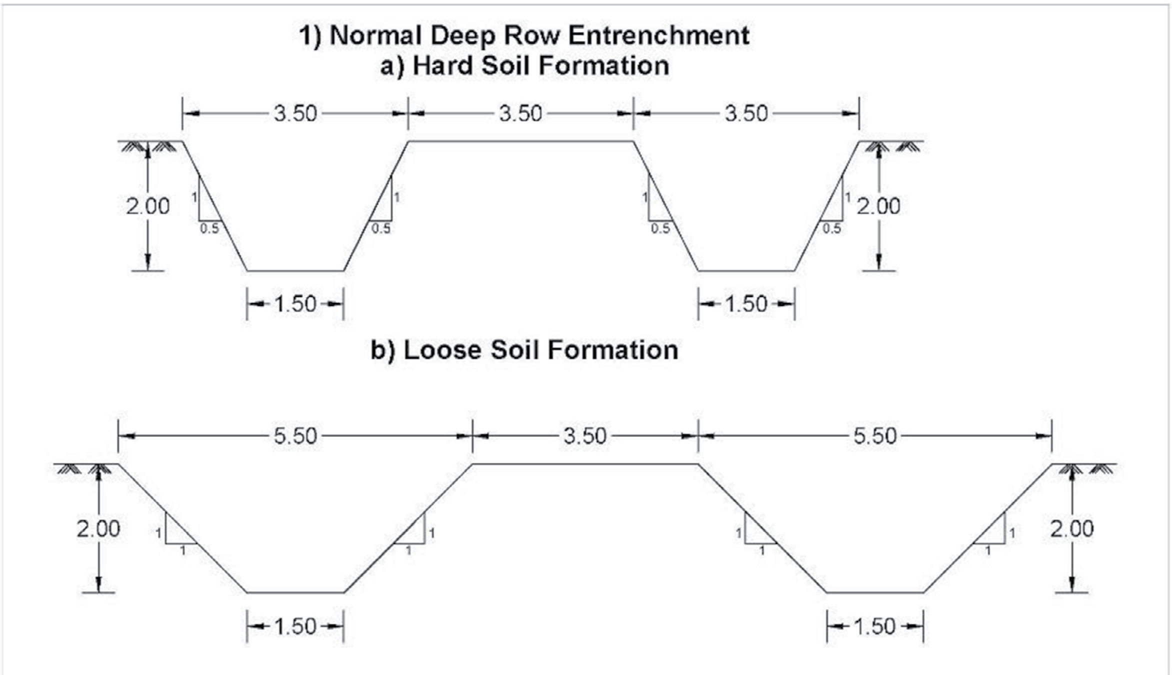
- There is no construction material requirement for this system. However in case use of a sand layer or agri film cover is planned, this needs to be procured as per the required quantity and laid as per specifications
- Test boreholes should be installed at a distance of about 50 m from the trenching site for water sample collection and periodic testing

**Figure 1:** Stages of Implementation and Management of Trenching System

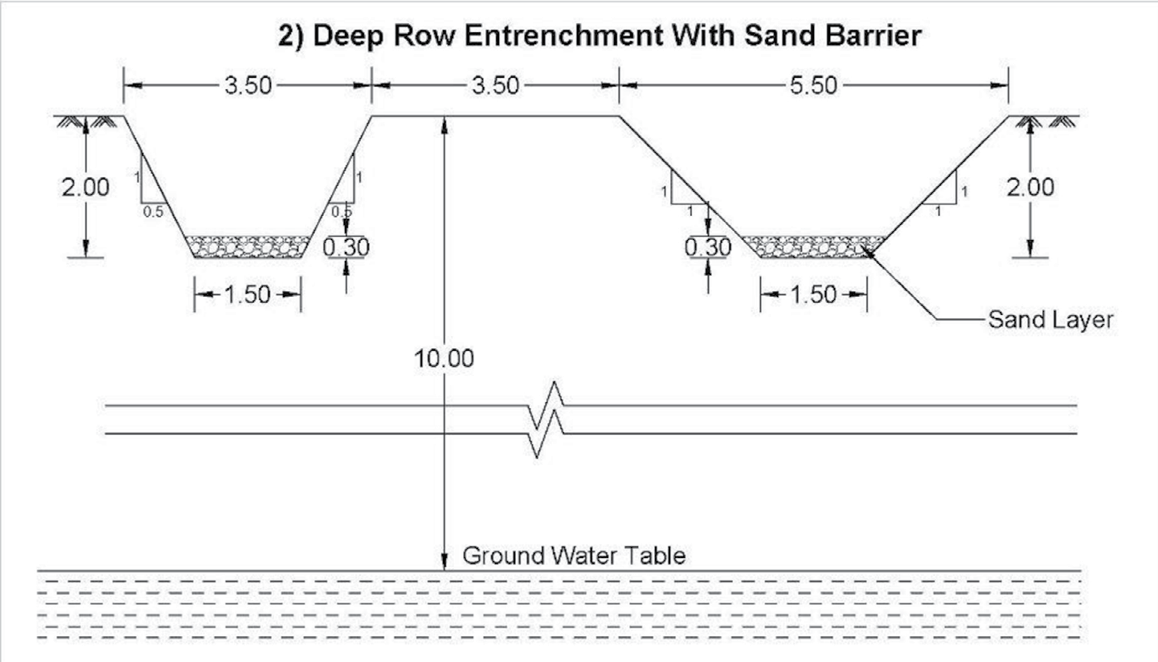


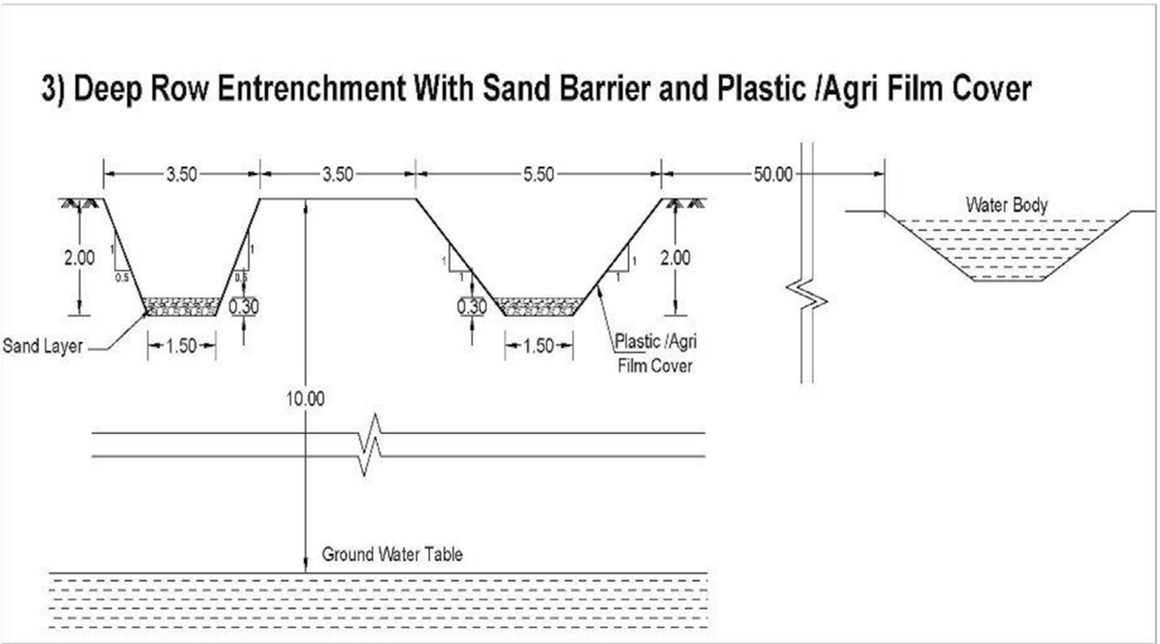

## B. Engineering Drawings

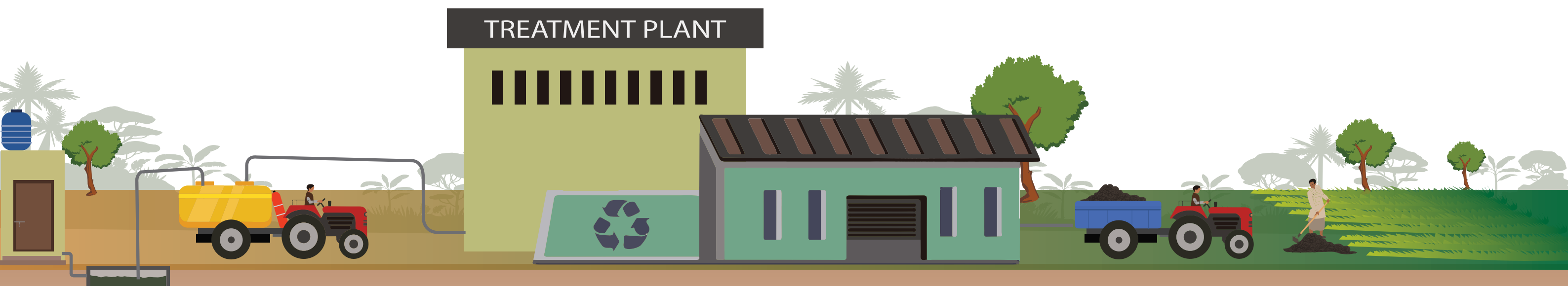
**Drawing 1:** Cross Section of Trenches in Hard Soil Formation (Top) and Loose Soil Formation (Bottom)




**Drawing 2:** Cross Section of Deep Row Entrenchment with Sand Barrier



## C. Operation and Maintenance Requirements

- Sludge from the septic tanks/single pit toilets shall be transported to the site by vacuum trucks, tractor mounted vacuum tanks, tankers, etc. Ensure that only faecal sludge from households, institutions (schools, hostels, health care centres, community sanitary complexes etc) or commercial establishments (shops, hotels, restaurants etc.) is disposed of in the trenches and no industrial or toxic sludge is disposed of there
- Sludge should be drained into the trench under supervision. Adequate safety gear must be used by the personnel during desludging of containment unit as well as during draining of the sludge into the trench. Under no circumstances should the raw sludge come into human contact
- A date wise log of the number of trucks entering, quantum of sludge emptied, days and/or time required to fill the trench should be maintained
- Application of sludge on the trenches should preferably be done in dry seasons. During rainy days/season leaching effect may be low and hence frequency of dumping in the same trench should be lowered. Two or more trenches can be used simultaneously in such cases
- After a trench is filled, it should be covered with local soil. Tree plantation can be adopted or the buried sludge can be left for two years for complete decomposition. Trees with high nitrogen demand, like eucalyptus, acacia are preferred
- The buried sludge can later be used as manure after laboratory testing to ensure that there are no traces of pathogens left

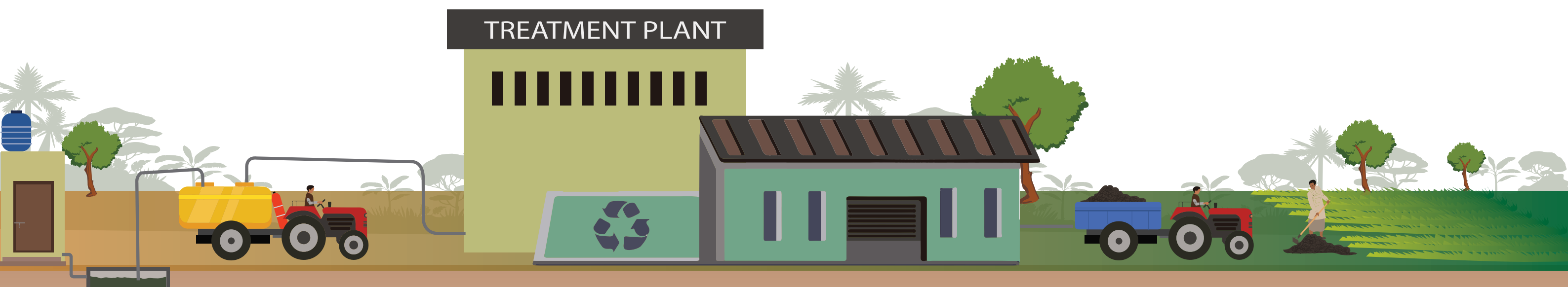
Annexure 3

# FSTP Based on Planted Drying Beds for 4 kld

## A. Design, Specification and Construction

The following parameters should be considered for design, detailing and implementation of the PDB system for the selected location.

| Design aspects | Detail description |
|---|---|
| Sludge volume | Preferred more than 1–2 truckloads equivalent to 4–12 $m^3$/day or less |
| Sludge loading rate, removal frequency, number of beds | • Loading drying bed with permissible TS: 100–250 kg TS/$m^2$/year. Higher number can be chosen when optimal conditions prevail, like higher temperature, well digested sludge, lower humidity, lower precipitation, etc.<br>• Sludge feeding thickness on beds: 10–15 cm. Lesser thickness is better<br>• Sludge removal frequency: once in 2–3 years as per design<br>• Resting period for each bed: once in 6–10 days. The longer duration is better<br>• Maximum loading depth of the sludge during one full feeding cycle: 0.75–1.5 m<br>• Total bed surface and number of beds: Should be calculated based on the amount of sludge to be discharged every day, total solid content in the sludge, feeding thickness of sludge layer and emptying frequency of digested sludge (2–3 years). Ideally 6–10 beds are preferred (depending on the resting period chosen) |



### a. Design and specification

As discussed in the previous section, this treatment system should be adopted if the per day sludge generation is 4 $m^3$ or above. Below are the design calculations for a treatment plant of 4 $m^3$ capacity, adopting planted sludge drying beds.

- Incoming volume of sludge = 4 $m^3$
- Thickness of the sludge layer per loading on a bed = 13.5 cm
- Area of sludge drying bed required = 30 $m^2$

Therefore, the dimensions of the sludge drying bed can be **6m** (length) x **5m** (width).

In order to ensure proper digestion as well as to ensure adequate crack formations in the sludge layer, it is proposed that a  day resting period be provided for each bed after the application of sludge. Further, it is suggested that six such beds be provided in order to maintain a continuous treatment flow. The incoming sludge should be loaded on the subsequent beds and the first bed loaded with fresh sludge on every eighth day.

As per the above calculation, the total area required for sludge drying beds = 6 x 5 x 6= **180 $m^2$**

The above calculation can be verified using the sludge loading rate. The calculation for the same is as follows:

Sludge loading rate (SLR) = **200 kg/$m^2$/year**[3]

Average total solids in septage as per table 4 = **29,746 mg/l i.e. 29.75 kg/$m^3$**

Average number of operational days/year = 312 days

Volume of sludge applied over the bed/annum = 29.75 x 4 x 312 = **37,128 kg/year**

Total area required considering per $m^2$ solid

Application rate as mentioned above= 37,128/200 = **185.64** which is almost equal to 180 $m^2$ assumed above

Therefore, 6 beds of PDB should be constructed with dimensions of **6m** (length) x **5m** (width) for each bed

As compared to the unplanted sludge drying beds, the percolates from planted sludge drying beds have a lower volume as well as less organic loading as some part is taken up by the plants in the sludge drying beds. However, they still require further treatment prior to their discharge or reuse. The area requirement for the treatment of the percolates depends on the technology adopted. The selection of the technology as well as the treatment modules

depends on the quality and quantity of the percolated liquids. DEWATS treatment modules can be applied for treatment of percolate water, which consists of settler, horizontal planted gravel filter, and polishing pond.

It can be assumed that 50–60 per cent of the volume applied on each bed will pass through the filter media and come out as percolate. An additional 10 per cent of percolate water due to rainfall is assumed. Hence, it is safe to assume 70 per cent of the total volume of the sludge can be considered as percolate water. As per this assumption the total capacity of percolate treatment required is as follows:

From the pilot projects, it is observed that the initial moisture content of faecal sludge is 94–96 per cent.[21]

Say, the initial moisture content is 95 per cent.

Total moisture in the incoming septage = 4 x 0.95 = 3.8 $m^3$

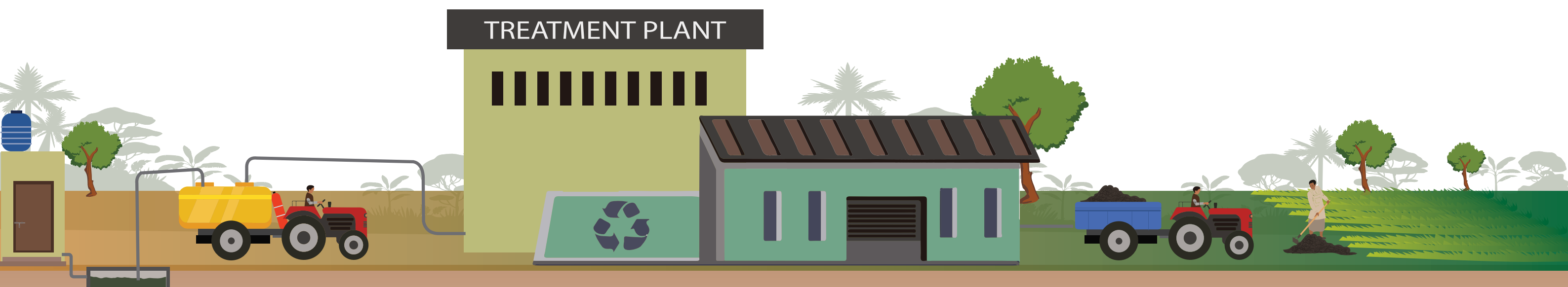
The percolation factor of the filter media is between 60–80 per cent.[21]

Say, the percolation factor of the filter media is 70 per cent.

Therefore, the free water loss due to percolation = 0.7 x initial moisture = **2.66 $m^3$**

### b. Execution of work and construction

| | |
|---|---|
| Construction material, filter media, plant species | As the treatment system is mostly civil structure based, construction material should be easily available.<br>Filter media with the following specifications should be made available:<br>• Bottom gravel layer: 40–60 mm for 50–225 mm thick<br>• 2nd gravel layer: 16–20 mm for 150 mm thick<br>• 3rd gravel layer: 6–8 mm for 100 mm thick<br>• Top layer with river sand: 250–300 mm thick<br>• The filter media should be sieved to the required size as mentioned above and washed well before being placed inside the bed<br>• A transparent roof top may be considered for a project location with heavy rainfall. This will help to reduce the shock load in the percolate treatment facility due to rainwater intrusion from the drying beds.<br>• The plant species chosen should originate from the local area. Commonly used species are *Phragmites australis, Cyperus papyrus, Canas Indica, Typha*, etc. |



| | |
|---|---|
| Construction details | • A slope is to be provided at the base (1%) of the drying beds for easy draining of percolate water into the outlet perforate discharge pipe<br>• 4–6” diameter uPVC outlet perforated discharge pipe to be provided at the base for easy draining of percolate water.<br>• 4” diameter uPVC ventilation/maintenance pipe to be provided for oxygen exchange and access for maintenance<br>• Equal distribution of sludge (solids) on the entire surface should be ensured with 4” diameter uPVC inlet sludge distribution pipe arrangement<br>• Adequate height difference to be ensured between the filter bed and outside area to ensure easy removal and transport of sludge from the beds<br>• Side wall of the tanks should be at least 30–50 cm above the outside finished ground level to avoid surface flow into the drying beds<br>• Splash plates should be provided at the discharge points to spread the sludge uniformly over the bed and prevent erosion of sand<br>• Internal roads are to be provided (if required) for easy movement of vehicles for sludge discharge and transportation of dry sludge from the drying beds. The minimum width of the road should be 3 m |

### c. Dimensions of treatment units

**Sludge drying beds**

| Parameters | Unit | Values | |
|---|---|---|---|
| Estimated volume of sludge to be treated | $m^3$ per day | 4 | 8 |
| Volume of each bed | $m^3$ | 4 | 8 |
| Thickness of sludge layer | cm | 13.5 | 13.5 |
| Minimum area required for each bed | $m^2$ | 30 | 60 |
| Chosen dimension of each bed | m | 6 X 5 | 10 X 6 |
| Total number of beds | no. | 6 | |
| Total area required | $m^2$ | 180 | 360 |
| Slurry feeding frequency | days | Each bed should be loaded with 6 days resting period | |
| Slurry drying period | days | 1 Year | |

**Settler**

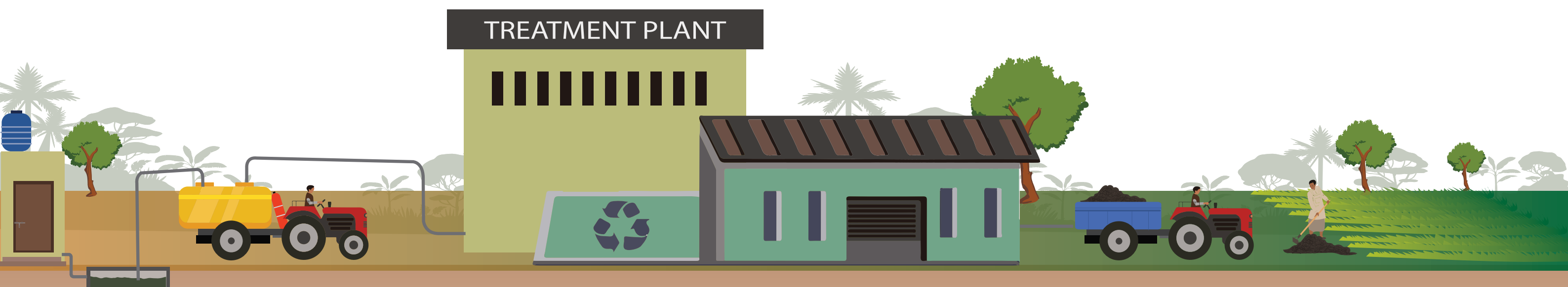
| Parameters | Unit | Values | |
|---|---|---|---|
| Estimated volume of liquid to be treated | $m^3$ per day | 3 | 5.5 |
| Length of first chamber | m | 1.5 | 1.8 |
| Length of second chamber | m | 0.75 | 0.9 |
| Width of the settler | m | 1.25 | 1.6 |
| Liquid depth in settler | m | 1.8 | 1.8 |
| Desludging frequency | year | 2 | |

**Horizontal planted gravel filter**

| Parameters | Unit | Values | |
|---|---|---|---|
| Estimated volume of liquid to be treated | $m^3$ per day | 3 | 5.5 |
| Length | m | 5 | 8 |
| Width | m | 3 | 4 |
| Filter height | m | 0.6 | 0.6 |

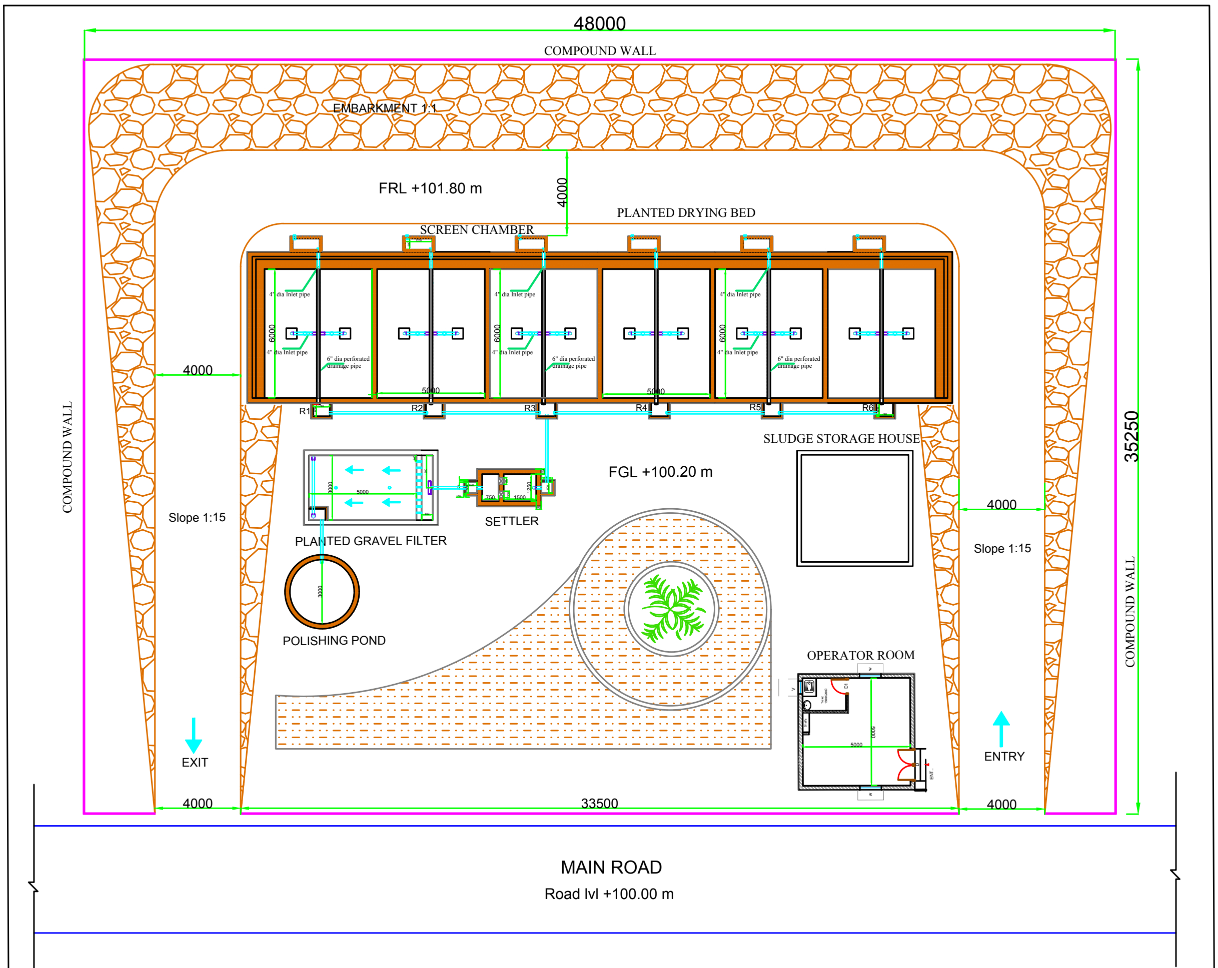
**Polishing pond**

| Parameters | Unit | Values | |
|---|---|---|---|
| Estimated volume of liquid to be treated | $m^3$ per day | 3 | 5.5 |
| Length | m | 2 | 8 |
| Width | m | 3 | 4 |
| Liquid Depth | m | 1 | 1 |



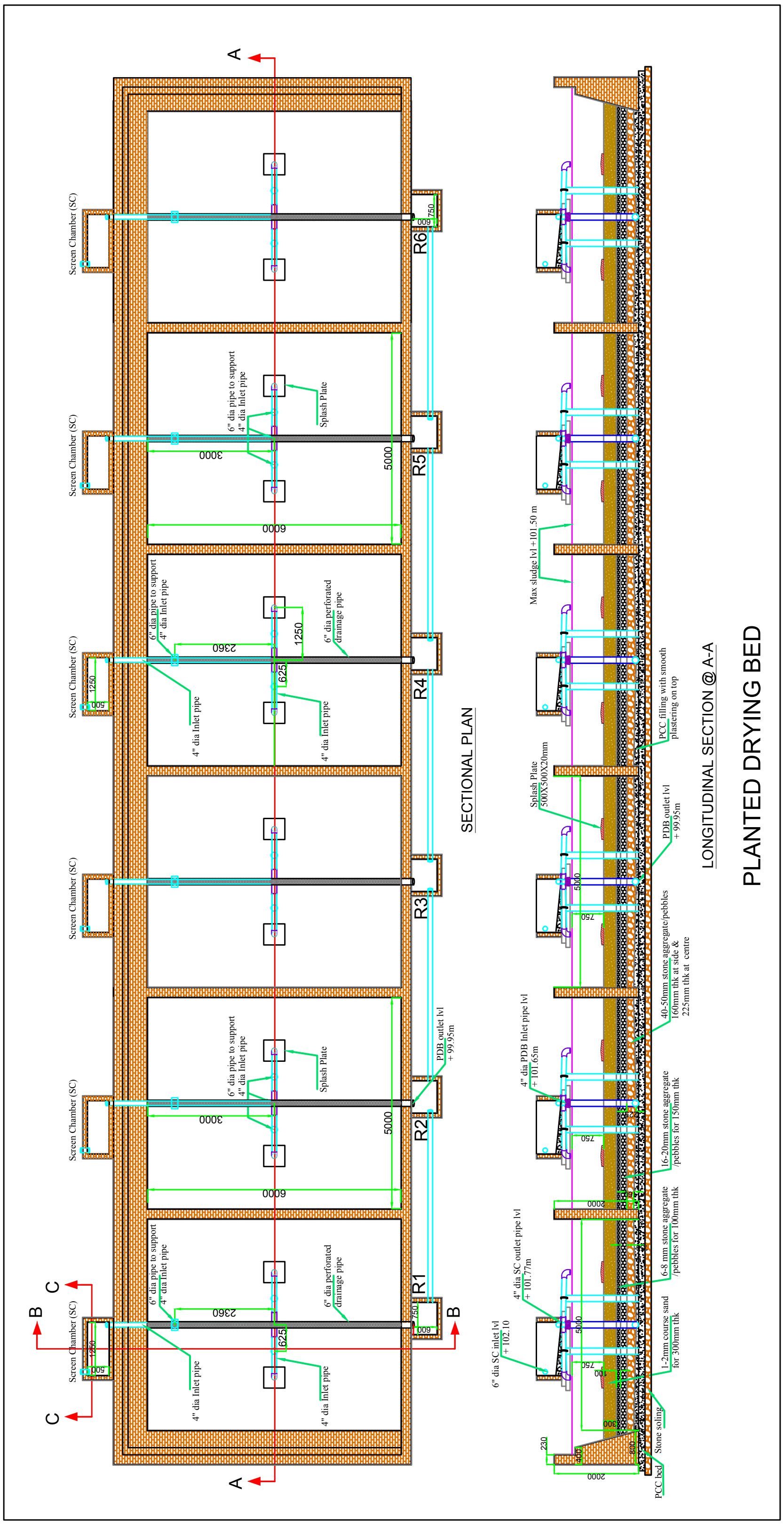
## B. Engineering Drawings

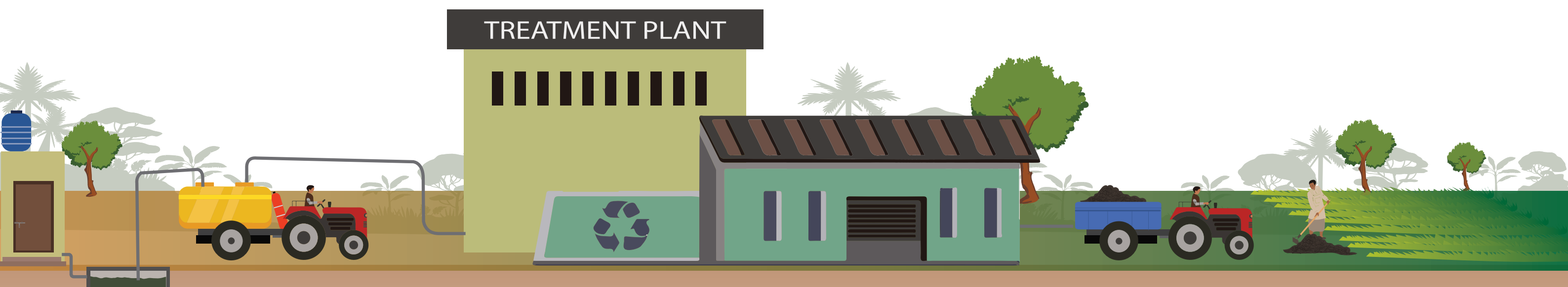
**Drawing 1:** Master Plan of 4 KLD FSTP



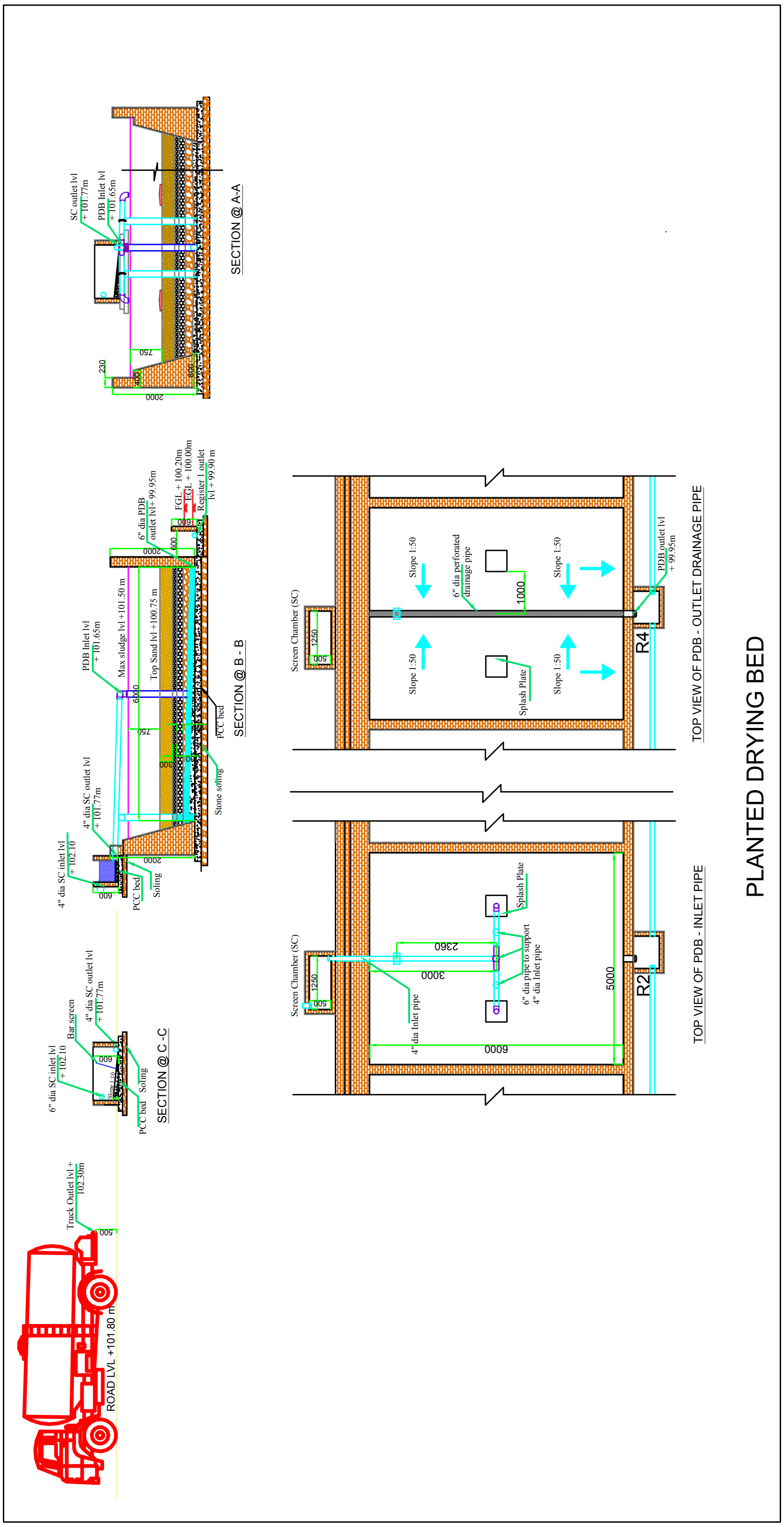

MASTER PLAN
4 KLD PLANTED DRYING BED

**Drawing 2:** Sections of Planted Drying Beds

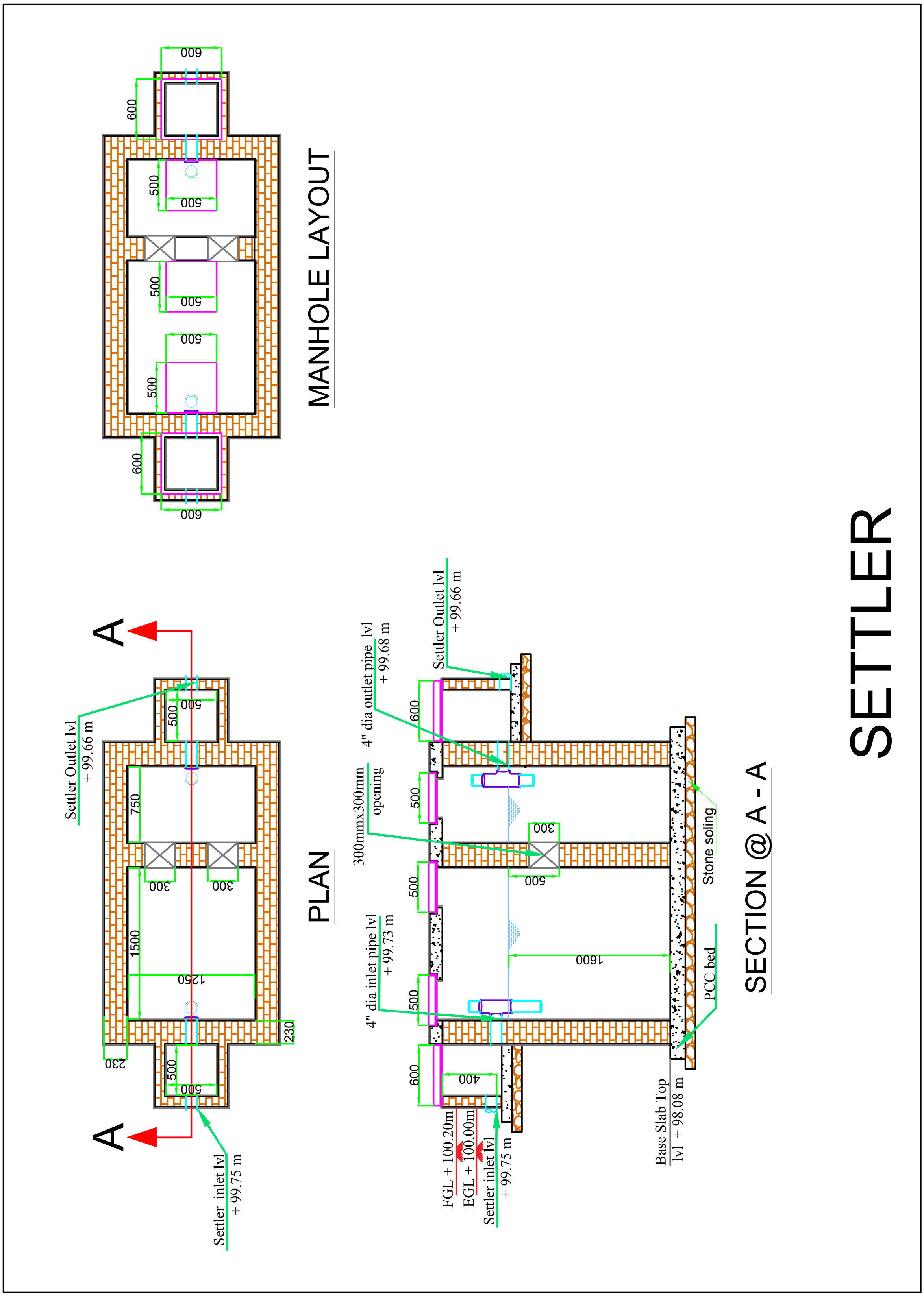


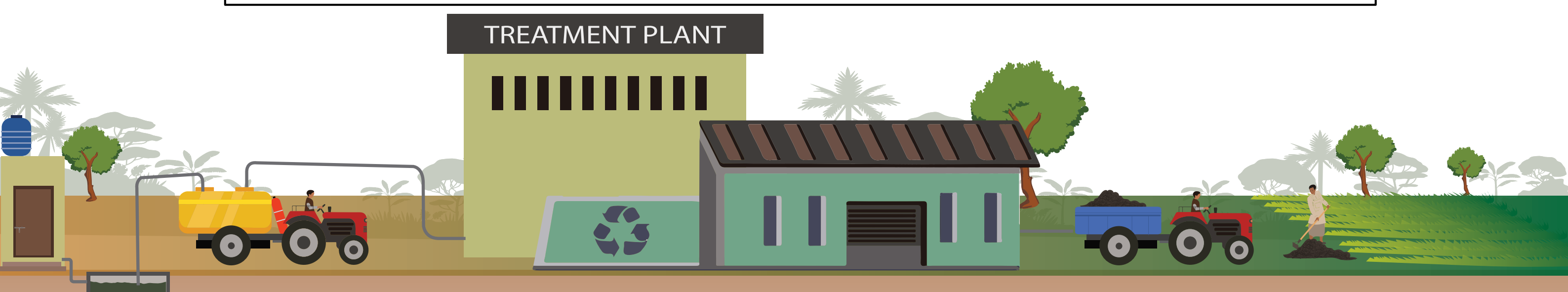



**Drawing 3:** Section of Planted Drying Bed

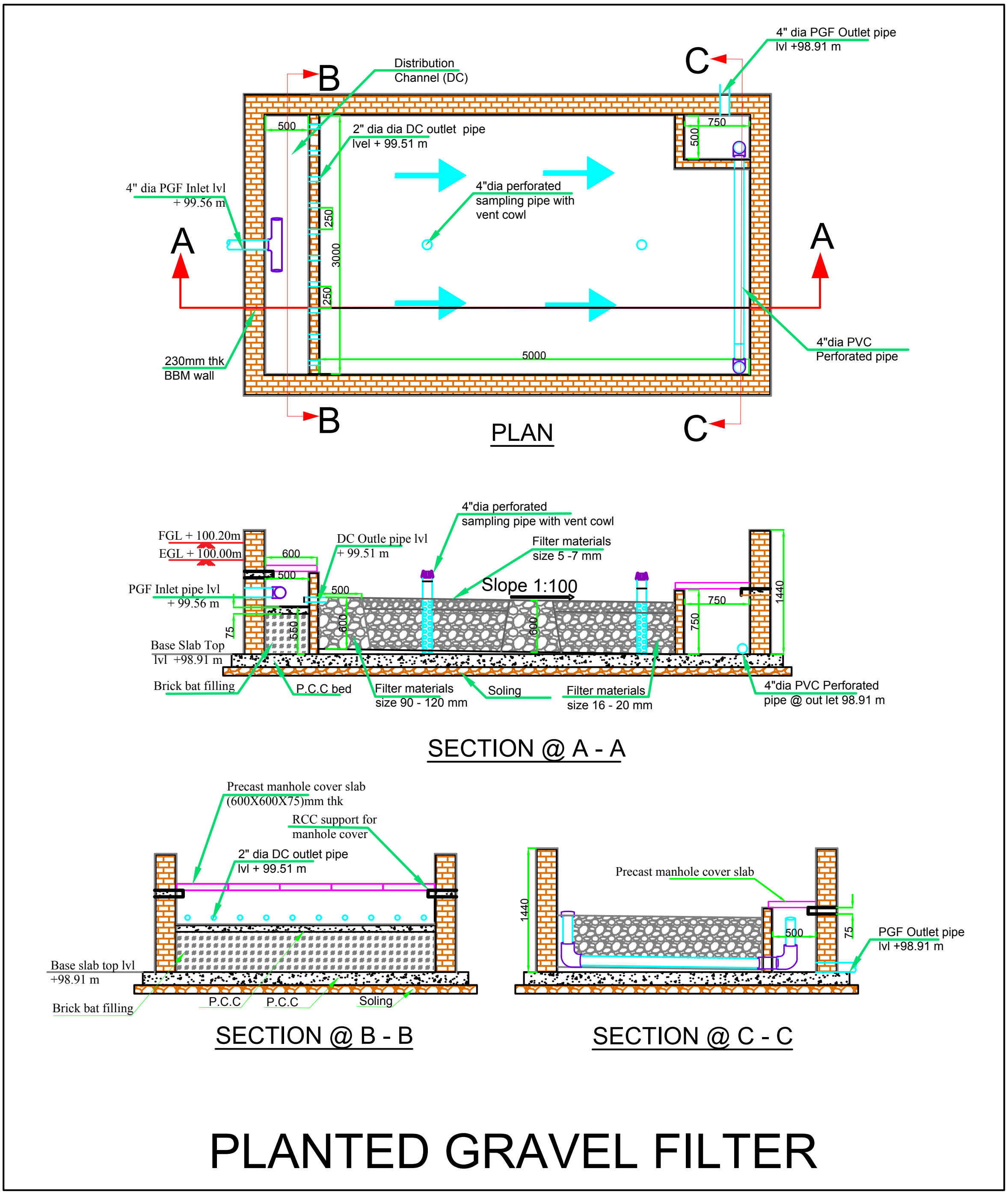



**Drawing 4:** Plan and Section of Settler

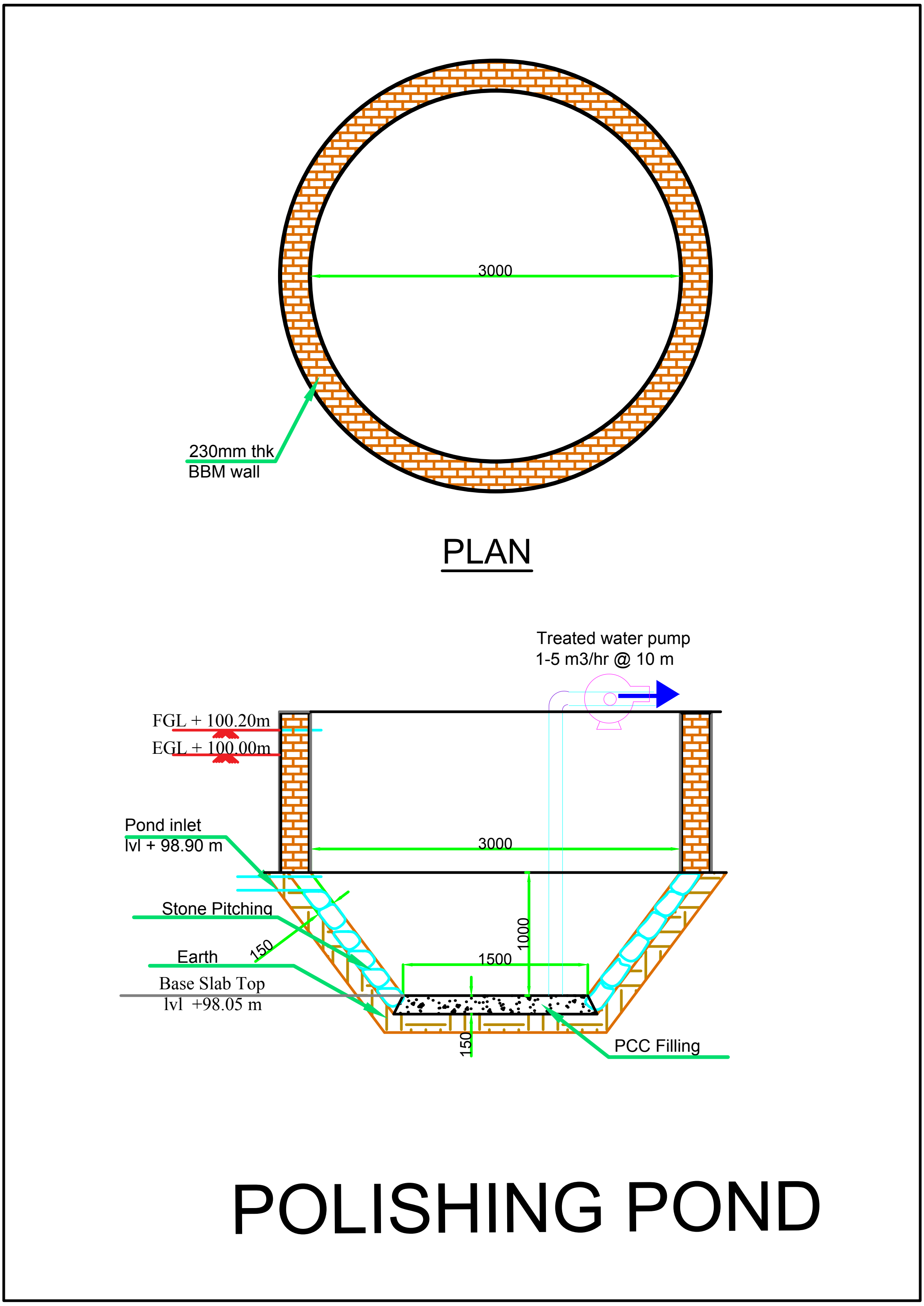


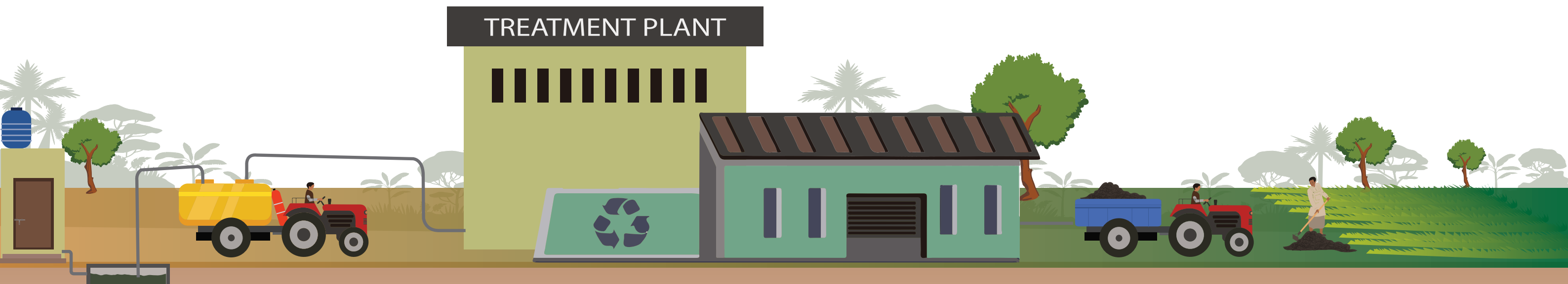



**Drawing 5:** Plan and Section of Planted Gravel Filter



**Drawing 6:** Plan and Section of Polishing Pond



## C. Detailed Estimate

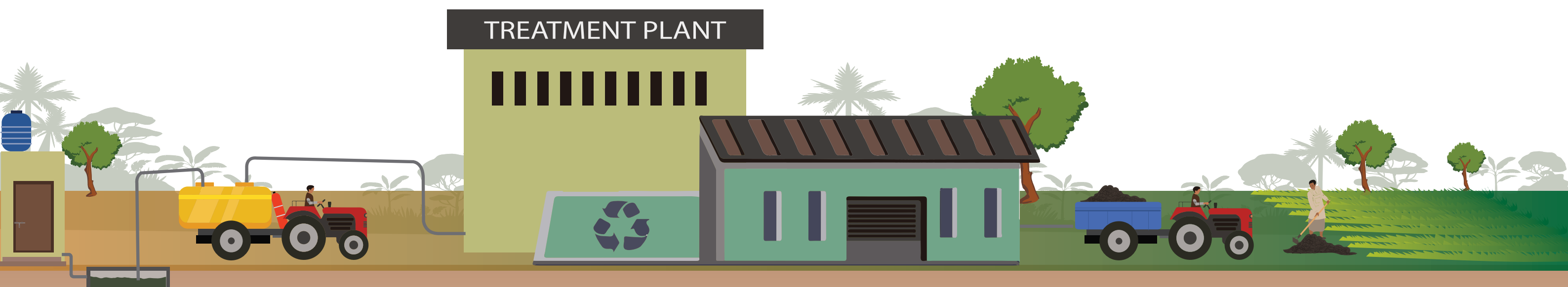
### Abstract costing treatment module wise

| Sl. no | Name of the module | Cost (INR) |
|---|---|---|
| 1 | Planted drying bed | 12,51,546.43 |
| 2 | Settler | 79,802.51 |
| 3 | Horizontal planted gravel filter | 1,17,648.21 |
| 4 | Polishing pond | 53,948.24 |
| | **Total cost for the modules** | **15,02,945.38** |
| *Costing includes only for key treatment modules; supporting infrasctrture and civil work such as internal roads, office building, boundary wall, stormwater drains shall be planned as per local condition and requirement.<br>**The cost is indicative and only for reference. Detail estimate should be prepared as per rates applicable for estimating final cost. | | |

### Cost estimate for construction of planted drying bed (PDB 1-PDB 6)

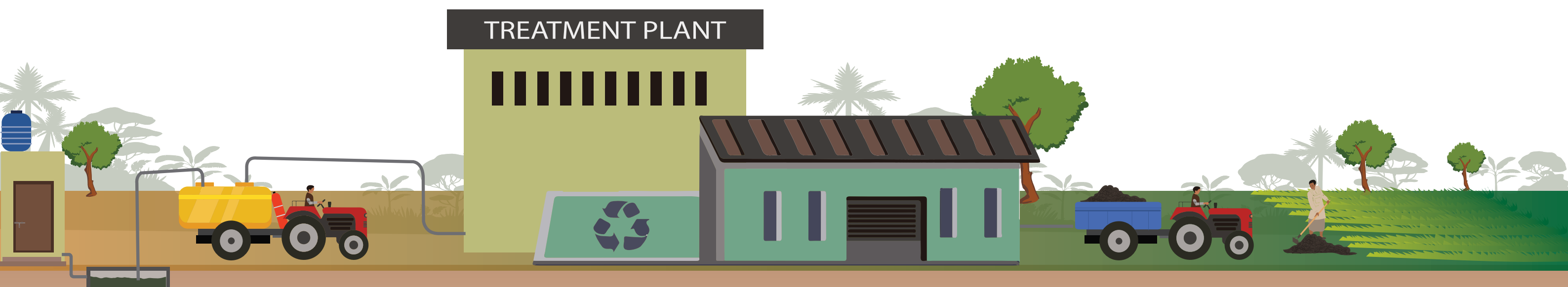
| Sl. no. | Description | Unit | Quantity | Rate (INR) | Amount (INR) |
|---|---|---|---|---|---|
| **A** | **Earthwork – excavation** | | | | |
| | Excavation for foundation / pipe trenches in earth, soils of all types, sand, gravel and soft murum, including removing the excavated material up to a distance of 50 metres and lifts as below, stacking and spreading as directed, normal dewatering, preparing the bed for foundation and excluding backfilling, etc. complete. | | | | |
| | Lift 0 to 1.5 M | | | | |
| | Excavation of the PDB | cum | 100.14 | | |
| | Excavation of the Register | cum | 6.07 | | |
| | Total | cum | 106.21 | | |
| **B** | **Refilling with excavated earth** | | | | |
| | Filling in plinth and floors murum bedding in trenches with approved murum from excavated materials from foundation in 15 cm to 20 cm layers including watering and compaction, etc. complete. | | | | |

| Sl. no. | Description | Unit | Quantity | Rate (INR) | Amount (INR) |
|---|---|---|---|---|---|
| | **Excavation below EGL** | **cum** | **106.21** | | |
| | Deduction for soling | cum | -36.66 | | |
| | Deduction for PCC | cum | -35.94 | | |
| | Deduction for wall | cum | -11.64 | | |
| | **Below screen chamber** | **cum** | **73.20** | | |
| | **Register** | | | | |
| | Deduction for soling | cum | -0.85 | | |
| | Deduction for PCC | cum | -1.01 | | |
| | Deduction for wall | cum | -0.43 | | |
| | Total | cum | 92.88 | | |
| **C** | **Soling** | | | | |
| | Providing dry trap/ granite/ quartzite/ gneiss, rubble stone soling in 15 cm to 20 cm thick layers including hand packing and compacting, etc. complete. | | | | |
| | Stone soling for PDB | cum | 36.66 | | |
| | Stone soling for screen chamber | cum | 1.15 | | |
| | Stone soling for register | cum | 0.14 | | |
| | Total | cum | 37.95 | | |
| **D** | **Plain cement concrete** | | | | |
| | Providing and laying in situ Cement Concrete M-15 of trap/ granite / quartzite/ gneiss metal for foundation and bedding including bailing out water, form work, compaction, curing, etc. complete. (Cement 5.90 bags / cum) | | | | |
| | **In PCC M-15 (PDB)** | | | | |
| | PCC bed | cum | 35.94 | | |
| | Sloped PCC | cum | 18.00 | | |



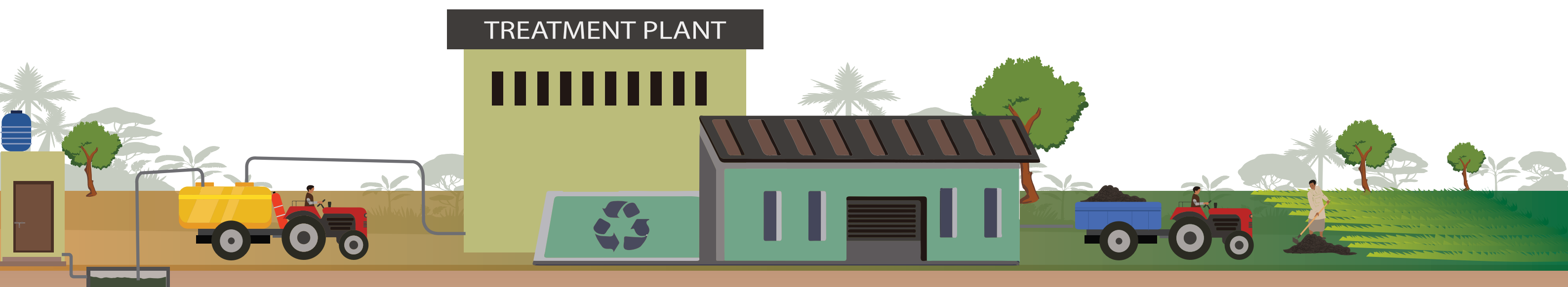
| Sl. no. | Description | Unit | Quantity | Rate (INR) | Amount (INR) |
|---|---|---|---|---|---|
| | **In PCC M-15 (screen chamber)** | | | | |
| | PCC bed | cum | 0.93 | | |
| | Sloped PCC | cum | 0.23 | | |
| | **PCC bed (register)** | cum | 0.17 | | |
| | Total | cum | 55.28 | | |
| **E** | **Brick work** | | | | |
| | 1st class brick work in 5:1 sand and cement of 1.25 fineness modulus mortar in super structure including necessary cutting and moulding of bricks required and also including honey comb brick work, thickness of walls more than one brick. | | | | |
| | **Brick work (PDB)** | | | | |
| | Outer short wall | cum | 10.84 | | |
| | Outer short wall | cum | 1.38 | | |
| | Intermediate short wall | cum | 13.85 | | |
| | Long wall screen chamber side | cum | 32.42 | | |
| | Long wall screen chamber side | cum | 2.27 | | |
| | Long wall register side | cum | 15.12 | | |
| | **Brick work (screen chamber)** | | | | |
| | Short wall | cum | 0.37 | | |
| | Long wall | cum | 0.90 | | |
| | **Brick work (register)** | | | | |
| | Short wall | cum | 0.44 | | |
| | Long wall | cum | 0.36 | | |
| | Total | cum | 77.95 | | |

| Sl. no. | Description | Unit | Quantity | Rate (INR) | Amount (INR) |
|---|---|---|---|---|---|
| F | **Plastering – inner** | | | | |
| | 12 mm cement plaster finished with a floating coat of neat cement of mix :1:4 (1 cement: 4 fine sand) with water roofing agent | | | | |
| | **Plastering (PDB)** | | | | |
| | Short wall | sqm | 144.58 | | |
| | Short wall outer – wall top | sqm | 4.82 | | |
| | Short wall intermediate – wall top | sqm | 12.05 | | |
| | Long wall | sqm | 120.58 | | |
| | Long wall screen chamber side - wall top | sqm | 12.06 | | |
| | Long wall register side - wall top | sqm | 6.93 | | |
| | **Plastering (screen chamber)** | | | | |
| | Short wall | sqm | 3.71 | | |
| | Short wall – wall top | sqm | 0.63 | | |
| | Long wall | sqm | 9.02 | | |
| | Long wall – wall top | sqm | 1.53 | | |
| | Flooring | sqm | 3.75 | | |
| | **Plastering (register)** | | | | |
| | Short wall | sqm | 4.41 | | |
| | Short wall – wall top | sqm | 0.73 | | |
| | Long wall | sqm | 2.79 | | |
| | Long wall – wall top | sqm | 0.46 | | |
| | Total | sqm | 328.04 | | |



| Sl. no. | Description | Unit | Quantity | Rate (INR) | Amount (INR) |
|---|---|---|---|---|---|
| G | **Plastering – outer** | | | | |
| | 12 mm cement plaster finished with a floating coat of neat cement of mix :1:4 (1 cement: 4 fine sand) | | | | |
| | **Plastering (PDB)** | | | | |
| | Short wall | sqm | 28.20 | | |
| | Long wall | sqm | 131.52 | | |
| | **Plastering (screen chamber)** | | | | |
| | Short wall | sqm | 5.13 | | |
| | Long wall | sqm | 5.20 | | |
| | **Plastering (register)** | | | | |
| | Short wall | sqm | 5.21 | | |
| | Long wall | sqm | 3.60 | | |
| | Flooring | sqm | 2.70 | | |
| | Total | sqm | 181.56 | | |
| H | **Media filling** | | | | |
| | Providing and laying of coarse aggregate size as below after washing & sieving to make it free from fines & dust. | | | | |
| | Stone aggregate (single size) : 40 mm nominal size | cum | 32.40 | | |
| | Stone aggregate (single size) : 20 mm nominal size | cum | 27.00 | | |
| | Stone aggregate (single size) : 06 mm nominal size | cum | 27.00 | | |
| | Coarse sand | cum | 54.00 | | |

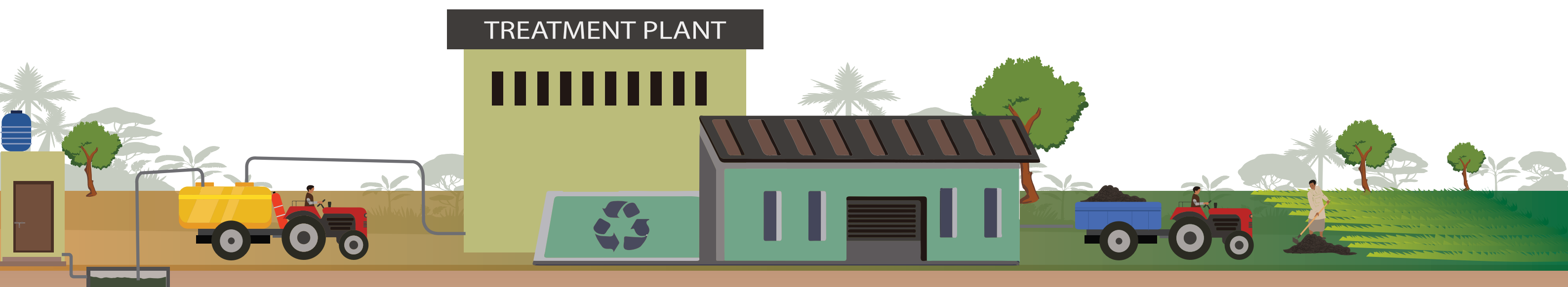
| Sl. no. | Description | Unit | Quantity | Rate (INR) | Amount (INR) |
|---|---|---|---|---|---|
| **I** | **Wastewater pipes** | | | | |
| | Providing at site, lowering & laying in trenches, aligning & jointing of PVC-U pipes (SN 8) as per IS 15328 (amended up to date) and as per specifications with rubber rings with socket and spigot joint, (EPDM/SBR) for all depths for pipe length as per drawing and specification including hydraulic field testing (including the cost and conveyance of water to site for testing) and commissioning etc complete as directed by Engineer. Note : E/w to be measured and paid separately | | | | |
| | 110 mm nominal diametre (PDB inlet & support pipe) | Metre | 67.20 | | |
| | 110 mm diametre uPVC equal Tee (class III, 6kg/sqcm) confirming to IS:7834 | Each | 24.00 | | |
| | 110 mm diametre uPVC double/ single socketed 90° bend (class III, 6kg/sqcm) confirming to IS:7834 (elbow fixing at PDB inlet) | Each | 12.00 | | |
| | 160 mm perforated bottom pipe | Metre | 37.80 | | |
| | 160 mm nominal diametre (screen chamber inlet) | Metre | 1.20 | | |
| | 110 mm nominal diametre – Inter connecting pipes for register | Metre | 27.00 | | |
| **J** | **Plantation** | | | | |
| | Providing and planting common reeds or other rhizome with four plant per square metre | No | 720.00 | | |
| **K** | **Splash plate** | | | | |
| | Providing and laying of kota stone kota stone slab 25 mm thick | sqm | 3.00 | | |



| Sl. no. | Description | Unit | Quantity | Rate (INR) | Amount (INR) |
|---|---|---|---|---|---|
| L | **Screens** | | | | |
| | Providing and fixing stainless steel (Grade 304) railing made of Hollow tubes, channels, plates etc., including welding, grinding, buffing, polishing and making curvature (wherever required) and fitting the same with necessary stainless steel nuts and bolts complete, i/c fixing the railing with necessary accessories & stainless steel dash fasteners, stainless steel bolts etc., of required size, on the top of the floor or the side of waist slab with suitable arrangement as per approval of Engineer-in charge, (for payment purpose only weight of stainless steel members shall be considered excluding fixing accessories such as nuts, bolts, fasteners etc.). | kg | 36.00 | | |
| M | **Painting** | | | | |
| | **Painting – PDB** | | | | |
| | Finishing walls with water proofing cement paint of required shade: | | | | |
| | New work (two or more coats applied @ 3.84 kg/10 sqm) | sqm | 509.60 | | |
| | **Painting – screen chamber** | | | | |
| | Finishing walls with water proofing cement paint of required shade: | | | | |
| | New work (two or more coats applied @ 3.84 kg/10 sqm) | sqm | 28.97 | | |
| | **Painting – register** | | | | |
| | Finishing walls with water proofing cement paint of required shade: | | | | |
| | New work (two or more coats applied @ 3.84 kg/10 sqm) | sqm | 19.90 | | |
| | **Total cost for PDB** | | | | |

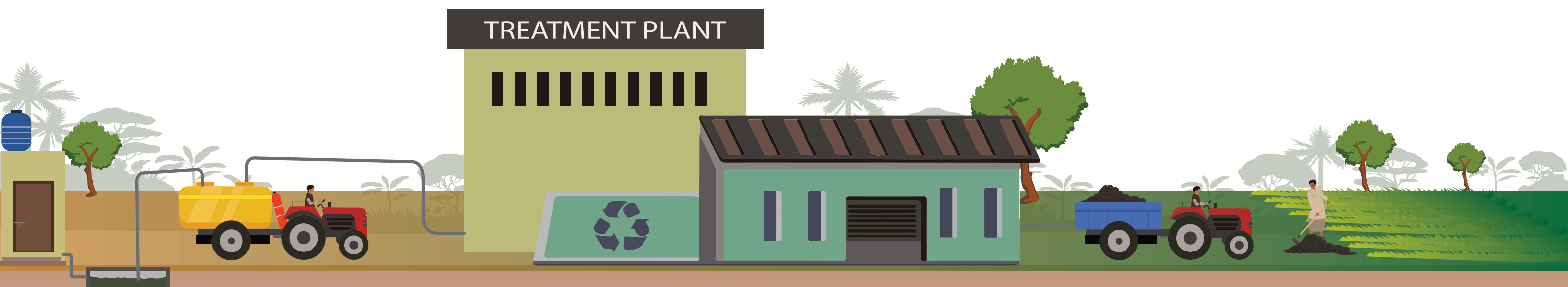
**Cost estimate for construction of settler**

| Sl. no. | Description | Unit | Quantity | Rate (INR) | Amount (INR) |
|---|---|---|---|---|---|
| **A** | **Earthwork – excavation** | | | | |
| | Excavation for foundation / pipe trenches in earth, soils of all types, sand, gravel and soft murum, including removing the excavated material up to a distance of 50 m and lifts as below, stacking and spreading as directed, normal dewatering, preparing the bed for foundation and excluding backfilling, etc. complete. | | | | |
| | Excavation of the module – lift 0 to 1.5 m | cum | 38.91 | | |
| | Excavation of the module – lift 1.5 To 2.17 m | cum | 17.38 | | |
| **B** | **Refilling with excavated earth** | | | | |
| | Filling in plinth and floors murum bedding in trenches with approved murum from excavated materials from foundation in 15 cm to 20 cm layers including watering and compaction, etc. complete. | | | | |
| | **Excavation below EGL** | **cum** | **56.29** | | |
| | Deduction for soling | cum | -0.78 | | |
| | Deduction for PCC | cum | -1.00 | | |
| | Deduction for wall | cum | -10.17 | | |
| | Total | cum | 44.35 | | |
| **C** | **Soling** | | | | |
| | Providing dry trap/ granite/ quartzite/ gneiss, rubble stone soling in 15 cm to 20 cm thick layers including hand packing and compacting, etc. complete. | | | | |
| | Stone soling – settler 1st and 2nd chamber | cum | 0.78 | | |
| | Stone soling – inlet register | cum | 0.11 | | |
| | Stone soling – outlet register | cum | 0.11 | | |
| | Total | cum | 0.99 | | |



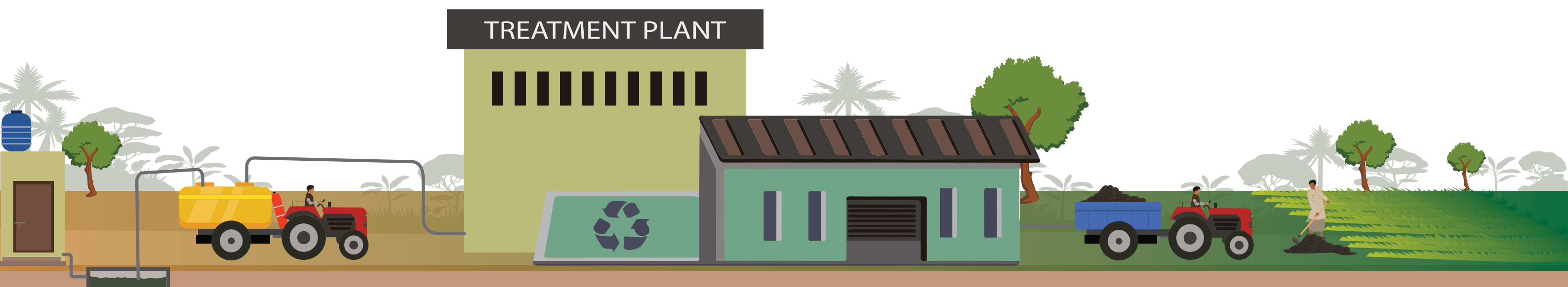
| Sl. no. | Description | Unit | Quantity | Rate (INR) | Amount (INR) |
|---|---|---|---|---|---|
| **D** | **Plain cement concrete** | | | | |
| | Providing and laying in situ Cement Concrete M-15 of trap/ granite/ quartzite / gneiss metal for foundation and bedding including bailing out water, form work, compaction, curing, etc. complete. (Cement 5.90 bags / cum) | | | | |
| | In PCC M-150 | | | | |
| | PCC bed – settler $1^{st}$ and $2^{nd}$ chamber | cum | 1.00 | | |
| | PCC bed – inlet register | cum | 0.08 | | |
| | PCC bed – outlet register | cum | 0.08 | | |
| | Total | cum | 1.16 | | |
| **E** | **Brick work** | | | | |
| | 1st class brick work in 5:1 sand and cement of 1.25 fineness modulus mortar in super structure including necessary cutting and moulding of bricks required and also including honey comb brick work, thickness of walls more than one brick. | | | | |
| | Long wall | cum | 3.10 | | |
| | Short wall | cum | 1.98 | | |
| | Inlet register long wall | cum | 0.04 | | |
| | Inlet register short wall | cum | 0.06 | | |
| | Outlet register long wall | cum | 0.05 | | |
| | Outlet register short wall | cum | 0.07 | | |
| | **Deduction** | | | | |
| | Wall openings | cum | -0.04 | | |
| | Total | cum | 5.26 | | |

| Sl. no. | Description | Unit | Quantity | Rate (INR) | Amount (INR) |
|---|---|---|---|---|---|
| **F** | **Plastering – inner** | | | | |
| | 12 mm cement plaster finished with a floating coat of neat cement of mix :1:4 (1 cement: 4 fine sand) with water proofing agent | | | | |
| | Long wall | sqm | 10.17 | | |
| | Short wall | sqm | 11.30 | | |
| | Inlet register long wall | sqm | 0.29 | | |
| | Inlet register short wall | sqm | 0.58 | | |
| | Outlet register long wall | sqm | 0.34 | | |
| | Outlet register short wall | sqm | 0.68 | | |
| | Total | sqm | 23.36 | | |
| **G** | **Plastering – outer** | | | | |
| | 12 mm cement plaster finished with a floating coat of neat cement of mix :1:4 (1 cement: 4 fine sand) | | | | |
| | Short wall | sqm | 14.35 | | |
| | Long wall | sqm | 8.30 | | |
| | Inlet register long wall | sqm | 0.42 | | |
| | Inlet register short wall | sqm | 0.61 | | |
| | Outlet register long wall | sqm | 0.49 | | |
| | Outlet register short wall | sqm | 0.71 | | |
| | Inlet register long wall – wall top | sqm | 0.07 | | |
| | Inlet register short wall – wall top | sqm | 0.10 | | |
| | Outlet register long wall – wall top | sqm | 0.07 | | |
| | Outlet register short wall – wall top | sqm | 0.10 | | |
| | Roof top | sqm | 5.19 | | |
| | Total | sqm | 30.42 | | |



| Sl. no. | Description | Unit | Quantity | Rate (INR) | Amount (INR) |
|---|---|---|---|---|---|
| H | **Reinforced cement concrete** | | | | |
| | Providing and casting in situ C.C. of trap / granite/ quartzite / gneiss metal of approved quality for RCC works as per detailed drawings and designs or as directed by Engineer-in-charge including normal dewatering, centering, form work, compaction, finishing the formed surfaces with C.M. 1:3 of sufficient minimum thickness to give a smooth and even surface wherever necessary or roughening if special finish is to be provided and curing, etc. complete. (By weigh batching and mix design for M-25 and M-30 only. Use of L&T, A.C.C., Ambuja, Birla Gold, Manikgad, Rajashree, etc. cement is permitted.) (Excluding M.S. or Tor reinforcement) | | | | |
| | In RCC M-30 | | | | |
| | Roof slap | cum | 0.65 | | |
| | **Deductions** | | | | |
| | Manhole covers | cum | -0.09 | | |
| | Total RCC for roof slab | cum | 0.56 | | |
| I | **Reinforcement** | | | | |
| | Providing and fixing in position steel bar reinforcement of various diameters for RCC piles, caps, footings, foundations, slabs, beams, columns, canopies, staircases, newels, chajjas, lintels, pardies, copings, fins, arches, etc. as per detailed designs, drawings and schedules; including cutting, bending, hooking the bars, binding with wires or tack welding and supporting as required, etc. complete (including cost of binding wire). | | | | |
| | Corrosion resistant steel (Fe 500) | | | | |

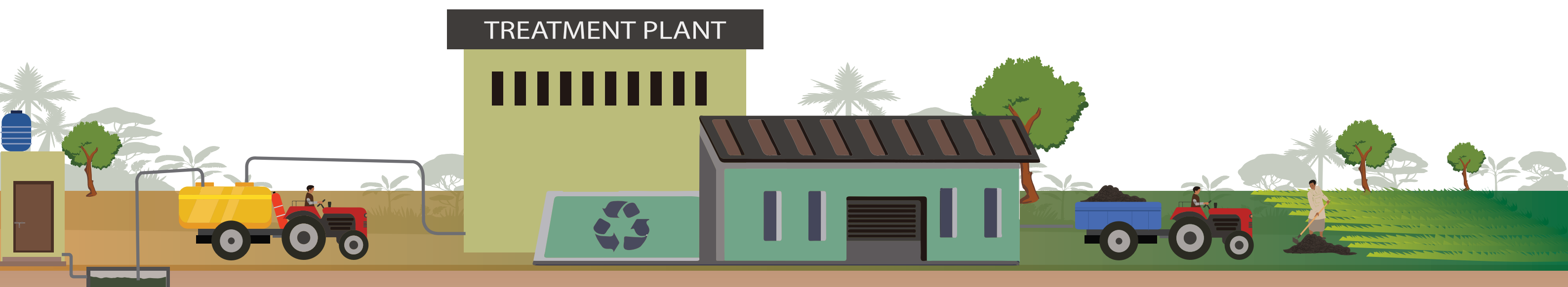
| Sl. no. | Description | Unit | Quantity | Rate (INR) | Amount (INR) |
|---|---|---|---|---|---|
| | Total Reinforcement for slab | KG | 66.98 | | |
| J | **Wastewater pipes** | | | | |
| | Providing at site, lowering & laying in trenches, aligning & jointing of PVC-U pipes (SN 8) as per IS 15328 (amended up to date) and as per specifications with rubber rings with socket and spigot joint, (EPDM/SBR) for all depths for pipe length as per drawing and specification including hydraulic field testing (including the cost and conveyance of water to site for testing) and commissioning etc complete as directed by Engineer. Note: E/w to be measured and paid separately | | | | |
| | 110 mm nominal dia pipes inside settler | Metre | 2.00 | | |
| | 110 mm dia U-PVC equal Tee (class III, 6kg/sqcm) confirming to IS:7834 | Each | 2.00 | | |
| K | **Manhole covers** | | | | |
| | Providing and laying of kota stone Kota stone slab 25 mm thick Providing and fixing in position steel fibre reinforced concrete (S.F.R.C.) frame and covers of approved make including loading, unloading, transportation, all taxes, etc. complete as directed by Engineer in-charge (20 tonnes capacity). | | | | |
| | 60 x 60 cm size | | | | |
| | Manhole covers in the RCC slap | No | 2.00 | | |
| L | **Painting** | | | | |
| | Finishing walls with water proofing cement paint of required shade: | | | | |
| | New work (two or more coats applied @ 3.84 kg/10 sqm) | sqm | 53.78 | | |
| | **Total cost for settler** | | | | |



**Cost estimate for construction of HPGF**

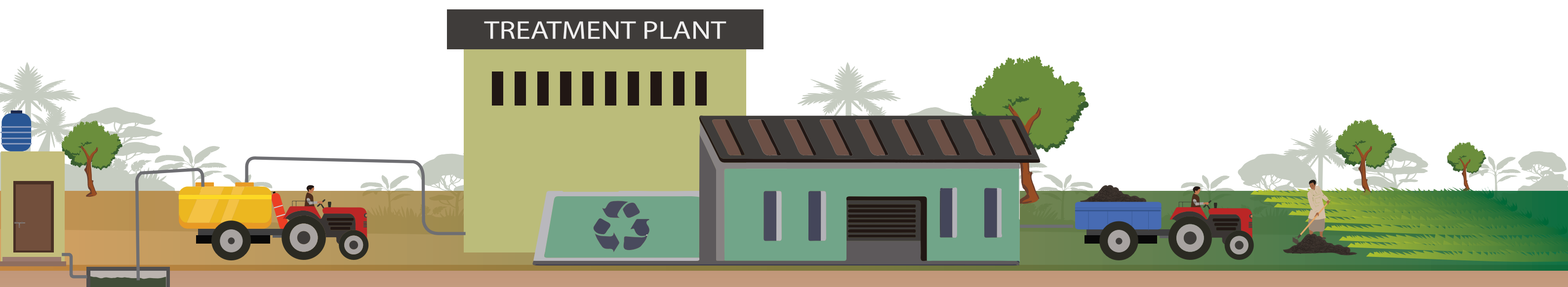
| Sl. no. | Description | Unit | Quantity | Rate (INR) | Amount (INR) |
|---|---|---|---|---|---|
| A | **Earthwork – excavation** | | | | |
| | Excavation for foundation / pipe trenches in earth, soils of all types, sand, gravel and soft murum, including removing the excavated material up to a distance of 50 metres and lifts as below, stacking and spreading as directed, normal dewatering, preparing the bed for foundation and excluding backfilling, etc. complete. | | | | |
| | Lift 0 to 1.5 m | | | | |
| | Excavation of the module | cum | 50.78 | | |
| | Total | cum | 50.78 | | |
| B | **Refilling with excavated earth** | | | | |
| | Filling in plinth and floors murum bedding in trenches with approved murum from excavated materials from foundation in 15 cm to 20 cm layers including watering and compaction, etc. complete. | | | | |
| | **Excavation below EGL** | cum | 50.78 | | |
| | Deduction for soling | cum | -2.63 | | |
| | Deduction for PCC | cum | -3.63 | | |
| | Deduction for wall | cum | -23.45 | | |
| | Total | cum | 21.07 | | |
| C | **Soling** | | | | |
| | Providing dry trap/ granite/ quartzite/ gneiss, rubble stone soling in 15 cm to 20 cm thick layers including hand packing and compacting, etc. complete. | | | | |
| | Stone soling | cum | 2.63 | | |
| | Total | cum | 2.63 | | |

| Sl. no. | Description | Unit | Quantity | Rate (INR) | Amount (INR) |
|---|---|---|---|---|---|
| D | **Plain cement concrete** | | | | |
| | Providing and laying in situ Cement Concrete M-15 of trap/ granite/ quartzite/ gneiss metal for foundation and bedding including bailing out water, form work, compaction, curing, etc. complete. (Cement 5.90 bags/ cum) | | | | |
| | In PCC M-15 | | | | |
| | PCC Bed | | 3.63 | | |
| | Sloped PCC | cum | 0.45 | | |
| | Distribution chamber PCC | cum | 0.11 | | |
| | Total | cum | 4.20 | | |
| E | **Brick work** | | | | |
| | 1st class brick work in 5:1 sand and cement of 1.25 fineness modulus mortar in super structure including necessary cutting and moulding of bricks required and also including honey comb brick work, thickness of walls more than one brick. | | | | |
| | Outer long wall | cum | 4.01 | | |
| | Outer short wall – DC side | cum | 0.94 | | |
| | Outer short wall – register side | cum | 0.99 | | |
| | Distribution chamber wall | cum | 0.28 | | |
| | Register long wall | cum | 0.07 | | |
| | Register short wall | cum | 0.04 | | |
| | Total | cum | 6.34 | | |



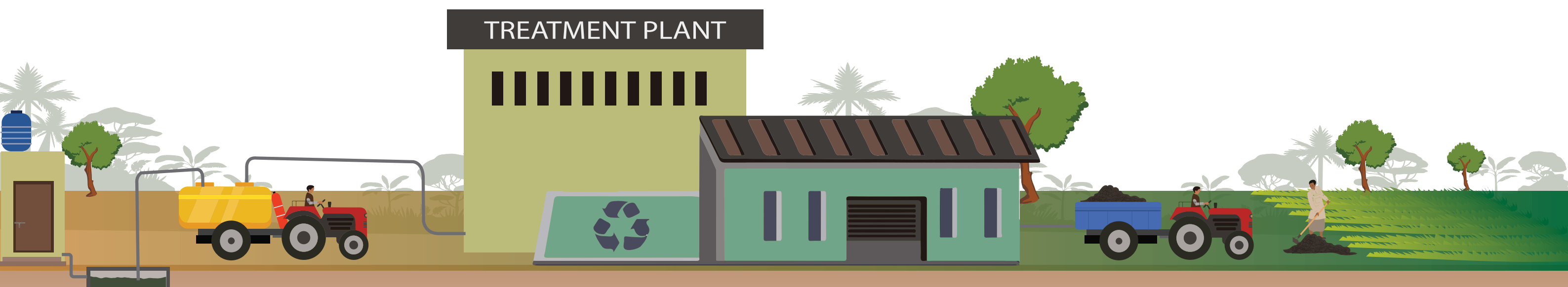
| Sl. no. | Description | Unit | Quantity | Rate (INR) | Amount (INR) |
|---|---|---|---|---|---|
| F | **Plastering – inner** | | | | |
| | 12 mm cement plaster finished with a floating coat of neat cement of mix :1:4 (1 cement: 4 fine sand) with water proofing agent | | | | |
| | Outer long wall | sqm | 16.16 | | |
| | Outer short wall | sqm | 8.64 | | |
| | Outer long wall – wall top | sqm | 2.81 | | |
| | Outer short wall – wall top | sqm | 1.39 | | |
| | Distribution chamber wall | sqm | 5.68 | | |
| | Distribution chamber wall – wall top | sqm | 0.30 | | |
| | Register long wall – Inner | sqm | 0.56 | | |
| | Register short wall – Inner | sqm | 0.38 | | |
| | Register long wall – outer | sqm | 0.65 | | |
| | Register short wall – outer | sqm | 0.39 | | |
| | Register long wall – wall top | sqm | 0.09 | | |
| | Register short wall – wall top | sqm | 0.05 | | |
| | Total | sqm | 37.09 | | |
| G | **Plastering – outer** | | | | |
| | 12 mm cement plaster finished with a floating coat of neat cement of mix :1:4 (1 cement: 4 fine sand) | | | | |
| | Short wall | sqm | 17.45 | | |
| | Long wall | sqm | 8.64 | | |
| | Total | sqm | 26.08 | | |

| Sl. no. | Description | Unit | Quantity | Rate (INR) | Amount (INR) |
|---|---|---|---|---|---|
| H | **Reinforced cement concrete** | | | | |
| | Providing and casting in situ C.C. of trap / granite/ quartzite / gneiss metal of approved quality for RCC works as per detailed drawings and designs or as directed by Engineer-in-charge including normal dewatering, centering, form work, compaction, finishing the formed surfaces with C.M. 1:3 of sufficient minimum thickness to give a smooth and even surface wherever necessary or roughening if special finish is to be provided and curing, etc. complete. (By weigh batching and mix design for M-25 and M-30 only. Use of L&T, A.C.C., Ambuja, Birla Gold, Manikgad, Rajashree, etc. cement is permitted.) (Excluding M.S. or Tor reinforcement) | | | | |
| | In RCC M-300 | | | | |
| | Support slab | cum | 0.07 | | |
| I | **Reinforcement** | | | | |
| | Providing and fixing in position steel bar reinforcement of various diameters for RCC piles, caps, footings, foundations, slabs, beams, columns, canopies, staircases, newels, chajjas, lintels, pardies, copings, fins, arches, etc. as per detailed designs, drawings and schedules; including cutting, bending, hooking the bars, binding with wires or tack welding and supporting as required, etc. complete (including cost of binding wire). | | | | |
| | Corrosion resistant steel (Fe 500) | | | | |
| | Total reinforcement for support slab | kg | 8.97 | | |



| Sl. no. | Description | Unit | Quantity | Rate (INR) | Amount (INR) |
|---|---|---|---|---|---|
| **J** | **Media filling** | | | | |
| | Providing and laying of coarse aggregate size as below after washing & sieving to make it free from fines & dust. | | | | |
| | Stone aggregate (single size) : 100 mm nominal size | cum | 2.97 | | |
| | Stone aggregate (single size) : 20 mm nominal size | cum | 4.51 | | |
| | Stone aggregate (single size) : 06 mm nominal size | cum | 1.88 | | |
| **K** | **Wastewater pipes** | | | | |
| | Providing at site, lowering & laying in trenches, aligning & jointing of PVC-U pipes (SN 8) as per IS 15328 (amended up to date) and as per specifications with rubber rings with socket and spigot joint, (EPDM/SBR) for all depths for pipe length as per drawing and specification including hydraulic field testing (including the cost and conveyance of water to site for testing) and commissioning etc complete as directed by Engineer. Note : E/w to be measured and paid separately | | | | |
| | 110 mm diametre pipes | Metre | 1.40 | | |
| | 63 mm diametre pipes | Metre | 2.50 | | |
| | 110 mm diametre uPVC equal tee (class III, 6kg/sqcm) confirming to IS:7834 | Each | 1.00 | | |
| | 110 mm diametre uPVC double/ single socketed 90° bend (class III, 6kg/sqcm) confirming to IS:7834 (elbow fixing at PDB inlet) | Each | 2.00 | | |
| | Slotted cowl (terminal guard) 100 mm diametre | Each | 3.00 | | |
| | 110 mm perforated bottom & vertical pipe | Metre | 4.25 | | |

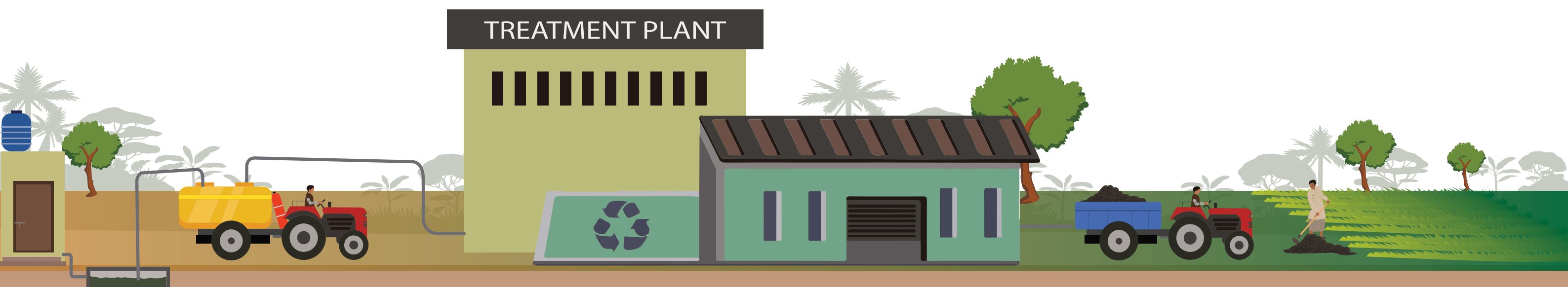
| Sl. no. | Description | Unit | Quantity | Rate (INR) | Amount (INR) |
|---|---|---|---|---|---|
| **L** | **Plantation** | | | | |
| | Providing and planting common reeds or other rhizome with four plant per square metre | No | 72.00 | | |
| **M** | **Kadappa stone** | | | | |
| | Providing and laying of kota stone kota stone slab 25 mm thick | | | | |
| | Distribution chamber top | sqm | 5.40 | | |
| | Register top | sqm | 0.38 | | |
| | Total of kadappa stone | sqm | 5.78 | | |
| **N** | **Brick bat filling** | | | | |
| | Providing and laying of brick bats in DC as per the instruction given by engineer in charge | | | | |
| | Brick fat filling inside distribution chamber | cum | 7.05 | | |
| **O** | **Painting** | | | | |
| | Finishing walls with water proofing cement paint of required shade: | | | | |
| | New work (two or more coats applied @ 3.84 kg/10 sqm) | sqm | 63.17 | | |
| | **Total cost for HPGF** | | | | |



**Cost estimate for construction of polishing pond**

| Sl. no. | Description | Unit | Quantity | Rate (INR) | Amount (INR) |
|---|---|---|---|---|---|
| A | **Earthwork – excavation** | | | | |
| | Excavation for foundation / pipe trenches in earth, soils of all types, sand, gravel and soft murum, including removing the excavated material up to a distance of 50 metres and lifts as below, stacking and spreading as directed, normal dewatering, preparing the bed for foundation and excluding backfilling, etc. complete. | | | | |
| | Lift 0 to 1.5 m | | | | |
| | Excavation upto brick level | cum | 10.15 | | |
| | Above 1.5 m | | | | |
| | Excavation for the stone pitching | cum | 6.35 | | |
| B | **Refilling with excavated earth** | | | | |
| | Filling in plinth and floors murum bedding in trenches with approved murum from excavated materials from foundation in 15 cm to 20 cm layers including watering and compaction, etc. complete. | | | | |
| | **Excavation below EGL** | **cum** | **16.50** | | |
| | Deduction for brick work | cum | -9.19 | | |
| | Deduction for stone pitching | cum | -6.35 | | |
| | Total | cum | 0.96 | | |
| C | **Stone pitching** | | | | |
| | Dry stone pitching 22.5 cm thick including supply of stones and preparing surface complete. | | | | |
| | Stone pitching | sqm | 23.63 | | |

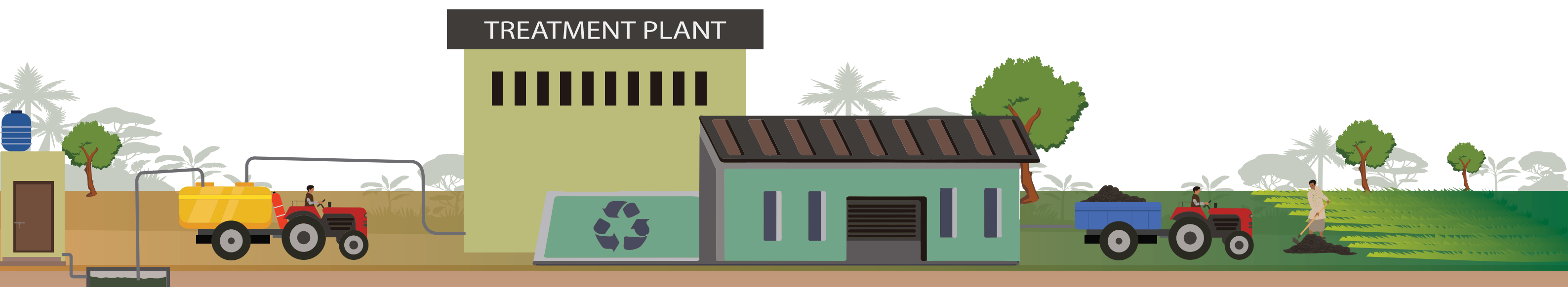
| Sl. no. | Description | Unit | Quantity | Rate (INR) | Amount (INR) |
|---|---|---|---|---|---|
| D | **Plain cement concrete** | | | | |
| | Providing and laying in situ Cement Concrete M-15 of trap/ granite/ quartzite/ gneiss metal for foundation and bedding including bailing out water, form work, compaction, curing, etc. complete. (Cement 5.90 bags/ cum) | | | | |
| | In PCC M-150 | | | | |
| | PCC bed | cum | 0.29 | | |
| E | **Brick work** | | | | |
| | 1st class brick work in 5:1 sand and cement of 1.25 fineness modulus mortar in super structure including necessary cutting and moulding of bricks required and also including honeycomb brick work, thickness of walls more than one brick. | | | | |
| | Wall | cum | 2.47 | | |
| F | **Plastering – Inner** | | | | |
| | 12 mm cement plaster finished with a floating coat of neat cement of mix :1:4 (1 cement: 4 fine sand) with water proofing agent | | | | |
| | Wall | sqm | 12.23 | | |
| | Wall top | sqm | 2.18 | | |
| | Total | sqm | 14.41 | | |
| G | **Plastering – Outer** | | | | |
| | 12 mm cement plaster finished with a floating coat of neat cement of mix :1:4 (1 cement: 4 fine sand) | | | | |
| | Wall | sqm | 14.10 | | |



| Sl. no. | Description | Unit | Quantity | Rate (INR) | Amount (INR) |
|---|---|---|---|---|---|
| H | **Wastewater pipes** | | | | |
| | Providing at site, lowering & laying in trenches, aligning & jointing of PVC-U pipes (SN 8) as per IS 15328 (amended up to date) and as per specifications with rubber rings with socket and spigot joint, (EPDM/SBR) for all depths for pipe length as per drawing and specification including hydraulic field testing (including the cost and conveyance of water to site for testing) and commissioning etc complete as directed by Engineer. Note : E/w to be measured and paid separately | | | | |
| | 63 mm diametre pipes | Metre | 3.50 | | |
| I | **Pumps** | | | | |
| | Supply, installation and commissioning of 1HP Monoblock pump of Kirloskar, CRI or equivalent make for pumping of water. Includes civil works, fabrication work for mounting the pump, necessary plumbing/ wiring as per the instructions of engineer in charge. | | | | |
| | Pump for polishing pond | No | | | |
| J | **Painting** | | | | |
| | Finishing walls with water proofing cement paint of required shade: | | | | |
| | New work (two or more coats applied @ 3.84 kg/10 sqm) | sqm | 28.51 | | |
| | **Total cost for polishing pond** | | | | |

## D. Operation and Maintenance

- Sludge from the septic tanks/single pits should be transported to the site by vacuum trucks, tractor mounted vacuum tanks, tankers, etc. It must be ensured that only faecal sludge from households, institutions or commercial establishment is disposed of in the sludge drying beds and no industrial or toxic sludge is deposited there
- This sludge should be laid over the sludge drying bed under supervision. Adequate safety gear should be used by the personnel and raw sludge should not come into human contact under any circumstances
- The thickness of the sludge layer should not exceed 10–15 cm (as per design). Two or more sludge drying beds can be simultaneously used to facilitate laying of sludge in thinner layers if necessary and if adequate bed area is available
- A date-wise log of the number of trucks entering and quantum of sludge deposited should be maintained. This will also be useful for scheduling evacuation or raking of the dried sludge
- Regular checks should be made for obstacles in inlet, outlet pipes of each of the treatment modules
- Regular removal of collected waste from the screening chamber and excess sludge from the settler should be undertaken periodically
- The dried sludge must be emptied when the bed is full, or as per designed desludging period. A bed should be allowed to rest for 6 months before it is emptied to allow complete drying and pathogen reduction. If resting within the bed is not practical, then the sludge may be emptied and heaped for six months outside the bed, away from human contact
- Dried sludge that has been removed should be transported for further treatment. If it is treated in the same premises, the O&M activities required as per the technology adopted for further treatment must be carried out
- Filter materials of the drying beds and planted gravel filters need to be cleaned of clogs or replaced if the percolation rate declines or drying time increases beyond what was expected
- Harvesting of plants in PDB and planted gravel filter should be done
- Emptying of a full bed should preferably be done in dry seasons
- Cleaning of perforated discharge pipe and inlet pipes should be carried out periodically, using appropriate equipment
- Refer to the following table in the next page for the O&M checklist and frequency for each activity



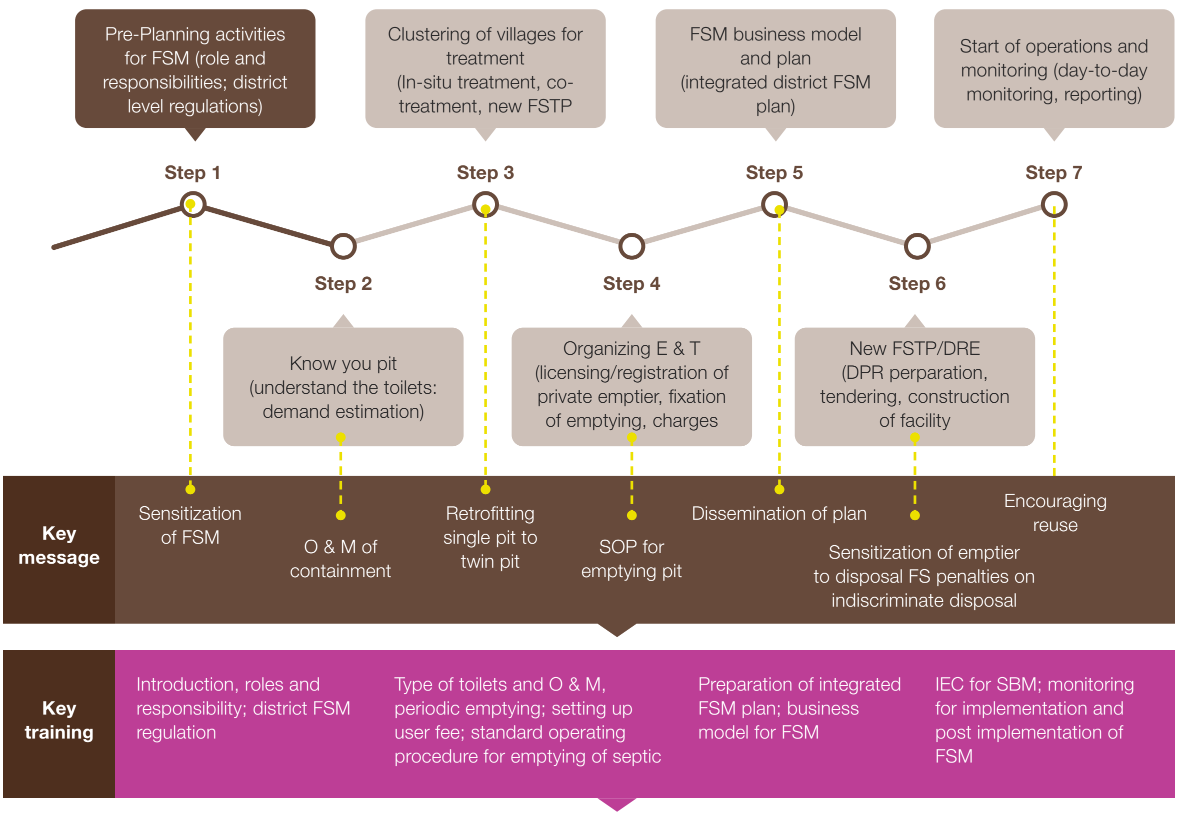
| Tasks | Frequency |
|---|---|
| Emptying of dried sludge | Once in 2–3 years |
| Washing and replacement of filter material | Once in 2–3 years/when clogging is observed |
| Refilling of sand | After removal of dried sludge |
| Cleaning of perforated drainage pipes | Once in 6 months |

Annexure 4

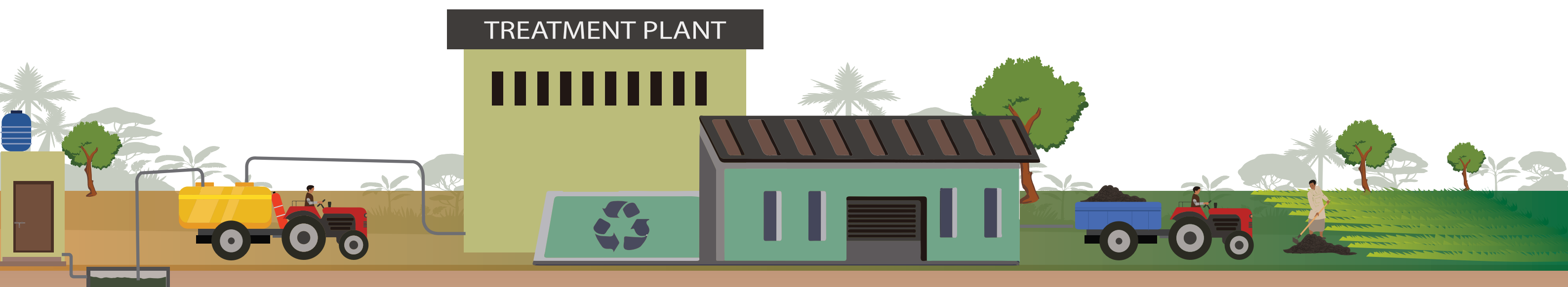
# Integrated District FSM Plan

Districts are responsible for the planning, implementation, O & M, and monitoring of FSM. The districts follow the step-by-step approach, with an integrated District FSM plan to be developed either at the very initial phase or after assessing necessary infrastructure gaps. Figure 3.1 below presents a snapshot of the step-by-step approach along with key IEC messages and training activities to be undertaken.

**Figure 2:** FSM Implementation approach




DPR: Detail project report, FS: Faecal sludge; E & T: Emptying and Transportation; FSTP Faecal sludge treatment plant; IEC: Information, education and communication; O & M: Opeation and Maintenance; SOP: Standard operating procedure;



| Step | Outcome/ Key milestones |
|---|---|
| **Step 1:** Pre-planning activities for FSM | • Orientation at district, blocks and GP<br>• Regulations to be enacted at district level including roles and responsibilities.<br>• Integrated district FSM plan preparation |
| **Step 2:** Know your pit | • List of villages requiring FSM services and estimation of the quantity of FS.<br>• Retrofitting of all single pit toilets to twin pit toilets |
| **Step 3:** Cluster the villages for treatment | • Every village is mapped to an existing STP/FSTP.<br>• Land and technology identified for the cluster of villages requiring new FSTP |
| **Step 4:** Organizing the emptying and transportation | • Estimate additional desludging vehicles required in the district.<br>• Licensing/ registration of private desludging operators |
| **Step 5:** FSM plan | • Operations plan for FSM in district prepared.<br>• Integrated district FSM plan approval from DWSC/ DWSM. |
| **Step 6:** Implement new FSTP or DRE | • Retrofitting of septic tank toilets with soak pit.<br>• Construction of FSTP/Trenches complete |
| **Step 7:** Start of operations and monitoring | • FSM monitoring is undertaken by district, block, and village administrations and respective water-sanitation committees |

**How to prepare integrated district faecal sludge management (FSM) plan**

1 Rapid Assessment (type of toilets, retrofitting of toilets by gran panchayat; inventory of STP/FSTP by district)

2 Estimate signle pit toilets that can be covertd into twin pit toilets

Segregate villages where all toilets are connected to twin pit or can be converted into twin pits or other in-situ treatment options

3 Organize emptying and transportation through accreditation of private sector*

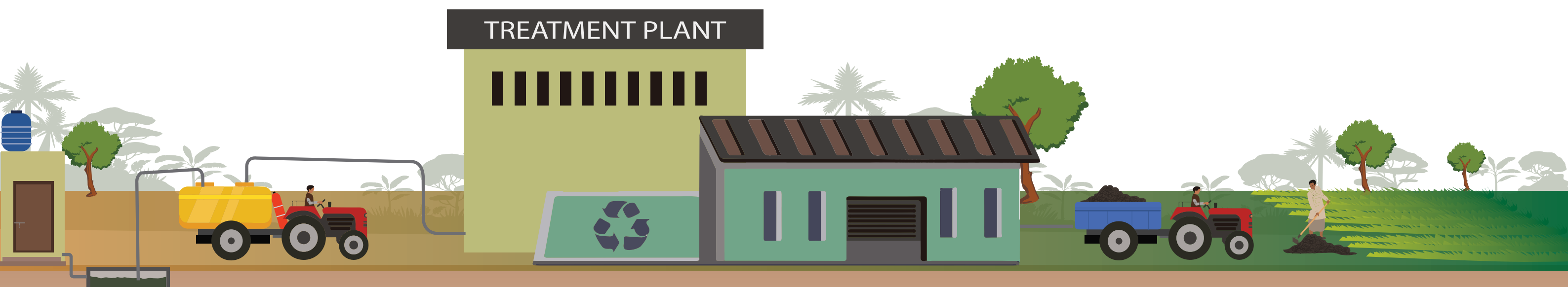
4 Form cluster of villages to be linked with existing and proposed STP/FSTP in urban areas

Organizing of emptying and transportation including registrations/ licensing shall be associated with linking them to treatment facility or site for disposal for all collected faecal sludge

5 Form cluster of left out villages for establishing new FSTPs. Take the retrofitting of septic tank with soak pits

6 Identify land for DRE (deep row entrenchment) as interim solutions for villages can not be clustered

1. The District Collector/ District Magistrate/ Chief Executive Officer (CEO) Zila panchayat with support from SBM (G), Rural Development (RD), and UD should ensure full inventory of all existing FSM infrastructure i.e., Sewerage Treatment Plant (STP), Faecal Sludge Management Plant (FSTP), Suction Machine for emptying septic tanks operated by private and public agencies. The information should be furnished in Tables 4 and 5.
2. GPs through Swachhagrahi/ volunteer should undertake a rapid appraisal for the type of toilets – Septic tanks, Twin pit, Single pit; and retrofitting of toilets. GPs should encourage households to retrofit all single pit toilets to twin pit unless is it technically unviable. The format for village-level rapid assessment is provided in table 4.
3. GPs shall collect and submit the data within 10 days to the respective block for compilation and verification. The block coordinator should undertake a back check and verifies information from 5 villages covering at least 50 toilets.
4. Verification should be undertaken by block within 10 days of data submission. The data after verification should be submitted to the district for further analysis and preparation of the integrated district FSM plan.
5. Estimate all single pit toilets to be converted into twin pit toilets unless it's technically unviable. Details at the district level to be compile as per table 5.



6. For estimating the requirement of faecal sludge following considerations should be taken:
   - In-situ treatment system such as twin pit does not require emptying. They should not be considered for FSM implementation
   - Faecal sludge from septic tank requires periodical mechanized emptying should be considered for FSM
   - Close pits or fully lined tanks that require periodical mechanized emptying should be considered for FSM
   - Single pit toilets that cannot be retrofitted require periodical mechanized emptying should be considered for FSM
   - Any other type of toilet that requires emptying of raw or partially treated faecal sludge should be considered for FSM implementation

Note: Number of rows in tables is representative, additional rows should be added as per requirement. This is the draft template for easing implementation, districts may do necessary augmentation as per their requirement.

## Draft Template for Integrated District FSM Plan

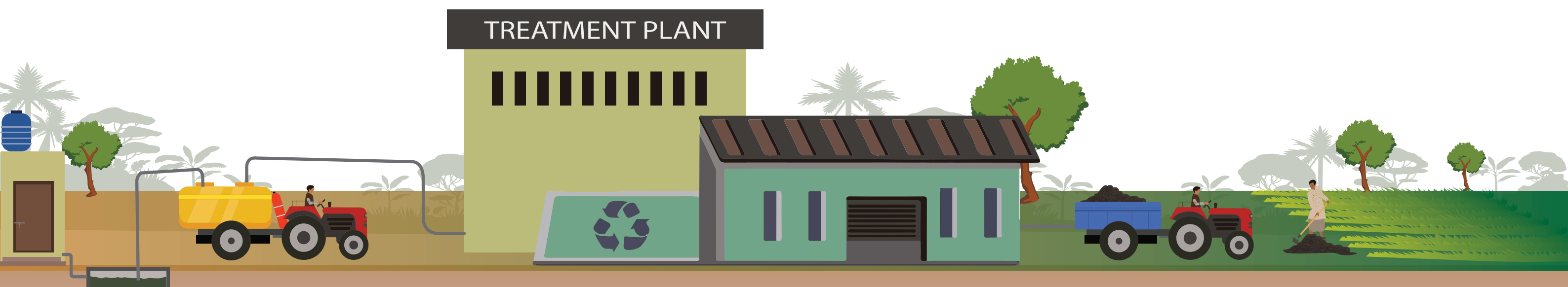
| District | | Number of blocks | |
|---|---|---|---|
| Number of GPs | | Number of villages | |
| Number of urban local bodies | | Number of urban local bodies with STP/FSTP | |
| Total rural population in district | | Total rural population require FSM (current year) | |

**Executive summary**

| Villages segregated for in-situ treatment and FSM implementation | | |
|---|---|---|
| In-situ treatment | Number of villages fully covered by twin pits or in-situ treatment toilets | |
| | Number of villages where retrofitting of single pit toilets to twin pit toilets will ensure full coverage by twin pit or in-situ treatment | |
| FSM implementation | Number of villages that require FSM implementation | |
| | Number of villages where septic tank effluent can be disposed through soak pit | |
| | Number of villages where a conveyance and treatment system is required for disposal of septic tank effluent/supernatant (to considered with greywater management) | |

| Emptying and transporation | |
|---|---|
| Number of emptying vehicles/ desludgers in the districts (urban + rural) | |
| Number of operator register/licensed ( district + municipality + other ) | |
| Number of emptying vehicles require | |

| Treatment infrastructure (urban + rural) | | | | |
|---|---|---|---|---|
| Total existing treatment facilities | No. of STPs | | No. of FSTPs | |
| Facilities available for rural FSM<br><br>(Co-treatment at STP/ Treatment at FSTP) | No. of STPs | | No. of FSTPs | |
| Number of proposed FSTPs | | | | |
| A number of temporary treatment units (deep row entrenchment ('DRE') etc.) | | | | |



**Financial :** Total Requirement: ____________________________ Lakhs

| | SBM Phase-II | 15th finance commission | MNGRES | Other |
|---|---|---|---|---|
| Funding (lakhs) | | | | |

## a. Basic Information

| | | | |
|---|---|---|---|
| Number of cities/ towns with STPs (please annex a list) | | Number of cities/ towns with FSTP (please annex a list) | |
| Number of cities/towns where treatment facility is under construction (please annex a list) | | Number of GPs having STP | |
| Number of GPs having FSTP | | Number of GPs where treatment facility is under construction (please annex a list) | |
| Number of GPs proposed with STP; GWM – WSP, DEWATS (please annex list) | | Number of DPRs prepared for FSM/FSTP in the district for rural FSM/FSTP | |

## b. Identification of villages for FSM and estimation of faecal sludge generated

| Sr. no | Block/ cluster | Total number of villages | Villages fully saturated with twin pit | Villages where retrofitting (single to twin pit) will ensure full coverage of in-situ toilets. | Villages require FSM |
|---|---|---|---|---|---|
| **(a)** | **(b)** | **(c)** | **(d)** | **(e)** | **(f= c - d-e)** |
| | | | | | |

| Sr. no | Block/ cluster | Total number of toilets | Toilets with twin pit or any other in-situ treatment technology | Total number of single toilets that can be retrofitted into twin pit toilets/in-situ toilets | Toilets needing FSM |
|---|---|---|---|---|---|
| **(a)** | **(b)** | **(c)** | **(d)** | **(e)** | **(f= c - d-e)** |
| | | | | | |

| Sr. no | Blocks/ cluster | Population requiring FSM | Faecal sludge generated (in kld[1]) | FSTP/ DRE capacity (j or minimum 4 kld)[1] |
|---|---|---|---|---|
| (g) | (h) | i = f X HH Size | j = i x 0.00021 | k = jX1.15 |
| | | | | |

| Sr. no | Blocks/ cluster | Total number of septic tanks+ other toilets discharging partially treated water into drains | Number of toilets having space available for construction of soak pit | Number of toilets to be connected to cluster-based soak pit/ dispersion trench | Houses where soak pit is not feasible (high water table, low permeability, space constraint, other) |
|---|---|---|---|---|---|
| (l) | (m) | (n) | (o) | (p) | (q) |
| | | | | | |

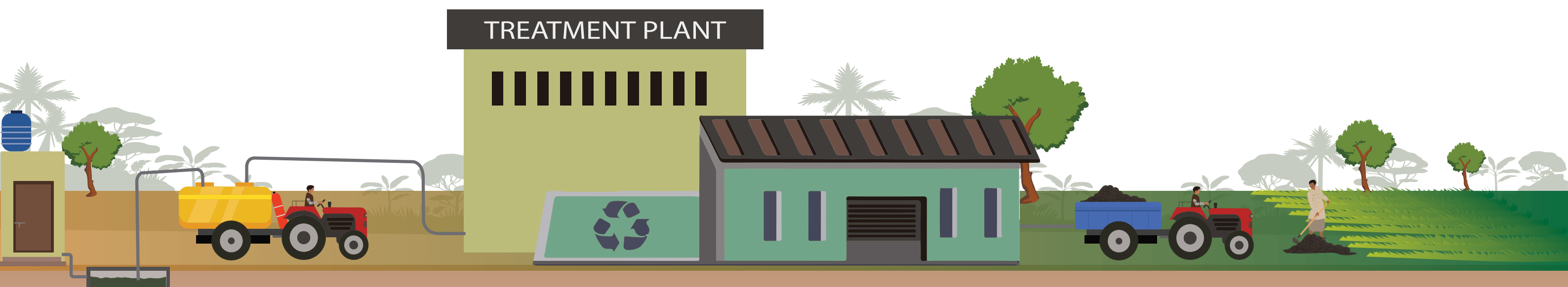
- First clustering should be carried out based on the existing STPs/FSTPs followed by left out villages based on the requirement of a new treatment facility to be established. Preferably, the block should be considered as a cluster unless the travel distance is 10 km or 15–20 km in extreme cases. If the travel distance is more than 20 km, blocks need to be divided into clusters, but if it is less than 10 km multiple blocks should be merged to form a cluster.

### c. Requirement for emptying and transportation services in the district

| Sr. no. | Blocks/ clusters | Total number of desludging trucks/ suction machine/ equipment | Desludging trucks/ suction machine/ equipment capacity available (in kld)[2] | Desludging trucks/ suction machine/ equipment requirement | Requirement can be fulfilled by suction machine/ equipment serving in other clusters (yes/ no) | Requirement of additional suction machine |
|---|---|---|---|---|---|---|
| (i) | (ii) | (iii) | (iv) | (v) | (vi) | (vii) |
| | | | | | | |

[1] Capacity of FSTP should be in multiple of average desludging/ emptying capacity.

[2] Average Capacity of suction trucks X Number of suction trucks X Maximum Trip per day)/1000



### d. Requirement for treatment infrastructure in districts

| Treatment of faecal sludge (FS) at existing infrastructure: Co-treatment at STP/ treatment at FSTP | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Sr. no | Block/ cluster number | Total FS generated in the cluster (in kld) | Location description of STP/ FSTP | Design/ installed capacity of STP/ FSTP (in kld) | Unutilized capacity (in kld) | Capacity to accept FS (in kld)[3] | Capacity allocated for rural FS (in kld) | Additional infra-structures require to treat FS |
| | (viii) | (ix) = k | (x) | (xi) | (xii) | (xiii) | (xvi) | (xv) |
| | | | | | | | | |

### Proposed treatment infrastructure in clusters

| Sr. no | Block/ cluster number | Total fs generated in the cluster (in kld) | Land identified in the cluster | The extent of land identified (in acres) | Location of land identified for the cluster (village; lat/long) | Temporary treatment provision (yes/no) |
|---|---|---|---|---|---|---|
| (vi) | (viii) | (ix) = q | (xi) | (xii) | (xiii) | (xvi) |
| | | | | | | |

- The private services provider available in urban-rural areas should provide emptying services to the villages and transport it to designated STP/FSTP. The gaps in emptying and transportation infrastructure should be addressed by the incentivizing the entrepreneurs/ private sector/SHGs to take the business.
- Temporary treatment system, particularly in areas without any existing facilities, may be taken on the land identified for construction of FSTP to allow the collected faecal sludge until the FSTP is commissioned.
- Proposed FSTP can be co-constructed with greywater management system i.e., WSP, DEWATS etc. This will reduce the construction cost by utilizing by co-treating liquid waste as well as it will allow sharing of O&M.

[3] Capacity to accept FS: xiii= xii for FSTP; Technical feasibility will require for STP in case of absence of such feasibility it may be calculated by xiii=(xii) x 0.01 for STP

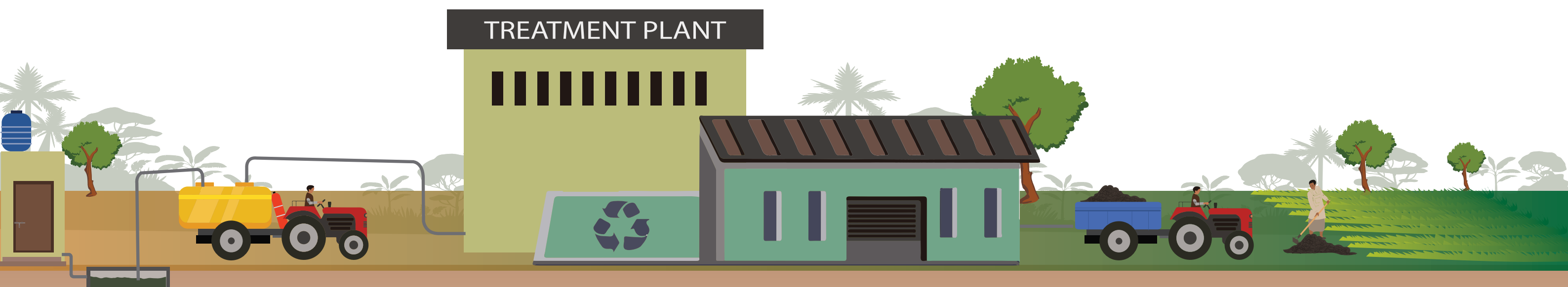
### e. Financial planning and convergence

| Activity | Physical quantity (number) | Funds required (lakh) | Share of fund from SBM Phase-II (lakh) | Share of fund 1:.......... | Share of fund 2:.......... |
|---|---|---|---|---|---|
| Retrofitting of toilets | | | | | |
| Emptying and transportation | | | | | |
| New FSTPs | | | | | |
| Deep row entrenchment (DRE) | | | | | |
| IEC | | | | | |
| Capacity building | | | | | |
| Other | | | | | |
| **Operation and maintenance** | | | | | |
| FSTP[4] | | | | | |
| DRE | | | | | |
| Other | | | | | |

### f. Implementation plan

| | Date of start | Date of completion |
|---|---|---|
| Retrofitting of the single pit to twin pit | | |
| Retrofitting of septic tanks with soak pits | | |
| Retrofitting of septic tanks with cluster-based soak pits/ dispersion trench | | |
| Memorandum of agreement/ memorandum of understanding (MoA/MoU) for co-treatment at STPs/ disposal at existing FSTP in urban area | | |
| Registration/ licensing of the private operators | | |
| Preparation of DPRs | | |
| Construction of proposed FSTPs | | |
| Construction of deep-row-entrenchment (interim solution) | | |

[4] Please annexe details for business models adopted for FSM



| | Date of start | Date of completion |
|---|---|---|
| **IEC activity** | | |
| Activity planned | | |
| Schedule of activity | | |
| **Capacity building** | | |
| Activity planned | | |
| Schedule of activity | | |

### g. Roles and responsibility

| | District | Block |
|---|---|---|
| Preparation, implementation, and monitoring of integrated district faecal sludge management plan | DWSC/ DWSM | |
| All matters on faecal sludge management | DWSC/ DWSM | |
| Registration/ licensing of all private emptier | | |
| Retrofitting of single pit to twin pit | | |
| Retrofitting of septic tanks with soak pit | | |
| Memorandum of agreement (MoA) for co-treatment at STPs/ disposal at existing FSTP in urban area | | |
| Construction of proposed FSTPs | | |
| Construction of deep-row-entrenchment (interim solution) | | |
| Operation and maintenance (O&M) of FSTPs | | |

1. Annex a list of officers with their designation responsible for the above roles and responsibilities.

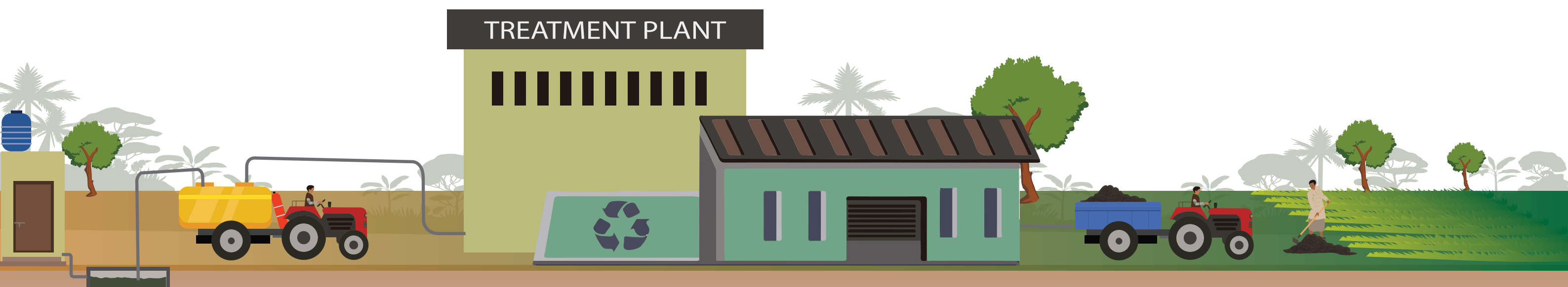
# Annexure 4.1: Template for Rapid Assessment of the Type of Toilets and Retrofitting Requirement

1. The template is developed for rapid assessment of the type of toilets i.e., twin pit, septic tank, single pit etc.
2. The template will help in identifying single pit toilets that have space and technically viable for retrofitting into twin pit toilets.
3. It will also help to identify the septic tank with space that can be retrofitted with the soak pit for safe management of partially treated wastewater (also known as effluent/ supernatant) discharged into open drains.
4. Other than septic tanks, toilets containment (pit) without any honeycombing wall and lined bottom (usually refer as close pits) require periodic mechanized emptying as well as soak pit to manage the liquid (effluent/ supernatant) coming out of it. They should be considered for the FSM as well as retrofitting with soak pit.

**Table 3:** Village Level Details on the Type of Toilets and Retrofitting Requirement

Name of GP ______________________________ Date ______________

| Name of village | Total number of toilets | Number of toilets connected to | | | | Number of toilets to be retrofitted | | |
|---|---|---|---|---|---|---|---|---|
| | | Twin Pit and other in-situ treatment (total) | Septic tank (total) | Single pit (total) | Other-requiring mechanized emptying | Single pit to twin pit | Septic tank with individual soak pit | Septic tank with cluster-based soak pit/ dispersion trench (2 toilets or more) |
| | | | | | | | | |



## Annexure 4.2: Spreadsheet Based Assessment Sheets

**Table 4:** Estimation of Vehicle Capacity Available for Emptying and Transport of Faecal Sludge in the District

| Sr. no. | Owner of the desludging vehicle/ suction machine | Number of desludging vehicles registered/ licensed* (yes/no) | Authority provided regist-ration/ license for emptying pits | Name of blocks providing services | Name of blocks interested to provide services in future | Contact details of the vehicle owner | Capacity of the vehicle (in liters) | Tractor mounter/ truck (other fast-moving) mounted | Maxi-mum possible trips in a day |
|---|---|---|---|---|---|---|---|---|---|
| A | B | C | D | E | F | G | H | I | J |
| | | | | | | | | | |
| | | | | | | | | | |
| Total emptying and transport capacity available in the district | | | | | | | | | |
| Households located in the areas where the vehicle cannot reach for desludging due to narrow lane | | | | | | | | | |
| *Any private vehicle carrying license or registration for emptying the septic tank given by any public agency (District/ Municipality/ Block). Desludging vehicles operated by the public agency should be considered registered/licensed. | | | | | | | | | |

**Table 5:** Estimation of Available Treatment Capacity at Existing Urban STPs or FSTPs

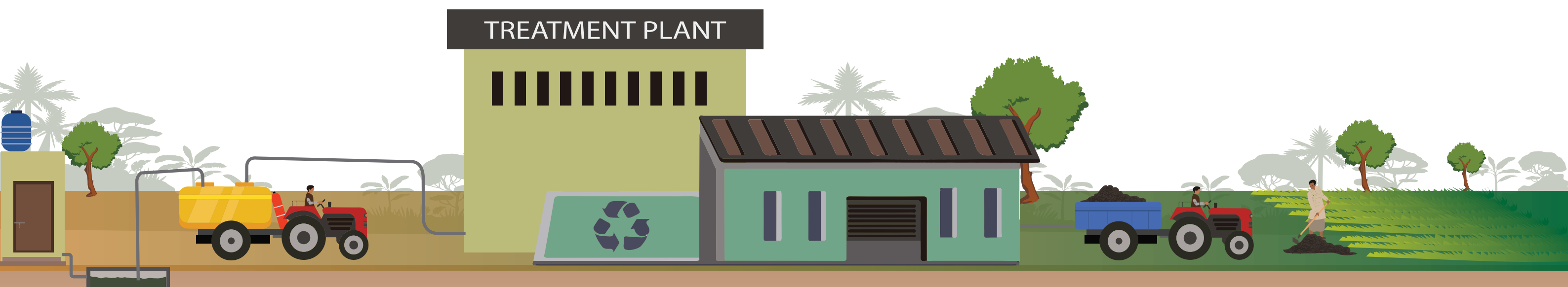
| Sr. no. | STP/ FSTP | City or town where STP/FSTP is located | Block | Location description of STP/ FSTP (latitude/ longitude) | Design capacity of STP/ FSTP (in kld) | Operating capacity (in kld) | Formal approval to accept FS from rural areas? (Yes/no) | If yes, for how many years? |
|---|---|---|---|---|---|---|---|---|
| A | B | C | | D | E | F | I | J |
| | | | | | | | | |

Annexure 5

# Detailed Project Report for FSTP

Districts can prepare the DPR up to 8 kld by using this manual. The sections to be included, along with references, are listed below. For FSTP above 8 kld a DPR can be prepared with similar guidelines.

1. Executive summary (Table showing location of FSTP, number of villages served, expected population, capacity, technology description, capital cost, annual maintenance cost; financial details – scheme convergence)
2. Introduction
   a. Detail of cluster: Name of villages, details of septic tank and single pit
   b. Details of emptying: Number of emptying vehicles (private/public) current and expected
   c. Treatment plant: Details of any treatment system available in cluster
   d. Need for the project.
3. Treatment technology (Based on technology: e.g., adapt section 6, Annexure 3 for PDB technology)
4. Costing (Based on technology: Adapt from Annexure 3)
5. Funding (Component wise: SBM (G) Phase-II, Fifteenth Finance Commission and other sources)
6. Annexure
   a. Drawings (Based on Annexure 3)
   b. Estimate (Based on Annexure 3)



Annexure 6

# Urban-Rural Convergence – Case study of Dhenkanal District, Odisha

The Dhenkanal district in Odisha has a total population of 12 lakh, with 2.7 lakh urban and rural households residing in 3 statutory towns and 199 gram panchayats (GMs)[5]. According to the Census of India (2011), septic tanks were one of the most prevalent on-site systems connected to flush/pour flush latrine systems in rural areas in Dhenkanal. This was further confirmed through a rapid assessment carried out in the district by UNICEF and its implementing partner CPR in 2020.

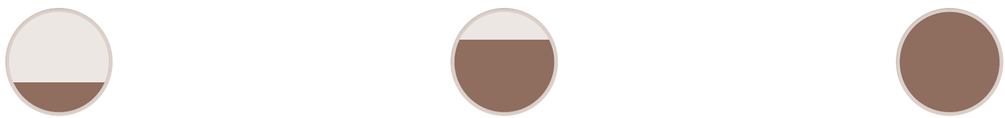
Given the prevalence of predominantly on-site sanitation systems in rural Odisha, without regular faecal sludge management (FSM) services, the toilets may become non-functional over time.

In the effort of achieving and sustaining an open, defecation free environment, it is not only important to ensure the continued usage of the newly constructed toilets under Phase I of the Swachh Bharat Mission (Grameen), but also to ensure the availability of affordable FSM services..

The SBM Grameen Phase II recommend and provide emphasis on urban-rural convergence, providing an opportunity to leverage existing Faecal Sludge Treatment Facilities (FSTPs) in urban areas to serve their rural surroundings as far as possible. Such a project was initiated in Dhenkanal, Odisha in 2020, with an aim to enable rural communities to access the urban-based FSM services and develop a novel district-wide approach to rural sanitation planning.

The broad timeline for the FSSM intervention is as follows:

**Figure 3:** Timeline for the FSM Intervention



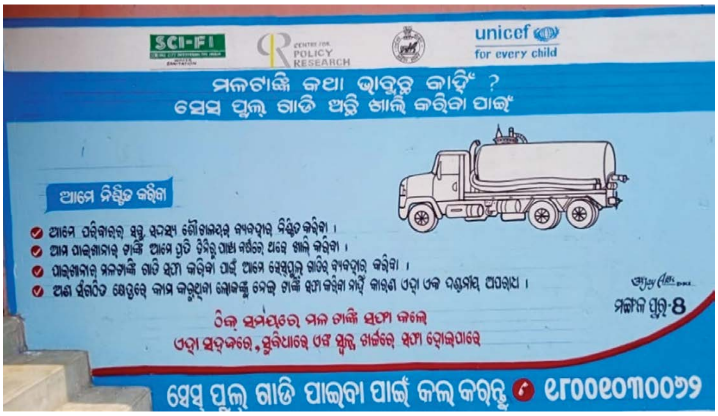
| **Oct 2018** | **June 2020** | **Dec 2020** |
|---|---|---|
| Urban FSTP commissioned | Urban FSTP handed over to SHG for O&M | Formal agreement with 17 GPs |

[5] Census of India (2011)

## Key Achievements:

- 17 GPs were identified and connected to the existing treatment plant located at Dhenkanal. For clusters of villages away from Dhenkanal,, new FSTPs are being developed.
- Septic tank emptying requests are received through a toll-free number (18001030072 and 14420) for both urban and rural areas. Dedicated FSSM call centres have been created to track requests and provide services.

**Figure 4:** IEC messages for awareness creation




- To create awareness about FSM, regular meetings have been held with the GP, and leaflets have been distributed door-to-door.
- The Area Level Federation (ALF) manages the entire operation and maintenance (O&M) of the cesspool emptier vehicles and the FSTP.
- ALF is also engaged in direct-indirect demand generation in both the urban and rural areas.

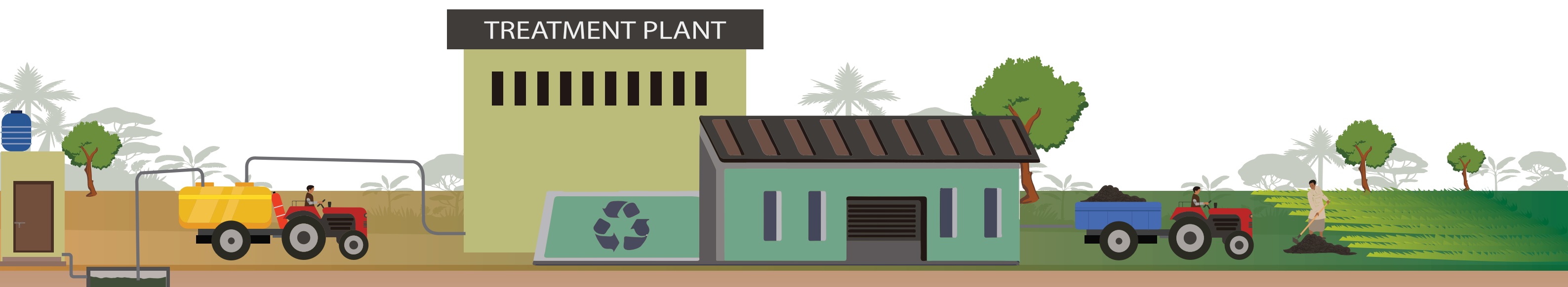
# Strategy for Urban-Rural Convergence

An FSM strategy was developed to enable rural communities to access the urban-based FSM services and develop a novel district-wide approach to rural sanitation planning. This approach was based on:

1. Leveraging the available urban FSTP facility in town (Dhenkanal Municipality) for safely managed faecal sludge generated in neighbouring GPs; and
2. Demonstrating pilots on SLWM in identified locations in rural areas.

## Strategy 1. Plug-In (Co-treatment at STP or Disposal at FSTP):

In the clustering model, neighbouring GPs were ‘plugged-in’ to the existing FSM facilities of Dhenkanal municipality, allowing service delivery to rural communities within a feasible radius. 17 GPs have entered into a formal agreement to extend the urban-based FSM services to areas adjacent to rural areas, without adding any additional infrastructure. A similar clustering approach is also planned for the upcoming urban facilities in other urban local bodies (ULBs) of the district.



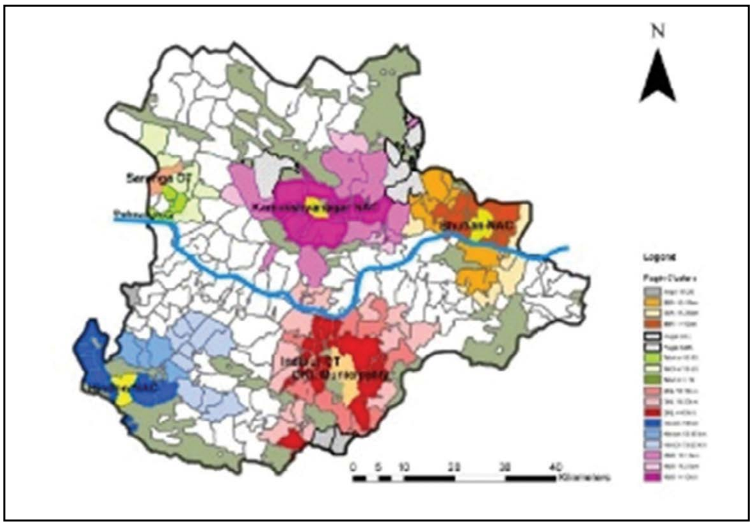
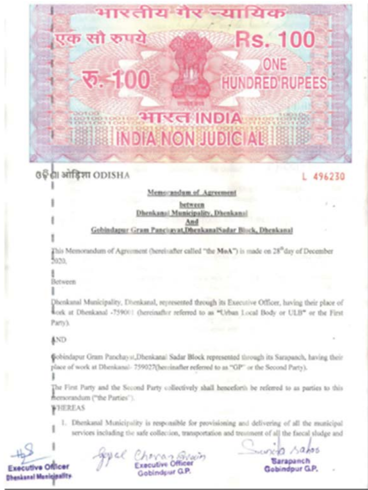



**Figure 5:** Clustering model in the district



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**Memorandum of Agreement**
**between**
**Dhenkanal Municipality, Dhenkanal**
**And**
**Gobindapur Gram Panchayat,DhenkanalSadar Block, Dhenkanal**

This Memorandum of Agreement (hereinafter called "the **MoA**") is made on 28th day of December 2020.

Between

Dhenkanal Municipality, Dhenkanal, represented through its Executive Officer, having their place of work at Dhenkanal -759001 (hereinafter referred to as "Urban Local Body or ULB" or the First Party).

AND

Gobindapur Gram Panchayat,Dhenkanal Sadar Block represented through its Sarapanch, having their place of work at Dhenkanal- 759027(hereinafter referred to as "GP" or the Second Party).

The First Party and the Second Party collectively shall henceforth be referred to as parties to this memorandum ("the Parties").

WHEREAS

1. Dhenkanal Municipality is responsible for provisioning and delivering of all the municipal services including the safe collection, transportation and treatment of all the faecal sludge and

Executive Officer Dhenkanal Municipality | Executive Officer Gobindpur G.P. | Sarapanch Gobindpur G.P.

**Figure 6:** MoA document between Municipality and GPs

## Technology Perspective in Existing FSTP

The entire system is based on gravity, requiring limited skills to manage the FSTP. The details and flow of the FSTP treatment process are illustrated below for further details.

**Figure 7:** The Plug-In Process flow

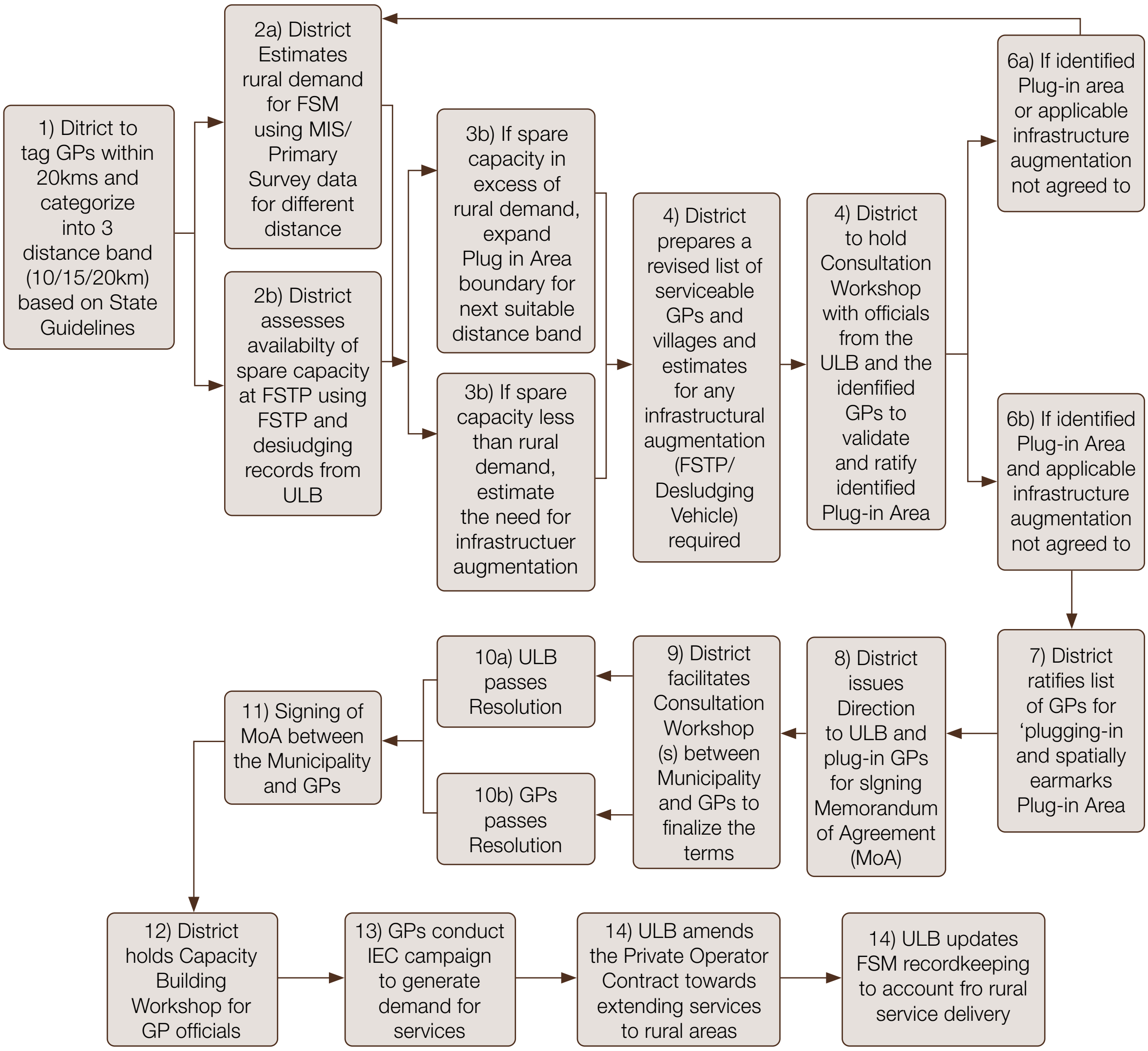
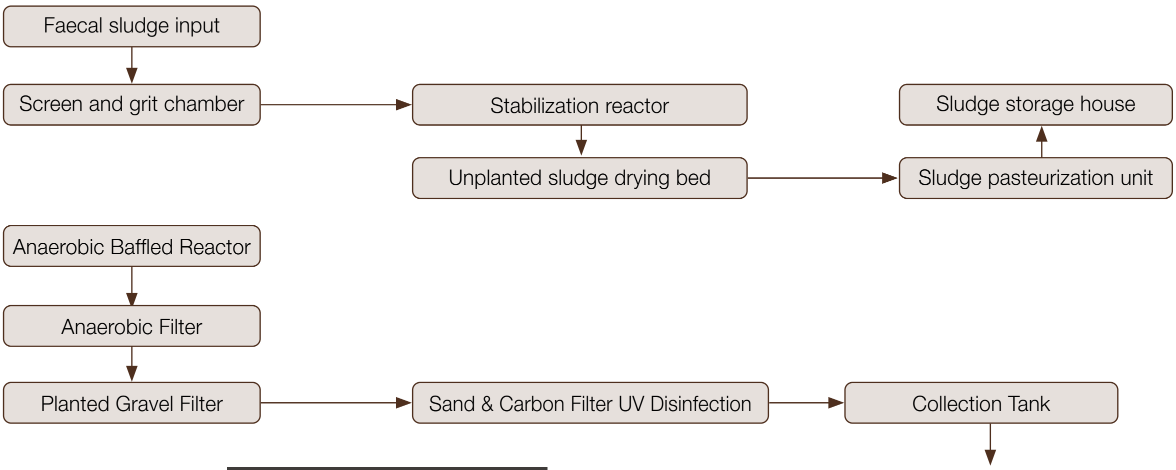
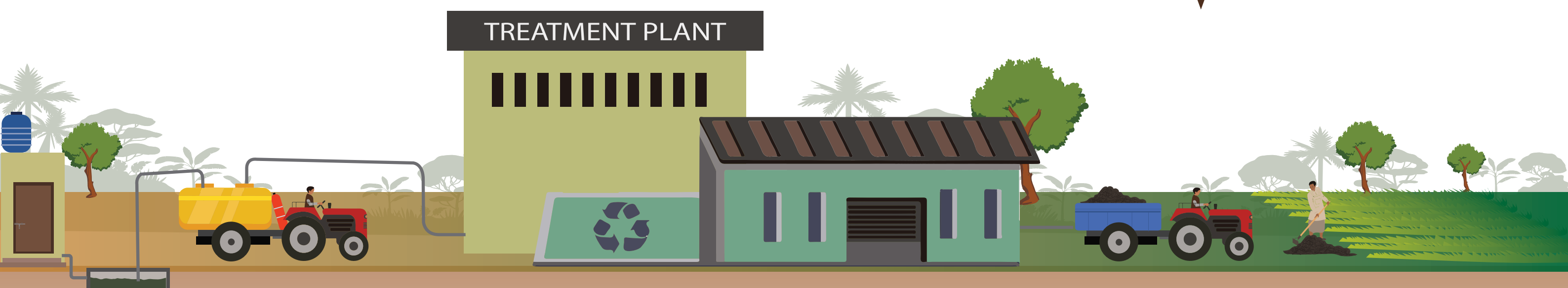



**Figure 8:** FSTP Treatment Process



## Emptying and Transportation

ALF is responsible for the emptying and transportation of faecal sludge with pre-approved rates for the emptying operation, as illustrated in Table 1. The district has adopted the ‘Plug-In’ solution for select GPs within 10 km of the Dhenkanal ULB. Given the FSTP’s spare capacity, the sub-cluster in the distance band 0-10 km from the FSTP was considered as the initial Plug-in area. Based on the top-down secondary and GIS data analysis that informed the demarcation of clusters, the selected sub-cluster and list of constituent GPs (17) and villages (95) was ratified in consultation with the District Administration.

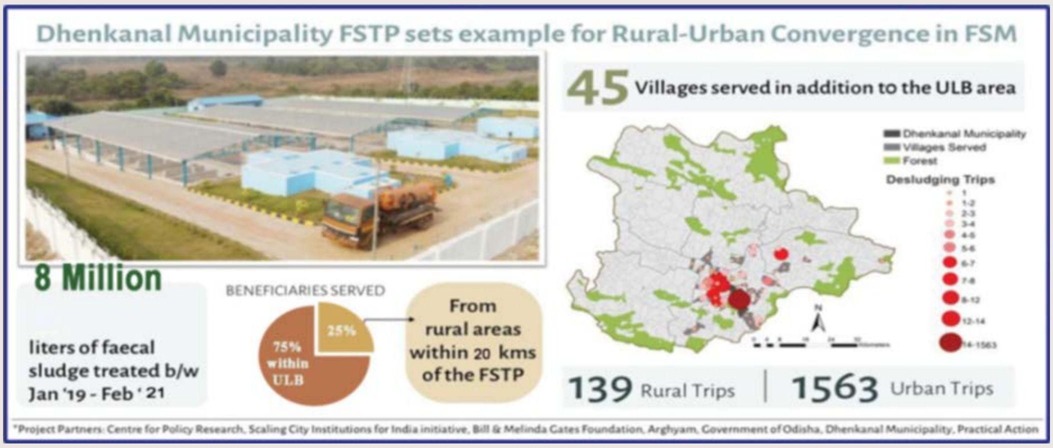
The GPs and the Municipality signed a Memorandum of Agreement (MoA) on December 28, 2020, to formalize the arrangement for managing the rural faecal sludge from the 17 GPs at the urban FSTP. In doing so, the urban and rural local bodies have set an example for sanitation in urban-rural convergence. As the district’s second urban FSTP is coming up in Kamakhyanagar, additional GPs in the district could be potentially served through such a ‘Plug-In’ approach. The signing of the MoA has been followed by extensive capacity-building of GP functionaries to manage the delivery of services.

**Table 6:** Contract of the Area Level Federation based on the approved rates

| Area | Category | Service Charges for 3000 litres Cesspool emptier (INR) | Service Charges for 1000 litres Cesspool emptier (INR) | Remarks |
|---|---|---|---|---|
| Urban Area | Residential | 1000 | 600 | Extra service charges are added for breaking the septic tank seal if not done by the house owner. |
| | Commercial | 1500 | 1000 | |
| Rural Area | Residential | 1250 | 750 | |

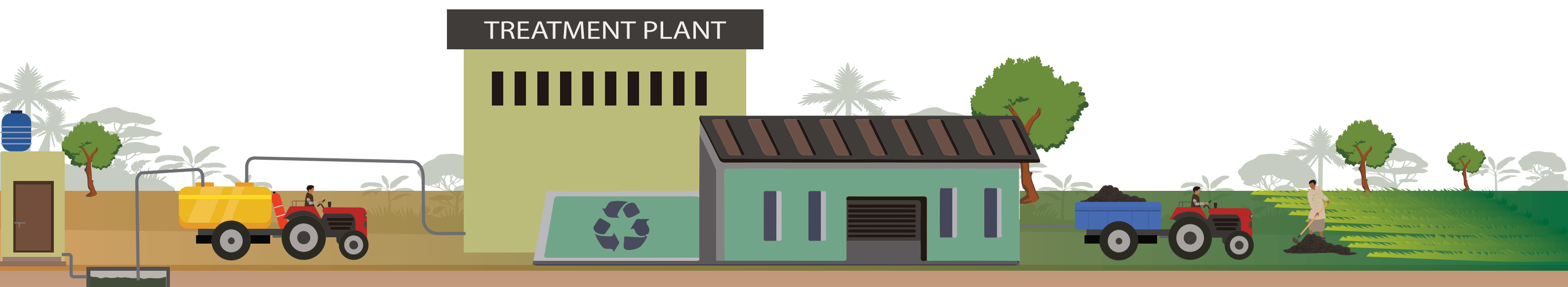
**Key Learnings**

- Utilization of the urban FSTP has been enhanced from 60% to 80% after urban-rural convergence.
- Enhanced revenue generation has resulted in the financial sustainability of the FSTP.
- The model may be potentially replicated, especially based on the involvement of ALFs for managing, emptying, transportation and treatment through the FSM process.




## Strategy 2. Greenfield clusters (Independent rural FSM-System for a cluster of GPs):

The Plug-in strategy, while suitable for villages abutting urban centres, is neither a feasible solution for panchayats located at larger distances, nor when the concerned urban FSMS is running at capacity. Both situations necessitate the creation of a Greenfield FSMS to enable safely managed sanitation services. Clusters of GPs have been identified that would require their own FSM-S , and pilot work has been initiated. The contract of the ALF was amended for serving rural areas (in addition to urban areas) based on the approved rates.



**Impact so far:**

This urban-rural convergence of FSM in first three months (Feb-Apr '21) of its operation has prevented 193 KL of sludge (~65 truckloads) from polluting the environment and has thereby curtailed the threat of faecal contamination in water bodies.

| Year & Month | Trips from Urban Area | Trips from Rual Area | Total Trip | Income from Urban Area @ Rs. 1000, Rs. 600 & Rs. 1500 per 3000 ltr. 1000 ltr. Vehicles in both Residential & Commerical Area (in Lakh) | Income Generated Rual Area @ Rs.1250 & Rs.750 per 3000 ltr. 1000 ltr. Vehicles (in Lakh) | Total Income generated (in Lakh) |
|---|---|---|---|---|---|---|
| April 2021 | 149 | 51 | 200 | 1.08 | 0.76 | 1.84 |
| May 2021 | 168 | 27 | 195 | 1.31 | 0.325 | 1.635 |
| June 2021 | 200 | 32 | 232 | 1.51 | 0.2475 | 1.7575 |
| | 517 | 110 | 627 | 3.9 | 1.3325 | 5.2325 |

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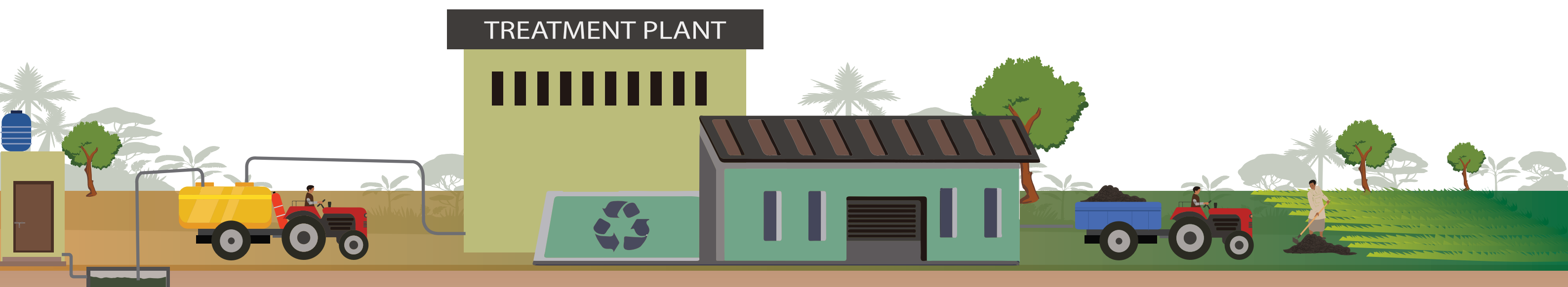

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सत्यमेव जयते

पेयजल एवं स्वच्छता विभाग
जल शक्ति मंत्रालय
भारत सरकार

DEPARTMENT OF DRINKING WATER AND SANITATION
MINISTRY OF JAL SHAKTI
GOVERNMENT OF INDIA

स्वच्छ भारत
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