# OPERATION AND MAINTENANCE COST OF FAECAL SLUDGE TREATMENT PLANTS

## IN UTTAR PRADESH



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# List of Abbreviations

| | |
|---|---|
| UP | Uttar Pradesh |
| CPCB | Central Pollution Control Board |
| QA and QC | Quality Assurance and Quality Control |
| FSTP | Faecal Sludge Treatment Plant |
| FS | Faecal Sludge |
| FSM | Faecal Sludge Management |
| FSSM | Faecal Sludge and Septage Management |
| O&M | Operation and Maintenance |
| GoI | Government of India |
| GoUP | Government of Uttar Pradesh |
| EO | Executive Officer |
| KL | Kilolitre |
| KLD | Kilolitre per Day |
| MLD | Million Litre per Day |
| O&M | Operation & Maintenance |
| OSS | On-site Sanitation |
| ULB | Urban Local Body |
| PPE | Personal Protective Equipment |

| | |
|---|---|
| SBM | Swachh Bharat Mission |
| CSE | Centre For Science and Environment |
| ST | Septic Tank |
| STP | Sewage Treatment Plant |
| BCC | Behaviour Change Communication |
| NMCG | National Mission for Clean Ganga |
| CB | Capacity Building |
| SMCG | State Mission for Clean Ganga |
| UPJN | Uttar Pradesh Jal Nigam |
| AMRUT | Atal Mission for Rejuvenation and Urban Transformation |
| DPR | Detailed Project Report |
| Capex | Capital Expenditure |
| Opex | Operational Expenditure |
| DoUD | Department of Urban Development |
| TBF | Tiger Bio Filter |

# Glossary

| Sl No | Components | Description |
|---|---|---|
| 1 | Sewage | Sewage comprises the following two components:<br>**Grey Water** from kitchens, bathrooms, wash basins, etc.<br>**Black Water** from toilets & urinals.<br>These may sometimes be mixed with other municipal flows, such as surface water and storm water. |
| 2 | Management of sewage | Management of sewage includes collection, conveyance, treatment & recycling/disposal of all the above stated flows. |
| 3 | Off-site system | Off-site system consists of sewage conveyance and treatment at STP. |
| 4 | Sewer network | Sewer network consists of continuous pipes laid underground—mostly along roads—to collect sewage from households and other establishments. |
| 5 | Septage (from septic tanks with soak-pits) | The semi-solid matter from on-site sanitation systems like septic tanks. It has an offensive odour, appearance and high concentration of BOD, COD and TSS, etc. |
| 6 | Faecal sludge | The settled contents of pit latrines and septic tanks. It differs from sludge produced in municipal wastewater treatment plants. |
| 7 | Sewage Treatment Plants (STP) | Sewage Treatment Plants (STP) are used for treatment of used water coming out from domestic, commercial, institutional establishments etc |

| Sl No | Components | Description |
|---|---|---|
| 8 | Faecal Septage Treatment Plants (FSTPs) | Faecal Septage Treatment Plants (FSTPs) are used for the treatment of faecal septage being periodically removed from the septic tanks of domestic, commercial, institutional establishments etc. to maintain their efficiency. |
| 9 | STP-cum-FSTP/ Co-treatment | Septage can be economically treated at STPs with certain minor modifications saving CAPEX, OPEX & land requirement. |
| 10 | Dewatering | Removal of water from solid material or soil by wet classification, centrifugation, filtration, or similar solid-liquid separation processes, such as the removal of residual liquid from a filter cake by a filter press as part of various industrial processes. |
| 11 | De-sludging | The process of removing sediments by draining and cleaning a septic tank. |
| 12 | Decentralized Treatment System | Decentralized wastewater systems convey, treat and dispose of or reuse wastewater from small and low-density communities, buildings and dwellings in remote areas, individual public or private properties |
| 13 | Centralized treatment system | Also known as conventional treatment. It treats water in a central location and then distributes water via dedicated distribution networks |
| 14 | Effluent | The supernatant liquid discharged from a septic tank. The liquid separated out from the septage is also referred to as effluent. |
| 15 | Reuse | Action or practice of using an item, whether for its original purpose (conventional reuse) or to fulfil a different function (creative reuse or repurposing). It should be distinguished from recycling, which is the breaking down of used items to make raw materials for the manufacture of new products. |
| 16 | Septic Tank | A water-tight, single-storied tank in which sewage is retained long enough to permit sedimentation and digestion |
| 17 | Stakeholders | A stakeholder is a party that has an interest in a company and can either affect or be affected by the business. The primary stakeholders in an FSM are government bodies, private players and citizens. |

# 1. Executive summary

Uttar Pradesh, the most populous state in India, largely relies on non-sewered sanitation systems. According to a 2021 CPCB report, only 31 towns (out of 734) have partial sewerage system coverage, treating only 40 per cent of the total sewage generated in the state.[1] In 2022, UP initiated faecal sludge and used water management using Interception-Diversion tapping of waste water, as a strategy to address this issue.

As of January 2023, 62 Faecal Sludge and Septage Management (FSSM) projects are at various stages of construction and operation in UP. Most of the treatment plants (Faecal Sludge Treatment Plants or Septage-Sewage Co-Treatment Plants), are being built under the national schemes of AMRUT and NMCG. A few are being built with the help of the city/ULB's own funding. These 62 projects are spread across 59 ULBs/towns in 53 districts. The projects have a total investment of Rs 220 crore, out of which Rs 190 crore is being spent for building 40 FSTPs, and Rs 30 crore for building 22 co-treatment plants.[2]

It is expected that all the 62 FSSM plants will begin operating by the end of 2023. The co-treatment plants are located within the existing STPs and would be operated and managed by the existing service provider/contractor of the STP.

## Aim of the study

Addressing the financial viability of Operation and Maintenance (O&M) of the upcoming FSTPs is a key priority for UP. The existing bid document of AMRUT-built FSTPs does not clarify how FSTPs will be run by a contractor.

The annual O&M cost under the AMRUT-built FSTPs of UP mentions the huge sum of Rs 1.25 crores, which includes the annual cost of plant operations and de-sludging services. This sum is to be recovered from households at the rate of Rs 2,500 per household, for 5,000 households per year, by private operators.[3] This scheme is unrealistic in terms of affordability and may not work at all, thereby risking the investments made in the development of FSTPs;  hence this study.

## Methodology

Considering the absence of sufficient data from the operative FSTPs in UP (there are only five partially operating FSTPs in UP at present), the study looked at the financial viability of O&M of FSTPs in two other states (Odisha and Tamil Nadu), to arrive at what should be a reasonable annual O&M of FSTPs in UP.

## Findings

Irrespective of the mode of operations (technology/treatment system) of an FSTP of 32 KLD in UP (the standard size), the study found that:

- The financial viability of Operation and Maintenance of FSTPs can be assured under a financing range of Rs 1,40,000 to Rs 1,90,000 per month (as per 2023 estimate).

- De-sludging operations for running a 32 KLD FSTP in UP, covering 5,000 households comes to approximately Rs. 3,300,000 a year.

**Recommendations to strengthen the operation of FSTPs across Uttar Pradesh**

- **Separate the services of plant O&M, and de-sludging of septic tanks**. FSTP O&M should be paid through the ULB's own funds or through the 15$^{th}$ Finance Commission grants. De-sludging fees should be kept at an affordable level and left to market-determined and privately enabled de-sludging operations by multiple tanker operators to avoid the monopoly of de-sludging service.

- **Develop a business case for O&M and de-sludging**.
  - o O&M costing. The average direct reimbursable annual O&M cost of running a natural or a mild hybrid treatment system is approximately Rs 200,000 a month, at 2022 price. A supervisory charge over and above the bare minimum O&M cost of FSTPs should be factored into the payment. We suggest this be 50 per cent of the annual direct reimbursable cost to cover the cost of working capital and supervision. This rate should be revised at a regular interval (at least once in three years) under a ULB-mandated contract with the O&M Plan operator.

  - o De-sludging Fee. Assessment shows that each household septic tank cleaning rate could range from Rs.1,000 to Rs.1,500, generating a reasonable profit for the de-sludging operators.

- **Recommendation for future FSTPs design**. Hybrid treatment systems offer two options for sludge management: mechanical de-sludging using screw press and sludge drying beds. However, only one of these options is necessary. Keeping in mind the climate of UP, installing only drying platforms is preferable and will lead to a reduced O&M expenditure in the future.

- **Standard Operating Procedures (SOPs) for mechanical O&M** of FSTPs and co-treatment infrastructure should be developed and followed by plant operators, they should also be maintained at site level.

- **Guidelines and FSM bye-laws are important for successful FS operation**. These guidelines should be enabling and not restrictive for private operators, focus on incentives and recognition for good performance. Provide revision of de sludging fee, at least once in three years to match inflation.

# 2. Introduction

Uttar Pradesh is the most populated state in India. 95 per cent of its cities and towns are totally dependent on non-sewered sanitation systems. According to a 2021 report by the Central Pollution Control Board (CPCB), only 31 towns (out of the 734 in the state) have partial sewerage system coverage. Together, they manage to treat just 40 per cent of the total sewage generated.[4]

Sustainable and scientific management of faecal sludge and septage is, therefore, a priority for Uttar Pradesh. Septage management has significant inclusive social outcomes, given that those dependent on septage systems comprise the poorest and marginalized. Women and other disadvantaged sections are often the worst impacted by poor sanitation. An effective and affordable septage management system will generate significant social, environmental and public health outcomes.

Only 20 per cent of the Uttar Pradesh's urban areas are serviced by sewerage systems.[4] The state's 107 sewage treatment plants have a wastewater treatment capacity of 3,374 million litre per day (MLD), even as the estimated sewage generation is 8,263 MLD.

Taking into consideration recent updates, 139 cities have submitted the City Sanitation Action Plan (CSAP). These cities will come up with a Sewage Treatment Plant (STP) along with an Interception and Diversion Arrangement (I&D). Also, as an interim arrangement, Deep Row Entrenchment has been proposed for cities that have a population below 20,000.[6]

As of June 2022, 62 FSSM projects are being built in Uttar Pradesh under AMRUT, NMCG or ULB funding. These are spread across 59 ULBs/towns, in 53 districts, and have a total investment of Rs 220 crore. Rs 190 crore of this sum will go towards building 40 FSTPs, and another Rs 30 crore for building 22 co-treatment plants.[7]

Presently, there are 10 FSTPs and one co-treatment plant in operation in UP, and many new FSTPs and co-treatment plants are to be commissioned soon. The installed and under-construction capacity of UP's septage treatment infrastructure stands at 2,075 kilolitre per day (KLD).[8]

During the month of May–June 2022, Centre for Science and Environment (CSE) conducted a detailed assessment of FSTPs and co-treatment plants in UP and

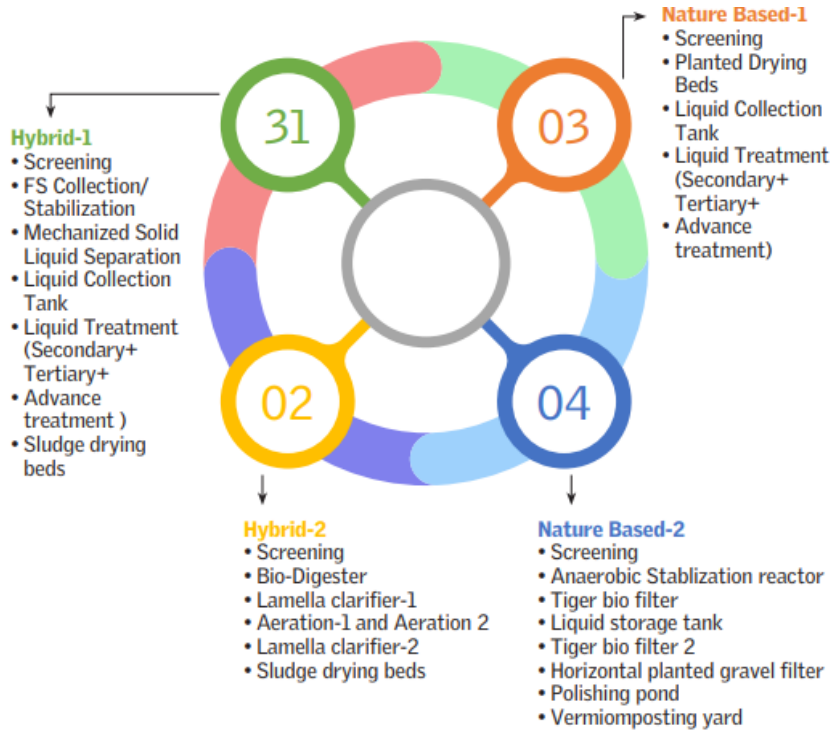
observed that two typologies of treatment systems including four treatment chains were used across 40 FSTPs:

1. **Nature-based**: Nature-based treatment modules, independent of electromechanical equipment involved in the treatment process. Within the hybrid and nature-based treatment systems, two treatment chains were identified. [9]

2. **Hybrid**: Modules comprising both natural and mechanized treatment technologies, used in the different combinations.

There are four treatment chains used for the treatment of faecal sludge in Uttar Pradesh (*see infographic below*).

**Figure 1. Treatment chains**




Source- CSE report on Septage Management for City Wide inclusive Sanitation

# 3. Need for the study

Currently, many of the FSSM plants in Uttar Pradesh are either in the final stages of construction or in the commissioning stage. These plants will soon become operational and would need to follow a proper operation & maintenance protocol. The stipulated amount to be recovered by the contracting agency against de-sludging services and plant operations is mentioned as Rs 1.25 crores per year. The break-up of the same is given below:

**Total households (HH) to be de-sludged per year:** 5,000

**De-sludging cost:** Rs 2,500 per HH

**Total cost in INR per year:** Rs 1,25,00,000

The total cost of Rs 1,25,00,000 includes both plant operations and de-sludging operations.[10]

The current contract between the implementing and executing agencies lacks a clear budget for operational and maintenance activities, despite stating that the contracting agency is responsible for recovering O&M costs by performing de-sludging activities in the town.

The study was undertaken to ensure that plants are operational and handed over to contractors for smooth operation. In order to achieve the same, the following areas were studied.

- Support the sustainability of the FSTP operations considering the present tender arrangements
- Provide a clear understanding of average actual O&M cost against various activities performed for the regular operations of FSTP
- To help maintain sustainability of FSSM plants across India by understanding existing O&M models from other states
- To understand what needs to be done to ensure sustainable operations of the upcoming FSTPs in UP.

# 4. Methodology of the study

The study tried to identify average actual O&M costs for smooth operations of an FSTP, based on the assessment of O&M costs of functional FSTPs in UP. A total of five towns were visited for this purpose. However, this exercise was found to be inadequate in drawing any conclusions. The methodology then extended to a study of O&M of other FSTPs in Odisha, Tamil Nadu and Maharashtra.

In this study, the life cycle costing was not considered for the following reasons:

- Plants in UP are in the early stages of operations

- The focus of the study is only on the O&M expenses incurred for various activities and not on the reuse and resource recovery including depreciation.

## Study of FSTPs in Uttar Pradesh

The CSE team visited five operational plants and collected relevant data from different stakeholders, such as government officials, O&M agencies de-sludging operators, plant operators. This study presents a detailed analysis of the O&M costs of different operational plants based on two types of technical solutions: nature-based and hybrid.

The content of this report is based on field visits made by the CSE team in the period between August 2022 and December 2022. A checklist was developed to identify the Operation and Maintenance cost of a FSSM plant in select cities. Interactions based on the checklists were done with the Municipal Commissioners, engineers of Uttar Pradesh Jal Nigam, sanitary officers, de-sludging operators and operators of the treatment plants.

The following cities were selected for the study, keeping in mind the diversity of technology and performance:

- Chunar: Planted Drying Bed Technology
- Bijnor: Co-Treatment
- Aligarh: Tiger Bio-filter Technology
- Jhansi: Planted Drying Bed Technology
- Unnao: Screw Press Technology

The above cities were selected keeping in mind technology, diversity and performance.

**Details about the technology used in the plants are listed below in Table 1.**

**Table 1: Technology details**

| Name of the ULB | Capacity in KLD | Technology Type | Modules |
|---|---|---|---|
| Jhansi | 12+6 | Nature-based | Planted Drying Bed, DWWTS, Planted Gravel Filter and Polishing Pond |
| Chunar | 10 | Nature-based | Planted Drying Bed, DWWTS, Planted Gravel Filter and Polishing Pond |
| Bijnor | 10 | Nature-based | Screen Chamber, Homogenization Tank, Sump Well, Sludge Drying Bed |
| Unnao | 32 | Hybrid | Screen Chamber, thickening tank, stabilization tank, screw press, ABR, PGF, Sludge Drying Bed |
| Aligarh | 32 | Nature-based | Screen Chamber, Anaerobic Stabilization Reactor, Tiger Bio-Filter-1, Tiger Bio-Filter-2, Horizontal Planted Gravel Filter and Polishing Pond |

Source- Compiled by CSE, 2022

## Two typologies and three treatment systems

To study the Operation and Maintenance (O&M) of FSTPs we considered two typologies with three treatment systems: natural-drying-bed-based, natural-tiger-bio filter-based and hybrid treatment system.

1. Nature-based systems: Two types of nature-based systems were considered for the analysis

a. Nature-based 1: In this system, the following modules were considered for arriving at the O&M cost.

- Screen chamber
- Stabilization reactor
- Sludge drying bed
- Percolate and liquid treatment systems – Anaerobic Baffle Reactor, Anaerobic Filter and Planted Gravel Filter, Activated Sand Filter and Pressurized Carbon Filter and UV treatment, Polishing Pond
- Sludge storage house

b. Nature-based 2- Tiger Bio Filter: In this system, the following modules were considered for arriving at the O&M cost.

- Screen chamber
- Stabilization reactor
- Tiger Bio Filter-1
- Tiger Bio Filter-2
- Planted gravel filter
- Polishing pond

2. Hybrid system- In this system, the following modules were considered for arriving at the O&M cost.
   - Screen chamber
   - Mechanical solid liquid separation unit
   - Percolate and Liquid Treatment Systems- Anaerobic Baffle Reactor, Anaerobic Filter and Planted Gravel Filter, Activated Sand Filter and Pressurized Carbon Filter and UV treatment, Polishing Pond

## Components of Operation and Maintenance (O&M) cost

Faecal sludge treatment plants (FSTPs) require ongoing and appropriate operations and maintenance (O&M) activities in order to ensure long term functionality. O&M activities are at the interface of the technical, administrative, and institutional frameworks that enable sustained FSTP function. "Operation refers to all the activities that are required to ensure that a FSTP delivers treatment services as designed and "maintenance" refers to all the activities that ensure long-term operation of the equipment and infrastructure. Proper O&M of FSTP requires a number of crucial tasks to be carried out regardless of the size of the plant, and complexity of the technological setup. Having skilled workers perform these tasks in a timely manner and in accordance with best practices will maximize the value of the FSTP and ensures its long-term performance.

The cost for operating a FSTP involves the following activities:

### Operation cost

- Human resource for operating the plant
- Energy cost, which is the electricity required for the operation of pumps, common lighting etc.
- Any chemicals or consumables required for the operating the plant
- Sampling cost for the monitoring of septage and wastewater
- Other miscellaneous costs

The cost for maintaining a FSTP involves the following activities.

### Maintenance cost

- Civil maintenance of the structures
- Maintenance/ replacement/ repair cost of electro mechanical equipment
- Maintenance of filter material if any
- Replacement of solar batteries, panels etc.
- Gardening

**Note:** The frequency of the maintenance varies between one to three years. For ease of understanding, the frequency has been converted to yearly cost.

### Service charge/profit

This is subjective and can be decided/negotiated.

# 5. Findings and analysis

## Findings from FSTPs in UP

All the FSTPs in Uttar Pradesh are designed 32 kilo litres per day capacity of FS treatment. As per analysis, little difference was found in the monthly O&M cost of the three different treatment chains (drying-bed-based-natural system, Tiger Bio Filter- based natural system and hybrid system).

On an average, the monthly O&M cost of three treatment systems adds up to

- Rs 1.4 lakh per month - Drying bed-based natural system
- Rs 1.86 lakh per month - Tiger Bio Filter (TBF)-based natural system
- Rs 1.54 lakh per month - Hybrid system.

Further, it was found that the TBF based system requires high energy for its operation compared to the rest of the two systems. Among the three, the drying-bed-based natural system requires the least energy footprint.

The data related to various O&M expenditure heads is presented in the tables below.

**Summary:** This table provides the total monthly Operation and Maintenance cost; it does not specify a breakup of the costs mentioned. The breakup of the summary cost is provided in the tables below which are further divided into Operation and Maintenance costs separately.

**Operation costs**: It defines the total cost of the daily operation of a plant. This includes human resource cost, energy costs, consumables and chemicals, cost of the operation of diesel generators, sampling charges, any miscellaneous costs.

**Maintenance costs**: It defines the cost of the periodic maintenance of the treatment system. This includes civil maintenance, maintenance of filter media, electromechanical equipment, maintenance of PSF, ACF (if any), UV bulbs (if any), solar panels and batteries (if any). This section presents a holistic understanding of the maintenance cost per frequency which is converted to the monthly maintenance cost.

# 1. Nature-based Sytem1 (Drying Bed-based)

### Table 2: Summary, Nature-based system 1

| | Description of activity | Total cost in INR/ month | Remarks |
|---|---|---|---|
| | Operation and Maintenance | | |
| A | Operation expenses for a 32 KLD nature-based treatment system | 98,182.40 | Detailed breakup of the cost is enclosed |
| B | Maintenance expenses for a 32 KLD nature-based treatment system | 42,291.67 | Detailed breakup of the cost is enclosed |
| | Total O&M cost (A+B) | 1,40,474.07 | |

Source: Compiled by CSE, 2022

## Operation cost

### Table 3: Human Resource cost, Nature-based System 1

| Type of Human Resource | Nos | Salary/ Month in INR | Total Salary/Month in INR |
|---|---|---|---|
| Gardener | 1 | 8,000 | 8,000 |
| Guard | 2 | 10,000 | 20,000 |
| Sanitary worker | 2 | 7,500 | 15,000 |
| Supervisor | 1 | 18,000 | 18,000 |
| | | Grand total in INR | 61,000 |

Source: Compiled by CSE, 2022

### Table 4: Energy cost, Nature-based System 1

| Electromechanical equipment | Consumption in a day in kWH | Total consumption in a month in kWH | Unit cost of electricity in kWH | Total cost of electricity in INR in a month | Remarks |
|---|---|---|---|---|---|
| Pumping cost-polishing pond to landscape area | 2.94 | 88.2 | 8 | 705.6 | Considering 1 HP pump works for 4 hours a day |
| Considering 3 fans running | 2.7 | 81 | 8 | 648 | One fan rating is 75 W and running for 12 hours a day |
| Street lighting-considering 8 lights of 80 W | 7.68 | 230.4 | 8 | 1,843.2 | Considering the lights will be lit for 12 hours a day |
| Pump for ACF and PSF- 1 HP submerssible pump | 2.94 | 88.2 | 8 | 705.6 | Considering 1 HP pump works for 4 hours a day |

| Electromechanical equipment | Consumption in a day in kWH | Total consumption in a month in kWH | Unit cost of electricity in kWH | Total cost of electricity in INR in a month | Remarks |
|---|---|---|---|---|---|
| Total cost | | | | 3,902.4 | |

Source: Compiled by CSE, 2022

### Table 5: Other costs, Nature-based System 1

| Description of the item | Cost/ Month in INR | Remarks |
|---|---|---|
| Safety Items | 3,000 | Every month |
| Water Quality Sampling | 6,000 | Every month |
| Diesel Generator- Considering 10 Kva diesel generator- Diesel Consumption 3 Litres/ hour. Assuming the DG will run for 2 hours per day. | 17,280 | Every month |
| Other expenses | 7,000 | Stationery, Internet, Cleaning Agents, guest entertainment, etc. |
| Total Cost | 33,280 | |
| Total Cost of Operation 1+2+3 in INR | 98,182.4 | |

Source: Compiled by CSE, 2022

## Maintenance cost

### Table 6: Maintenance cost, Nature-based System 1

| Module | Type of maintenance | Frequency | Cost/Frequency in INR | Cost/Month in INR | Remarks |
|---|---|---|---|---|---|
| Sludge drying bed | Cleaning of filter materials | 2 Years | 49,000 | 2,042 | 10 workers for 7 days. 70 HR days. 70*700= 49,000 |
| Planted gravel filter | Cleaning of filter materials | 2 Years | 21,000 | 875 | Considering 3 workers for 10 days. 15 HR Days. 30*700= 21,000 |
| De-sludging cost in ABR | De-sludging | 2 Years | 5000 | 208 | |
| Replacement of screens | | 2 Years | 50,000 | 2,083 | |
| Solar battery | Replacement of batteries | 5 Years | 100,000 | 1,667 | Replacement of solar batteries are required once in 5 years. Considering 10 units. Per unit cost is 10,000 |

| Module | Type of maintenance | Frequency | Cost/Frequency in INR | Cost/Month in INR | Remarks |
|---|---|---|---|---|---|
| Replacement of media in Activated Carbon Filter and Pressurized sand filter | Replacement of media | 1 Year | 35,000 | 2,917 | |
| Civil works- 1.5% per year of the capital cost. Capital cost = 2,00,00,000 | Civil | 1 Year | 300,000 | 25,000 | |
| Garden maintenance | | 1 Year | 30,000 | 2,500 | |
| 10 Kva DG maintenance | | 1 Year | 10,000 | 833 | |
| E&M repair/ replacement | | 1 Year | 50,000 | 4,167 | |
| | | Grand Total in INR | | 42,292 | |
| Total cost of maintenance per month in INR | | | | 42,292 | |

Source: Compiled by CSE, 2022

## 2. Tiger Bio Filter, Nature-based System 2

### Table 7: Summary, Nature-based system 2

| | Description of activity | Total Cost in INR/ month | Remarks |
|---|---|---|---|
| | Operation and Maintenance | | |
| A | Operation expenses for a 32 KLD nature-based treatment System | 124,032.80 | Detailed breakup of the cost is enclosed |
| B | Maintenance expenses for a 32 KLD nature-based treatment System | 62,591.67 | Detailed breakup of the cost is enclosed |
| | Total O&M cost (A+B) | 186,624.47 | |

Source: Compiled by CSE, 2022

## Table 8: Human resource cost, Nature-based System 2

| Type of Human Resource | Nos | Salary/ month in INR | Total salary/month in INR |
|---|---|---|---|
| Supervisor | 1 | 18,000 | 18,000 |
| Guard | 2 | 10,000 | 20,000 |
| Plant operator | 1 | 10,000 | 10,000 |
| Gardener | 1 | 8,000 | 8,000 |
| Sanitary worker | 3 | 7,500 | 22,500 |
| | | Grand total in INR | 78,500 |

Source: Compiled by CSE, 2022

## Table 9: Energy cost, Nature-based System 2

| Electromechanical equipment | Consumption in a day in kWH | Total consumption in a month in kWH | Unit cost of electricity in kWH | Total cost of electricity in INR in a month | Remarks |
|---|---|---|---|---|---|
| Pumping cost- Polishing pond to landscape area | 2.94 | 88.2 | 8 | 705.6 | Considering 1 HP pump works for 4 hours a day |
| Considering 3 fans running | 2.7 | 81 | 8 | 648 | One fan rating is 75 W and running for 12 hours a day |
| Street Lighting- considering 8 lights of 80 W | 7.68 | 230.4 | 8 | 1,843.2 | Considering the lights will be lit for 12 hours a day |
| Pump for SR to TBF-1 (5 HP submersible pump) | 14.7 | 441 | 8 | 3,528 | Considering working of 4 hours a day |
| Pump for Liquid CT to TBF-2 (5 HP submersible pump) | 14.7 | 441 | 8 | 3,528 | Considering working of 4 hours a day |
| Total cost | | | | 10252.8 | |

Source: Compiled by CSE, 2022

### Table 10: Other costs, Nature-based System 2

| Description of the item | Cost/ month in INR | Remarks |
|---|---|---|
| Safety Items | 3,000 | Every month |
| Water Quality Sampling | 6,000 | Every month |
| Diesel generator- Considering 10 Kva diesel generator- Diesel consumption 3 Litres/ hour. Assuming thr DG will run for 2 hours per day. | 17,280 | Every month |
| Sodium Hypo | 2,000 | Every month |
| Other expenses | 7,000 | Stationery, internet, cleaning agents, guest entertainment, etc. |
| Total cost | 35,280 | |
| Total cost of operation 1+2+3 in INR | 124,032.8 | |

Source: Compiled by CSE, 2022

## Maintenance cost

### Table 11: Maintenance cost, Nature-based System 2

| Module | Type of Maintenance | Frequency | Cost/ Frequency in INR | Cost/ Month in INR | Remarks |
|---|---|---|---|---|---|
| TBF-1 | Cleaning of Filter Materials | 2 Years | 49,000 | 2,042 | 10 workers for 7 days. 70 HR days. 70*700= 49000 |
| TBF-2 | Cleaning of Filter Materials | 2 Years | 49,000 | 2,042 | 10 workers for 7 days. 70 HR days. 70*700= 49000 |
| Planted Gravel Filter | Cleaning of Filter Materials | 2 Years | 21,000 | 875 | Considering 3 workers for 10 days. 15 HR Days. 30*700= 21,000 |
| De-sludging cost in Stabilization Reactor | De- sludging | 2 Years | 10,000 | 417 | |
| Replacement of screens | | 2 Years | 50,000 | 2,083 | |
| Solar Battery | Replacement of batteries | 5 Years | 100,000 | 1,667 | Replacement of solar batteries are required once in 5 years. Considering 10 units. Per unit cost is 10,000 |
| Cleaning of Polishing Pond | Every Quarter | 3 Months | 4,200 | 16,800 | 3 Workers for 2 Days. 6 HR days. 6*700= 4,200 |
| Media Top Up | | 1 Year | 60,000 | 5,000 | |

| Module | Type of Maintenance | Frequency | Cost/ Frequency in INR | Cost/ Month in INR | Remarks |
|---|---|---|---|---|---|
| Civil Works- 1.5% of per year of the capital cost. Capital cost = 2,00,00,000 | Civil | 1 Year | 300,000 | 25,000 | |
| Garden Maintenance | | 1 Year | 20,000 | 1,667 | |
| 10 Kva DG maintenance | | 1 Year | 10,000 | 833 | |
| E&M Repair/ replacement | | 1 Year | 50,000 | 4,167 | |
| Grand Total in INR | | | 62,592 | | |
| Total cost of maintenance per month in INR | | | 62,592 | | |

Source: Compiled by CSE, 2022

# 3. Hybrid System

## Summary

### Table 12: Summary, Hybrid System

| | Description of activity | Total Cost in INR/ Month | Remarks |
|---|---|---|---|
| | Operation and Maintenance | | |
| A | Operation expenses for a 32 KLD nature Hybrid treatment System | 113,596.8 | Detailed breakup of the cost is enclosed |
| B | Maintenance expenses for a 32 KLD nature Hybrid treatment System | 41,291.67 | Detailed breakup of the cost is enclosed |
| | Total O&M cost (A+B) | 154,888.47 | |

Source: Compiled by CSE, 2022

### Table 13: Human Resource cost, Hybrid System

| Type of Human Resource | Nos | Salary/ Month in INR | Total Salary/Month in INR |
|---|---|---|---|
| Supervisor | 1 | 18,000 | 18,000 |
| Guard | 2 | 10,000 | 20,000 |
| Plant operator | 1 | 10,000 | 10,000 |
| Gardener | 1 | 8,000 | 8,000 |
| Sanitary worker | 2 | 7,500 | 15,000 |
| | | Grand Total in INR | 71,000 |

Source: Compiled by CSE, 2022

## Table 14: Energy cost, Hybrid System

| Electromechanical Equipment | Consumption in a day in kWH | Total consumption in a month in kWH | Unit cost of electricity in kWH | Total cost of electricity in INR in a month | Remarks |
|---|---|---|---|---|---|
| Pumping cost- Polishing pond to landscape area | 2.94 | 88.2 | 8 | 705.6 | Considering 1 HP pump works for 4 hours a day |
| Considering 3 fans running | 2.7 | 81 | 8 | 648 | One fan rating is 75 W and running for 12 hours a day |
| Street Lighting- considering 8 lights of 80 W | 7.68 | 230.4 | 8 | 1,843.2 | Considering the lights will be lit for 12 hours a day |
| Power requirement for the operations of the screw presss- Considering 12 hours of operation, power consumption shall be 18 kW per day. Screw Press Motor is of 1.5 kW. It may vary as per 8-12 hours of operations. | 18 | 540 | 8 | 4,320 | The data sourced from HUBER |
| Total cost | | | | 7,516.8 | |

Source: Compiled by CSE, 2022

## Table 15: Any other cost, Hybrid System

| Description of the item | Cost/ Month in INR | Remarks |
|---|---|---|
| Safety Items | 3,000 | Every month |
| Water Quality Sampling | 6,000 | Every month |
| Polymer dosing for the screw press- 2KG/ day @ INR 30/KG | 1,800 | Every month |
| Diesel Generator- Considering 10 Kva diesel generator- Diesel Consumption 3 Litres/ hour. Assuming thr DG will run for 2 hours per day. | 17,280 | Every month |
| Other Expenses | 7,000 | Stationery, Internet, Cleaning Agents, guest entertainment, etc. |
| Total Cost | 35,080 | |
| Total Cost of Operation 1+2+3 in INR | 113,596.8 | |

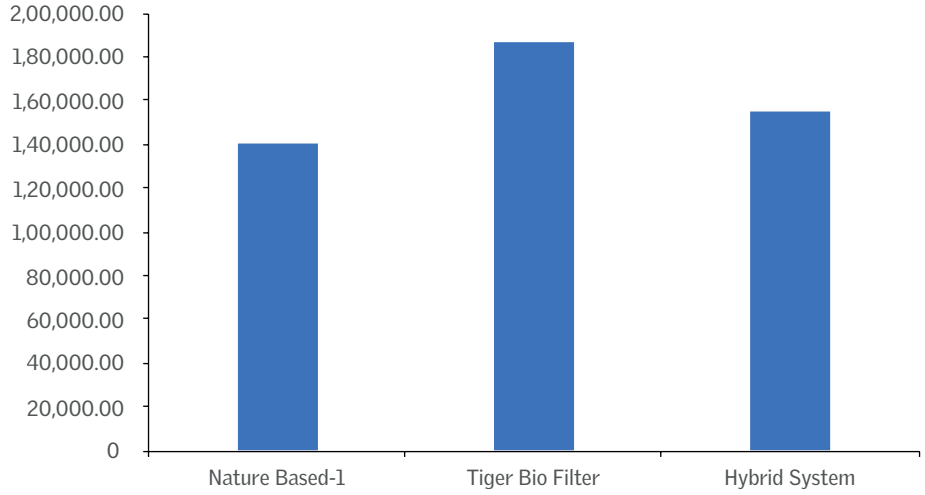
Source: Compiled by CSE, 2022

## Maintenance cost

### Table 16: Maintenance cost, Hybrid System

| Module | Type of Maintenance | Frequency | Cost/ Frequency in INR | Cost/Month in INR | Remarks |
|---|---|---|---|---|---|
| Planted Gravel Filter | Cleaning of Filter Materials | 2 Years | 21,000 | 875 | Considering 3 workers for 10 days. 15 HR Days. 30*700= 21,000 |
| Replacement of screens | | 2 Years | 50,000 | 2,083 | |
| Solar Battery | Replacement of batteries | 5 Years | 100,000 | 1,667 | Replacement of solar batteries are required once in 5 years. Considering 10 units. Per unit cost is 10,000 |
| Media Top Up | | 1 Year | 60,000 | 5,000 | |
| Civil Works- 1.5% of per year of the capital cost. Capital cost = 2,00,00,000 | Civil | 1 Year | 300,000 | 25,000 | |
| Garden Maintenance | | 1 Year | 20,000 | 1,667 | |
| 10 Kva DG maintenance | | 1 Year | 10,000 | 833 | |
| E&M Repair/ replacement | | 1 Year | 50,000 | 4,167 | |
| Grand Total in INR | | | 41,292 | | |
| Total Cost of Maintenance per Month in INR | | | 41,292 | | |

### O&M cost comparison of 3 types of treatment systems




Source: Compiled by CSE, 2022

## Findings from FSTPs in Odisha, Tamil Nadu and Maharashtra

The learnings from the other states—Odisha, Tamil Nadu and Maharashtra—are very specific to the Operation and Maintenance models for FSTP/ co-treatment plants.

**Tamil Nadu**

A total of 56 FSTPs have been planned across the state of Tamil Nadu. Out of the 56 plants, around 25 plants have been completed as of January 2023. After construction, the plants will be handed over to the ULB for Operation and Maintenance. Post-handover to the Urban Local Body (ULB), the O&M of the plant will be done directly by the ULB staff or it will be outsourced to a third party. The O&M cost will be paid from the ULB own sources or through SFC/CFC. The FSTP vary between 10 to 40 KLD. The yearly O&M cost vary between 10,00,000 to 12,00,000/- annually for different capacity plants. The data was collected by secondary sources by the interview from TNUSSP.

Most of the Faecal Sludge Treatment Plants in Tamil Nadu are nature based. It works on Sludge Drying Bed Technology.

**Odisha**

There are 118 plants across 114 ULBs in Odisha. 110 FSTPs are already operational and are receiving sludge as of January 2023. The plants range from the capacity starting from 10 KLD to 40 KLD in multiples of 10. After the construction of FSTP, the plants will be commissioned and will be handed over to the ULB. The Urban Local Body would handover these plants to Self Help Groups (SHG) for the Operation and Maintenance of the plant. The SHG team will comprise 10 to 12 people, depending on the size of the plant. The cost for the Operation and Maintenance will be paid by the ULB from its own sources or through a SFC/ CFC grant. The average cost per year for the Operation and Maintenance of the plant is Rs 10,00,000 to Rs 12,00,000.

All the Faecal Sludge Treatment Plants in Odisha are nature-based. It works on Sludge Drying Bed Technology, complemented with ABR based DWWT system. The pumps are used in these plants to manage the gravity and convey the wastewater/sludge between the modules.

**Maharashtra**

There are 311 proposed FSTPs across the state out of which 214 FSTPs have been completed. The FSTPs vary from 3 KLD to 20 KLD. In this model the individual

ULBs will do the tendering for the implementation of FSTPs. Post-implementation, the ULBs will be responsible for the O&M of the plant.

## Analysis

According to the tender document, the total O&M cost per year needs to be recovered by the contractor itself by performing de-sludging services on a scheduled basis that comes around Rs 1.25 crores (plant operations plus de-sludging services). The contractor will be required to submit a monthly report against the number of septic tank cleaning and ask for the payment that is set at Rs 2,500 per house hold. The ULB is required to verify the same and make the payment on actuals (if the contractor does only 70 per cent of the targeted de-sludging then only 70 per cent payment of the total amount will be made to the contractor).

A successful FSTP operation requires the recovery of O&M cost of the FSTP plant and the de-sludging of the septic tanks.

According to the study on Uttar Pradesh, irrespective of the mode of operations of the FSTP and the de-sludging operations—

- Operation and Maintenance cost of FSTP's should range from INR 1,40,000 to 1,90,000 per month (as per 2023).

- The cost of de-sludging operations for running 32 KLD FSTP for covering 5,000 households comes to approximately INR 33,00,000 a year. The detailed calculation for the same is mentioned in the annexure along with the assumptions.

The average direct reimbursable annual Operation and Maintenance cost of running a natural or a mild hybrid treatment system is approximately Rs. 2,00,000 per month. A supervisory charge over and above the bare minimum Operation and Maintenance. cost should be factored into the payment. We suggest this be 50 per cent of the annual direct reimbursable cost to cover the cost of working capital and supervision. This rate should be revised at regular intervals (at least once in three years) under a ULB mandated contract with the Operation and Maintenance plan operator.

# 6. Recommendations and way forward

1. The de-sludging operation needs to be de-linked from private operators. The de-sludging operation should be the responsibility of the ULB. The O&M cost for the plant operation has to be recovered from sources ranging from ULB's own funds, SFC/CFC, sanitation/property tax or any other programmes and schemes.

2. Amendments to the existing O&M model. In the existing O&M model, the contractor will have to maintain the FSSM plant for a period of seven years. It is recommended that:

    - The contractor should be paid a fair remuneration for the Operation and Maintenance of the FSTP, delinked from de-sludging fee. ULB should pay for O&M from its own sources or from SFC/CFC funds.

    - The contractor should handover the de-sludging vehicles to ULB and will only be responsible for the smooth functioning of the O&M plant with full efficiency as per a service agreement.

3. De-sludging services: De-sludging services should be regulated by the ULB. The ULB should also take the responsibility for the registration of de-sludging vehicles. The annual registration fee for individual tankers is justified for monitoring operations, and to ensure the prevention of indiscriminate dumping.

4. De-sludging fee: Assessments show that the cleaning rate of each household septic tank could range from Rs 1000 to Rs 1500, generating a reasonable profit for de-sludging operators.

5. Recommendation for future FSTP design: Hybrid systems in upcoming projects do not require additional drying beds. The purpose could be served by installing a drying platform.This will further help in reducing the capital expenditure as well as Operations and Maintenance expenditure.

6. Standard Operating Procedure (SOP) for Operation and Maintenance of FSTPs and co-treatment infrastructure should be developed and followed by plant operators, they should also be maintained at site level.

7. Guidelines and FSM bye-laws are important for successful FS operations. These guidelines should be enabling and not restrictive for private operators. The focus should be on incentives and recognition for good performance. They should provide for revision of de-sludging fee at least once in three years

# Annexure

## 1. Calculating the cost of de-sludging 5000 households

**Table 17: Calculation of the de-sludging Cost for 5000 HH**

| Particulars | Vehicle-1 4000 L Capacity | Vehicle-2 4000 L Capacity | Vehicle-3 1000 L Capacity |
|---|---|---|---|
| Trip per year to no of households | 2,000 | 2,000 | 1,000 |
| Driver's salary per year | 1,62,000 | 1,62,000 | 1,62,000 |
| Helper salary per year | 1,08,000 | 1,08,000 | 1,08,000 |
| Average distance covered in on households | 20 | 20 | 20 |
| Average distance per year | 40,000 | 40,000 | 20,000 |
| Fuel cost per year | 9,00,000 | 9,00,000 | 4,50,000 |
| Maintenance per year | 45,000 | 45,000 | 30,000 |
| Registration per year | 1,000 | 1,000 | 1,000 |
| Insurance of vehicle per year | 13,500 | 13,500 | 10,000 |
| PPE per year | 2,000 | 2,000 | 2,000 |
| Other expenses per year | 12,500 | 12,500 | 12,500 |
| Total cost per year in INR | 12,44,000 | 12,44,000 | 7,75,500 |

Source- Compiled by CSE, 2022

**Note**- In order to suggest an indicative de-sludging fee, a mathematical model for reaching a de-sludging fee was developed where the number of households was fixed according to the tender document. The following assumptions were considered which could be modified to any specific city easily by entering city-specific data:

i. Fuel cost considered: Rs 90/litre
ii. Driver salary: Rs 13,500/ month
iii. Helper salary: Rs 9,000/ month
iv. Annual maintenance: Rs 45,000/year for 4000 L vehicles and Rs 30,000/ year for 1000 L
v. Other miscellaneous expenses (PPE, insurance, registration, etc.) = Rs 12,500
vi. PPE: Rs 2,000/ year
vii. Insurance: Rs 13,500/Year for 4000 L vehicle and Rs 10,000/year for 1000 L
viii. Average distance covered: 20 km

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3. Tender Document- Septage Management Project (FSTP with Collection and Treatment- 32 KLD)- by Uttar Pradesh Jal Nigam, Lucknow

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