Sanitation Capacity Building Platform

Detailed Project Report

Septage Treatment Plant (SeTP)

for

Rudrapur City, Uttarakhand

Detailed Project Report on Septage Treatment Plant (SeTP) for the Rudrapur City, Uttarakhand under Sanitation Capacity Building Platform (SCBP) by National Institute of Urban Affairs (NIUA), New Delhi.

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Abbreviations

ABR	Anaerobic Baffle Reactor
AF	Anaerobic Filter
BOD	Biological Oxygen Demand
CapEx	Capital Expenditure
COD	Chemical Oxygen Demand
CPCB	Central Pollution Control Board
CW	Constructed Wetland
DPR	Detailed Project Report
FCO	Fertiliser Control Order
FSS	Faecal Sludge and Septage
FSSM	Faecal Sludge and Septage Management
O&M	Operation and Maintenance
OpEx	Operational Expenditure
PT	Public Toilets
RCC	Reinforced Cement Concrete
SeTP	Septage Treatment Plant
SFRC	Steel Fibre Reinforced Concrete
TSS	Total Suspended Solids
TWT	Treated Water Tank
WHO	World Health Organisation

Detailed Project Report

Technical Section

1 Septage treatment Plant (SeTP)

This section elaborates the treatment scheme for solid and liquid fraction of the FSS coming at the treatment plant. The first section elaborates on the different stages of treatment of FSS and focuses on selected component for each stage. The third section provides a graphical representation of the process of the treatment scheme at the SeTP. The fourth and fifth section describes each component, its design criteria and assumption made. It also elaborates on the performance and strength and weaknesses.

1.1 Process flow diagram

Process flow diagram helps to understand the flow of different streams from one component to other. It recognizes, what goes in and out of each component and helps us to understand all the interlinkages between different components in a SeTP. Figure 1 shows the process flow diagram of the proposed SeTP at Rudrapur.

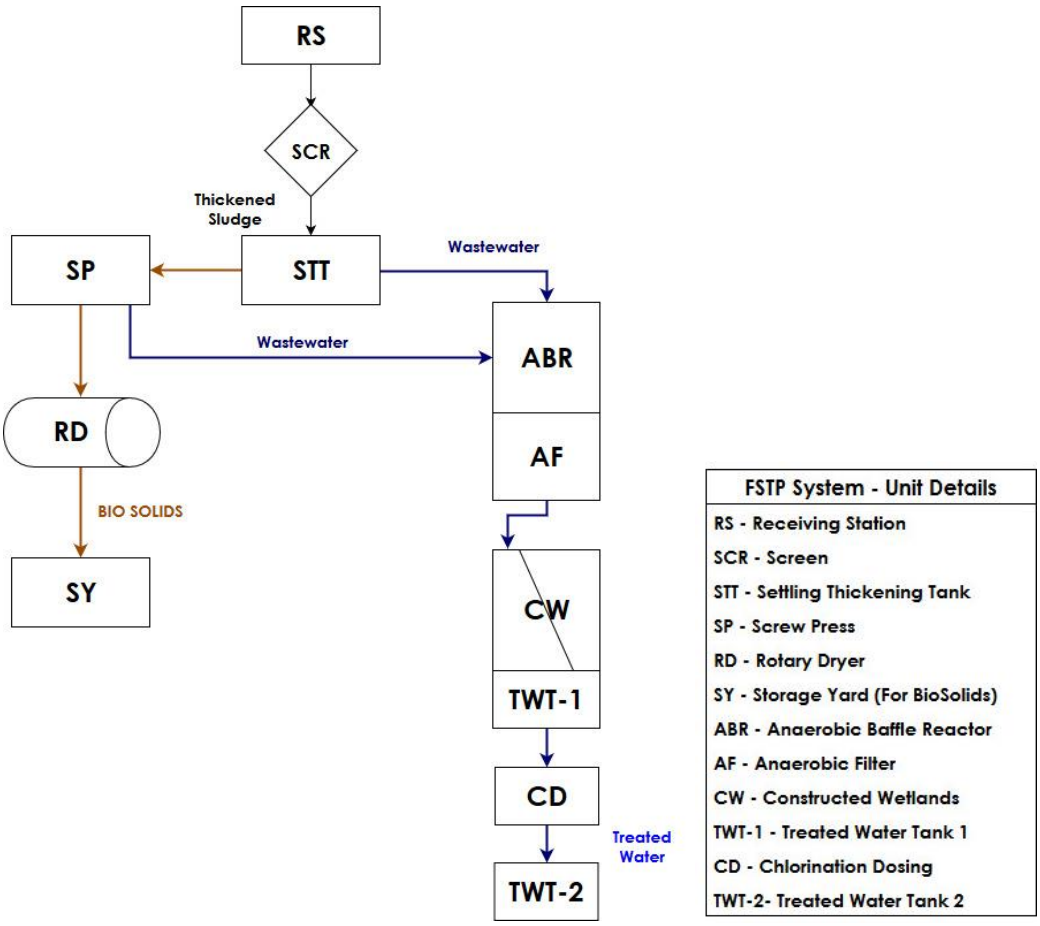


FIGURE 1: PROCESS FLOW DIAGRAM FOR SETP

The characteristic of the septage expected at the septage treatment plant are as follows;

Parameter	Value
pH	5.5-9.0
Chemical Oxygen Demand (COD)	<16,000 mg/L
Biological Oxygen Demand (BOD)	<5,000 mg/L
Ratio COD/BOD	5:1 to 10:1
Ammoniacal Nitrogen	<1000 mg/L
Total Suspended Solids	<8000 mg/L
Helminth eggs	4000 t/mL
Total Dissolved Solids	< 1000 mg/L

1.2 Solid treatment scheme

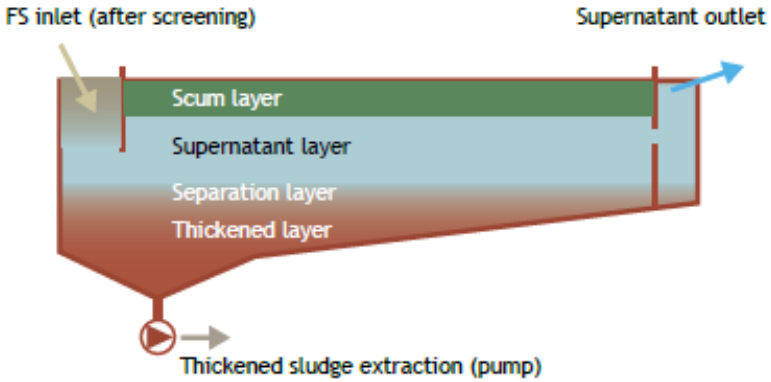
This section describes in detail the treatment scheme for solids in FSS. Starting with treatment mechanisms, followed by the criteria for design and assumptions are stated.

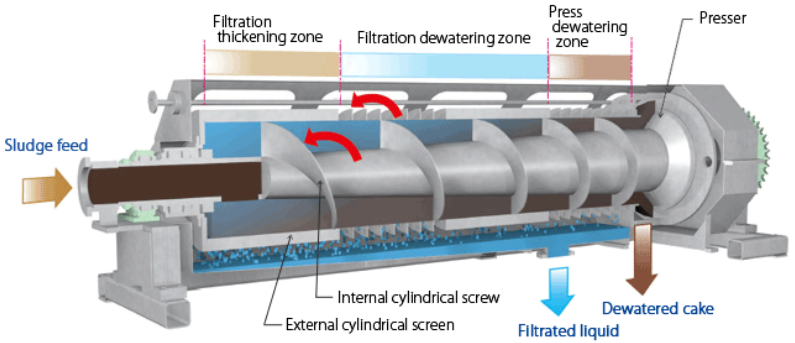
1.2.1 Fundamental mechanism

The three stages in solid treatment scheme are; (1) Solid-liquid separation, (2) Dewatering and (3) Pathogen reduction.

The treatment mechanism of each component of the solid treatment scheme is described in Table 1 and design considerations are given in the section 1.2.2.

TABLE 1: TREATMENT MECHANISMS OF EACH COMPONENTS OF SOLIDS TREATMENT SCHEME

Components	Treatment Mechanism	Picture
Screens	1. Physical exclusion of waste depending upon the size. 2. Set of coarse and fine screens provide necessary removal of solid waste (sanitary napkins, condoms, cloths, rags, plastic bags etc.) from the FSS received through vacuum truck.	
Settling-Thickening Tank	1. Settling: Sedimentation of suspended solids due to difference in the specific gravity of the particles and water. 2. Thickening: The accumulated sludge at the bottom get further compressed due to the weight of the particles above. 3. Floatation: Due to difference in the density; the oil, fats etc. floats to the top surface of the tank. 4. Anaerobic digestion: Digestion of the settled sludge happens in the thickened layer of sludge at the bottom.	

Screw Press	1. It is a simple, slow moving device that accomplishes dewatering by continuous gravitational drainage. 2. The screw press squeezes the material against a screen or filter and the liquid is collected through the screen for collection and use. 3. Screw presses possess different options that include perforated/slotted screens, a rotating cone, hard surfacing on the screw, and supplemental screen surface in the inlet hopper on the face of the cone.	
Rotary Dryer	1. The dewatered sludge goes into rotary dryer in batches, where it is exposed to heat and continuously tumbled. 2. The tumbling process ensures even distribution of heat in the solids and evaporates the bound water. 3. The exposure of sludge to heat above 100 ^{0}C, results in inactivation and reduction of pathogens.	

1.2.2 Design considerations

The following Table 2 gives the design considerations for each component of the solid's treatment scheme.

TABLE 2: DESIGN CONSIDERATION OF SOLID TREATMENT SCHEME

Components	Design considerations
Screens	Two sets of screens (coarse and fine) to trap the solid waste (sanitary napkins, condoms, cloths, rags, plastic bags etc.) with manual raking system to remove the solid waste.
Settling-thickening tank	Daily average flow: 125 m^3/d; Peaking factor: 1.5; Daily hours of operation: 10 h; Up flow velocity: 0.5 m/h; SS initial concentration: 8.0 g/L; SS concentration after thickening: 80 g/L; Efficiency: 70%; Scum height: 0.4 m; Supernatant height: 0.5 m; Separation height: 0.5 m; Length:Width ratio: 5:1;
Screw press	Average flow: 2.5 m^3/hr; Inlet Solid Content: 8%
Rotary dryer	200 kg Solids per hour; Inlet Solid content: >15%
Bio Solids	A faecal coliform density of less than 1000 MPN/g total dry solids and Salmonella sp. Density of less than 3 MPN per 4 g of total dry solids.

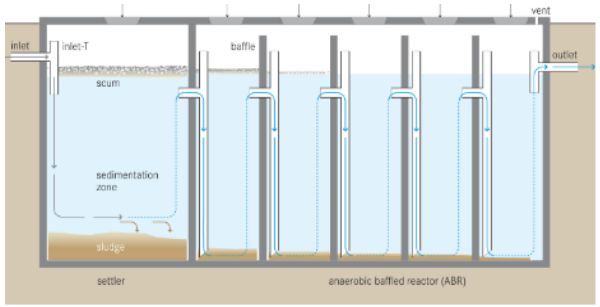
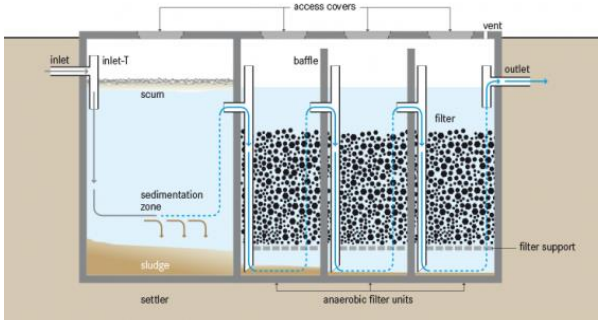
1.3 Liquid treatment scheme

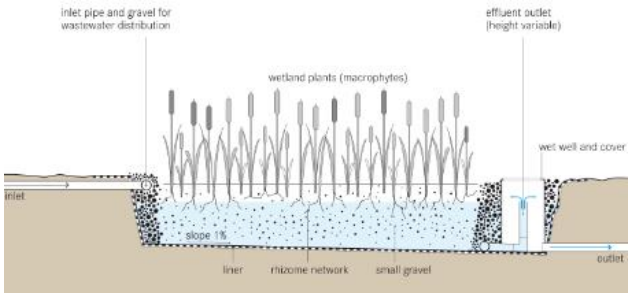
This section describes in detail the treatment scheme for liquid in FSS. Starting with treatment mechanisms, followed by the criteria for design and assumptions are stated.

1.3.1 Fundamental mechanism

The two stages in liquid treatment scheme are; (1) Anaerobic Treatment (2) Aerobic Treatment and (3) Disinfection. Table 3 describes the treatment mechanism of each component of the liquid treatment scheme.

TABLE 3: TREATMENT MECHANISMS OF EACH COMPONENTS OF LIQUID TREATMENT SCHEME

Components	Treatment Mechanism	Picture
Anaerobic Baffled Reactor	1. It is an improved septic tank with a series of baffles under which the wastewater is forced to flow. 2. The increased contact time with the active biomass (sludge) results in improved treatment. 3. The up-flow chambers provide enhanced removal and digestion of organic matter.	
Anaerobic Filter	1. It is a fixed-bed biological reactor with one or more filtration chambers in series. 2. Wastewater up flows through the filter, particles are trapped and organic matter is degraded by the active biomass that is attached to the surface of the filter material. 3. Larger the surface for bacterial growth, quicker will be the digestion.	

Horizontal Constructed Wetland	1. Different sizes of gravel basin that is planted with wetland vegetation. 2. Filter material filters out particles and microorganisms degrade the organics. 3. The filter media acts as a filter for removing solids, a fixed surface upon which bacteria can attach, and a base for the vegetation. 4. The vegetation transfers a small amount of oxygen to the root zone so that aerobic bacteria can colonize the area and degrade organics as well. 5. The plant roots play an important role in maintaining the permeability of the filter.	
Chlorine Disinfection	Chlorination is the most common method of wastewater disinfection and plays a key role in the treatment process by removing pathogens and other physical and chemical impurities. Chlorine's important benefits to wastewater treatment are disinfection, controlling odour and preventing septicity, controlling foaming and foul air scrubbing, destroying cyanides and phenols, ammonia removal.	

1.3.2 Design of the component

The following Table 4 gives the design considerations for each component of the liquid treatment scheme.

TABLE 4: DESIGN CONSIDERATION OF LIQUID TREATMENT SCHEME

Components	Design considerations
ABR	Daily average flow: 125 m^3/d; COD_{in}: 2500 mg/L; BOD_{in}: 500 mg/L; TSS_{in}: 1100 mg/L; HRT: 20 hr
AF	Average flow: 125 m^3/d; COD_{in}: <250 mg/L; BOD_{in}: <100 mg/L, TSS_{in}: 100 mg/L; HRT: 10 hr
Horizontal Constructed Wetland	Average flow: 125 m^3/d; COD_{in}: <120 mg/L; BOD_{in}: <50 mg/L, TSS_{in}: 50 mg/L; HRT: 24 hr
Final Output expected	COD_{in}: <100 mg/L; BOD_{in}: <30 mg/L, TSS_{in}: <50 mg/L

1.4 End products and specifications

1.4.1 Bio solids (Soil Conditioner)

Currently, it is considered to landfill the bio-solids in the vacant land near SeTP site without any use of it for other reuse purposes. If, it is considered to reuse it as a soil conditioner in the form of bagged compost that is sold as a commercial product for household level use in horticulture. Using FS as a soil amendment has many benefits over using chemical fertilisers alone. Organic matter in FSS can increase soil water holding capacity, build structure, reduce erosion and provide a source of slowly released nutrients. As mentioned above, when using FS as a soil conditioner, the fate of and exposure to pathogens and heavy metals needs to be taken into consideration, and social acceptance can be closely linked to potential commercial value. Other factors that need to be considered include nutrients, which may or may not be available in the ratio required by soil and crop systems.

In India, no regulations and standards have been set for treated bio-solids from treatment of FSS. Apart from the moisture content, pH and bulk density, other parameters of bio-solids cannot be controlled during the treatment of FSS. Hence US

EPA and WHO (2006) have set standards with respect to pathogen contents of the bio-solids to be used as fertilizer in agriculture.

For dewatered septage/sludge use as fertilizer in agricultural application, it should satisfy the following criteria of Class A Bio-solids of US EPA; (1) A faecal coliform density of less than 1000 MPN/g total dry solids and (2) Salmonella sp. Density of less than 3 MPN per 4 g of total dry solids.

WHO (2006) suggests following standards; (1) Helminth egg concentration of < 1/g total solids and (2) E coli of 1000/g total solids in treated septage for use in agriculture.

Following use of the bio solids are recommended;

1. The bio solids can be used in the public parks operated and maintained by Rudrapur Nagar Nigam for flowering plants and trees.
2. The bio-solids can be co composted with the organic waste to improve the characteristics of the compost currently being produced at the composting plant.

1.4.2 Treated water

Currently, it is considered that the liquid streams from treatment processes can be directly discharged into the nearer surface water bodies following the treated wastewater discharge standards. The treated water will meet the following standards laid down by CPCB on 13th October, 2017 (Annexure 1);

TABLE 5: TREATED WASTEWATER STANDARDS SET BY CPCB (2017, OCTOBER)

N°	Parameter	Concertation
1	pH	6.5-9.0
2	BOD	<30 mg/L
3	COD	<50 mg/L
4	TSS	<50 mg/L
5	Faecal coliform	<1000 MPN/100 mL

Following are the different use of treated water recommended;

1. For irrigation in the agricultural land.
2. For irrigation in public spaces such as parks.

2 Operation and Maintenance of SeTP

Septage treatment plant (SeTP) require ongoing and appropriate operation and maintenance (O&M) activities in order to ensure long-term functionality. O&M plan for the SeTP will include the following information shown in Figure 2,

FIGURE 2: INFORMATION INCLUDED IN THE O&M PLAN OF SETP

2.1 Procedures for receiving and off-loading of FSS at the station

It is important to take the traffic patterns and the management of truck traffic in and out of SeTPs into consideration in order to maximise the efficiency of the receiving and off-loading processes. Receiving FS loads at the SeTP involves,

TABLE 6: PROCEDURES FOR RECEIVING AND OFF-LOADING OF FSS AT THE RECEIVING STATION

Traffic control	Approval of FS discharge into the facility
• Provide directions of the access roads for the vacuum trucks at the receiving station, assistance to drivers to avoid accidents. • SOPs for the off-loading of FSS at the receiving station. • Vehicle parking areas	• Record keeping – Approval Manifest to discharge FSS at the receiving facility (Refer: Annexure 2) • Vehicle driver has to fill the Manifest form at the FSS collection site and has to handover it to the operator at the SeTP receiving station. After signing the Manifest • Training to the operators of the Physical inspection (colour, odour, and presence of grease or oil) of FS samples

2.2 O&M plan of SeTP

In the section 3 of FS treatment design, the components of Septage Treatment Plant (SeTP) are designed in detailed. The O&M requirements of the components of SeTP are given in the following Table 7 and Table 8.

TABLE 7: O&M ACTIVITIES FOR THE COMPONENTS OF SOLID TREATMENT SCHEMES

Components	O&M Activities	Schedule
Solid Treatment Scheme (STS)		
Screens	Manual cleaning of screens after every unloading	Daily
Settling thickening tank	Scum and sludge removal	Weekly
	Start-up period - adjust the load time, assess the depths of the different zones and optimise the compaction time and sludge removal frequency.	
	Observation of Seasonal variations as loss of water through evaporation which could increase the solids content of the scum. High temperatures may also increase the anaerobic digestion process, and therefore the height of the scum layer.	Seasonal
Screw Press	Washing of screw press after daily use	Daily
	Replacement of moving rings	After its life average
	Oiling and Lubrication	Twice a Week
	Records keeping of all screw press performance parameters, including the volume of biosolids fed to the screw press, polymer dosage, and other chemical usage.	Daily
Rotary Dryer	Routine cleaning to avoid corrosion	Daily
	Removal of scales by washing with acids or high-pressure water jets	Fortnightly
Note: Operation and Maintenance Manual for screw press and rotary dryers should be provided by the treatment components provider company and those O&M activities has to be followed by the operator. Routine cleaning and oiling of pumps and maintenance of electrical components is necessary		

TABLE 8: O&M ACTIVITIES FOR THE COMPONENTS OF LIQUID TREATMENT SCHEME

Components	O&M Activities	Schedule
Liquid Treatment Scheme (LTS)		
ABR	Check for wastewater flow in inspection chambers or inlet / outlet of ABR	Once in a Month
	Check for grease formation if any	Once in a week
	Desludging of Chambers	Once in 2 - 3 years
AF	Check for wastewater flow in inspection chambers or inlet / outlet of AF	Once in a Month
	Check water level in a treated water tank	Once in a week
Horizontal Constructed Wetland	Weeding and removal of dead leaves and litter	Once in a week
	Visual inspection for blockages and damage and water flow at inlet and outlet. Visual inspection of weed, plant health or requirement of pest problems	Fortnightly
	Control weeds in wetland by handweeding, herbicide application and/or temporary water level increase, quality and quantity of effluent	Two Monthly
	Check clogging of the substrate, remove the substrate, clean it and replace if necessary. Remove endcaps of pipes and distribution network and flush out to remove slimes and blockages. Check sludge levels in primary treatment and avoid sludge drift into wetland	Yearly
Chlorination	Restocking of chemical and checking of dosing equipment	As per the O&M manual of the provider
Note: Operation and Maintenance of the ABR-AF and Constructed Wetland should be done by the operator. Frequent maintenance tasks include:		

- repacking and exercising valves (i.e. locating and maintaining fully operational valves);
- oiling and greasing mechanical equipment such as pumps or emptying trucks; and
- housekeeping activities.

2.3 Monitoring & Record Keeping

2.3.1 Monitoring

It has to structure the monitoring program in order to provide the operations employees with adequate information to continuously optimise the plant performance, and to provide control over the effluent quality. Monitoring system will include the following aspects,

- Visual or sensory observations of the plant conditions, (example: scum on a treatment lagoon, colour of the sludge, odours emanating from a pump tank)
- Regular analysis or measurement at source (test strips or kits has to be used for the measuring pH, dissolved oxygen, temperature)
- Scheduled laboratory sample analysis.

It is recommended to operations department for setting - up a small-scale laboratory at the SeTP site or carry out the sampling by accredited private or government labs. It is suggested to carry out the analysis of basic parameters i.e. pH, TSS, BOD_5, COD, E-Coli at certain fixed interval and analysis of treated bio-solids considering the parameters as per FCO (2013).

2.3.2 Record Keeping

It is recommended to maintain the records or reports for the effective O&M programmes of SeTP. Operators can refer maintained records in order to identify previous fluctuations in the operation of the facility and operational problems that may recur periodically, can review the effectiveness of mitigation measures that may have been used to correct past operating problems, and to optimise the O&M procedures. It is suggested to prepare the different documentation formats for the activities listed below,

- information on the operation of the SeTP including daily operating records, the operators log book, manifest reports, the treatment unit operating data sheet and records related to FS deliveries to the plant;
- preventative and corrective maintenance records including the equipment maintenance log books and store room supply reports
- compliance reports including field and analytical data, and correspondence from regulatory officials
- employee records, such as employee schedules, time sheets and injury reports.

3 SeTP: Description and specification

3.1 Site selection

This section describes the proposed site details for SeTP. The land is already shortlisted, demarcated and is located near the Bagul river (28°57'51.34"N and 79°24'6.13"E) in Ward No 08 – Rampura area as shown in Figure 3. The SeTP site is easily accessible and will not pose any nuisance of odour and vehicular traffic to the residential areas. The site is located near the elevated storage reservoir of 11 KLD capacity for Rampura area.

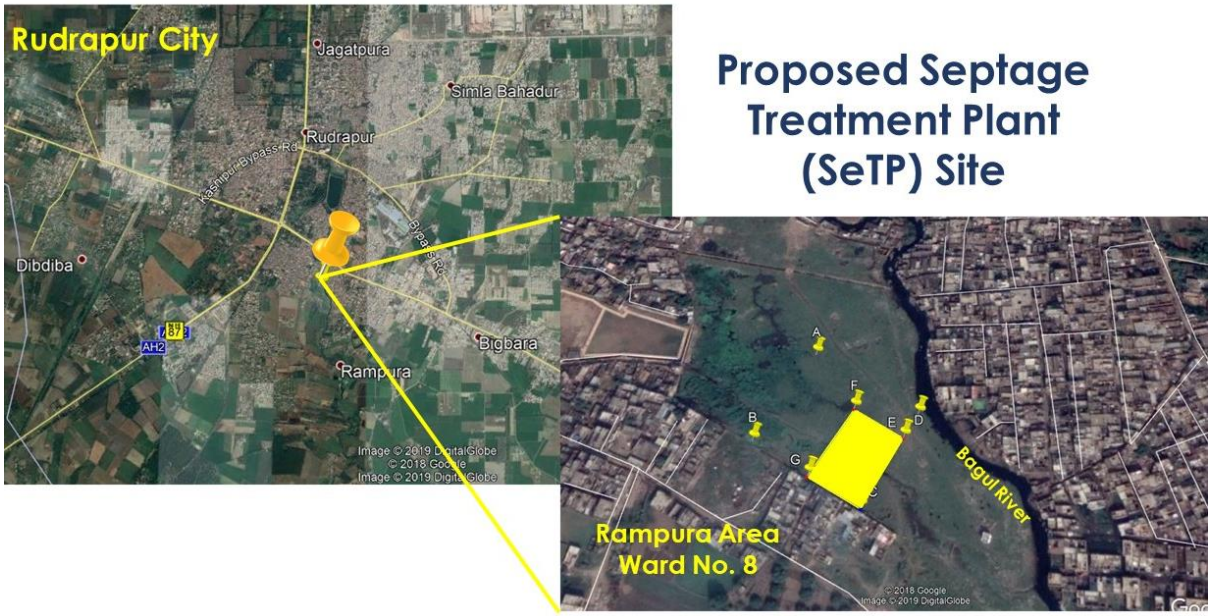
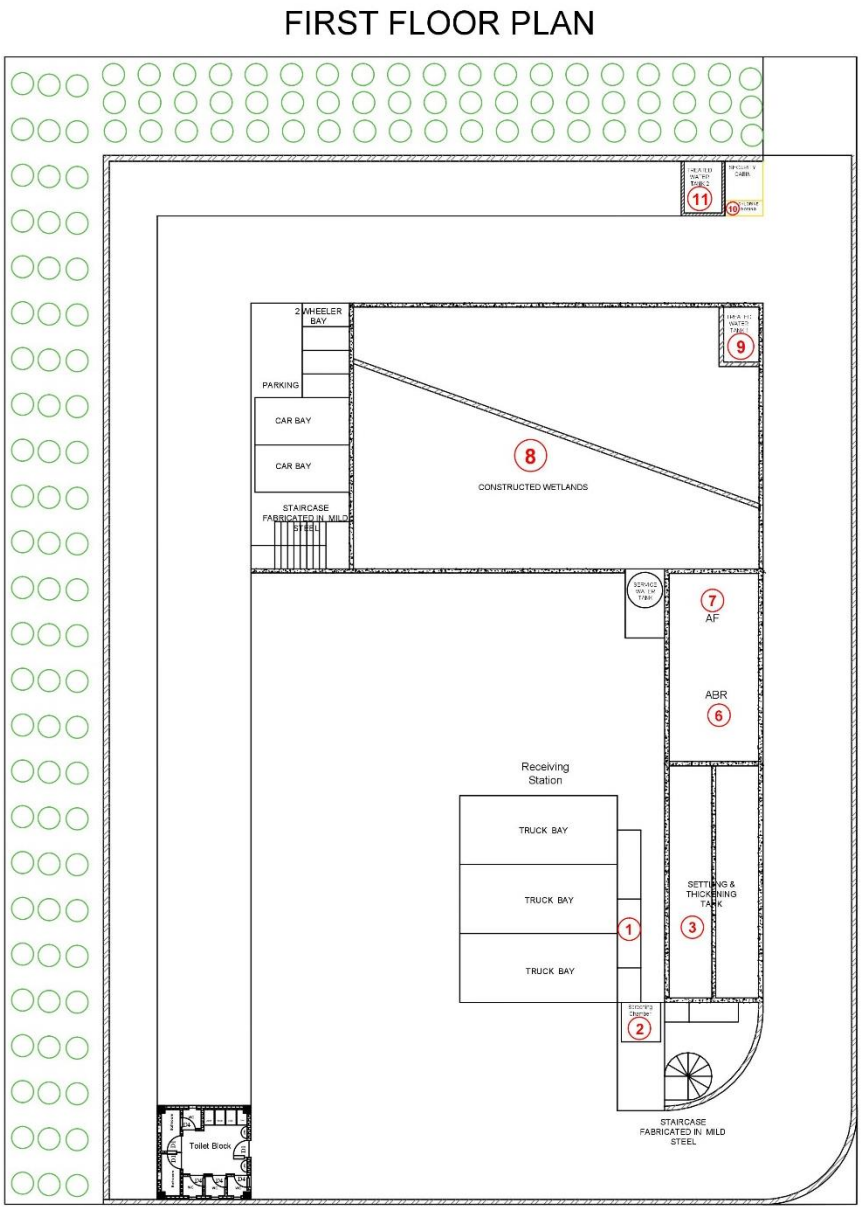


FIGURE 3: LOCATION OF SETP SITE IN RUDRAPUR CITY

3.2 Plan of SeTP site



SeTP System - Unit Details	
1	RECEIVING STATION
2	SCREENING CHAMBER
5	ROTARYDRYER
6	ANAEROBIC BAFFLE REACTOR
7	ANAEROBIC FILTER
8	CONSTRUCTED WETLAND
9	TREATED WATER TANK 1
10	CHLORINE DOSING
11	TREATED WATER TANK 2

FIGURE 4: LAYOUT OF PROPOSED SEPTAGE TREATMENT PLANT (SETP) SITE - FIRST FLOOR

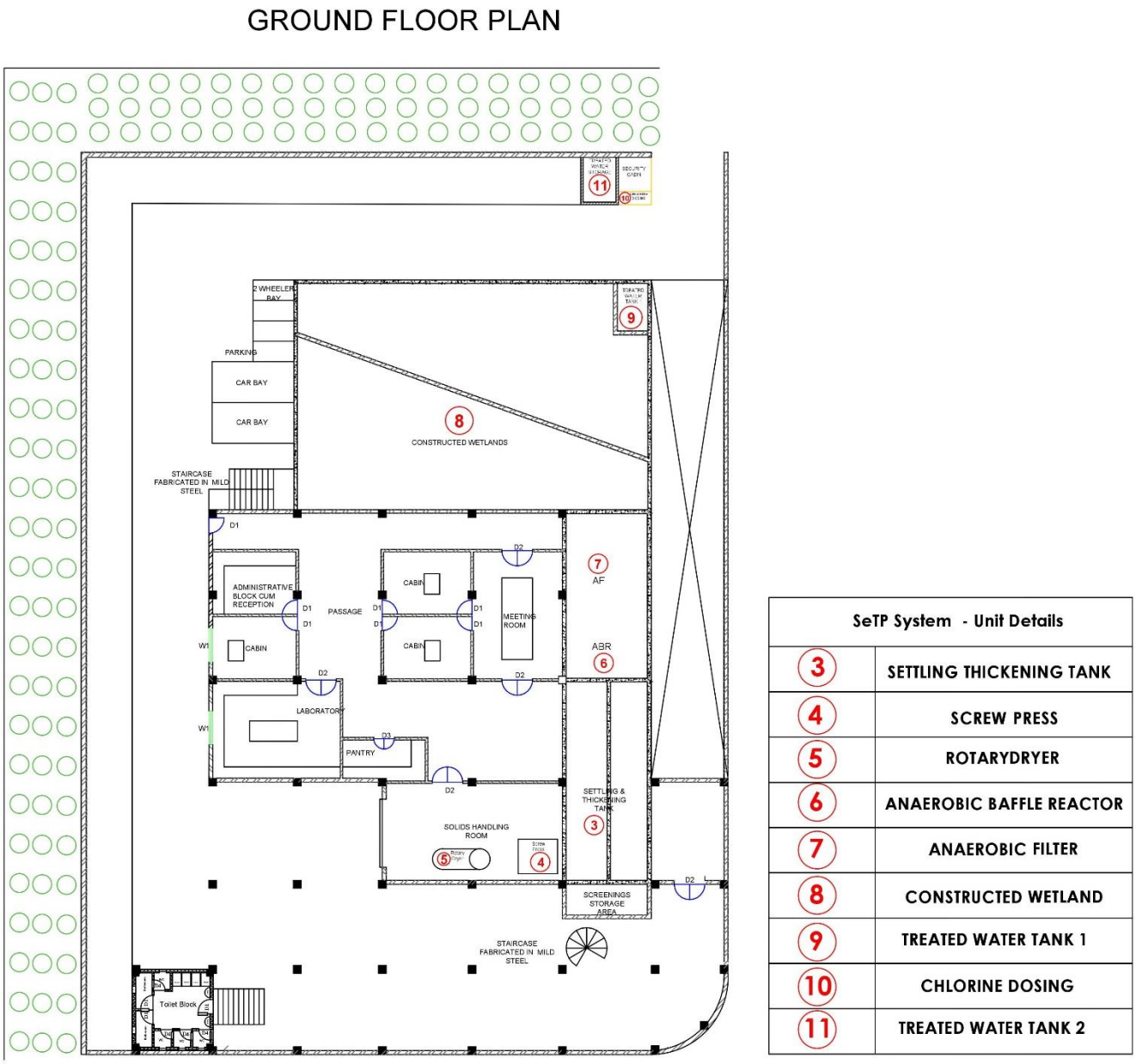


FIGURE 5: LAYOUT OF PROPOSED SEPTAGE TREATMENT PLANT (SETP) SITE - GROUND FLOOR

3.3 Description and specification solid treatment scheme

An FSS receiving station is proposed before the screens at the SeTP site. The receiving station will have three truck bays. Each truck bay will have an inlet point i.e. a pipe with a locking mechanism which locks onto the outlet of the truck. Thus, thee trucks can be emptied simultaneously. All the three pipes will be connected to a main pipe which will be connected with a dual screen. Each truck bay will be provided with a water hose for cleaning and washing of trucks and any spillage. The water used here will be treated water from liquid treatment scheme.

TABLE 9: DETAILS OF THE RECEIVING STATION

N°	Details	Unit	Value/Description
Receiving station			
1	Number of trucks served	No.	3
2	Size of each truck bay	No.	8 m x 4 m
4	Area required	m^2	120

3.3.1 Screens

Single receiving main pipe and dual screen will be installed at the initial stage of SeTP (refer process flow diagram in section 3.2). The septage collected from the containment system of individual households, societies, CT/PT or Hotels/Resorts will be transported through the receiving channel and screen. Screens will be installed after the main pipe of 0.2 m diameter having slope 1:15. The total length of the pipe will be 12 m respectively. The velocity of the FSS in the pipe should be between 0.3-1.0 m/s. This ensures no deposition of solids takes place in the channel. The first screen will have bar spacing of 12 mm followed by second screen with the bar spacing of 5 mm.

TABLE 10: SPECIFICATION OF SCREENS

N°	Dimensions	Unit	Value/Description
Receiving Channel Pipe			
1	Length	m	12
2	Diameter	m	0.2

N°	Details of equipment	Unit	Value/Description
Coarse screen			
1	Type		Bar screen
2	Make		Stainless Steel
3	Clear spacing	mm	12
4	Angle frame size	mm	450 x 200
5	Vertical bar width	mm	50
6	Vertical bar thickness	mm	10
Fine screen			
1	Type		Bar screen
2	Make		Stainless Steel
3	Clear spacing	mm	5
4	Angle frame size	mm	450 x 200
5	Vertical bar width	mm	50
6	Vertical bar thickness	mm	10

Manual raking is proposed since not much solid waste is expected to come in the FSS. The raked out solid waste will be collected in the pan behind the screen and sent to the land fill for disposal. After the screens, the FSS will directed to the settling thickening tank and the anaerobic digestor through the screens separately.

After disposal of FSS at SeTP, the suction trucks will be washed at the receiving station platform. The washing facility with compressor (5 HP Capacity) and jet system will be provided at the receiving station. A 200-litre compressor attached water tank will be provided and water will be pumped from treated water tank (TWT-2) for O&M of the receiving station and desludging vehicles. The submersible pump will be used with 1 HP and 30 LPH discharge capacity for the purpose. The details of the pump are mentioned in the Table 21.

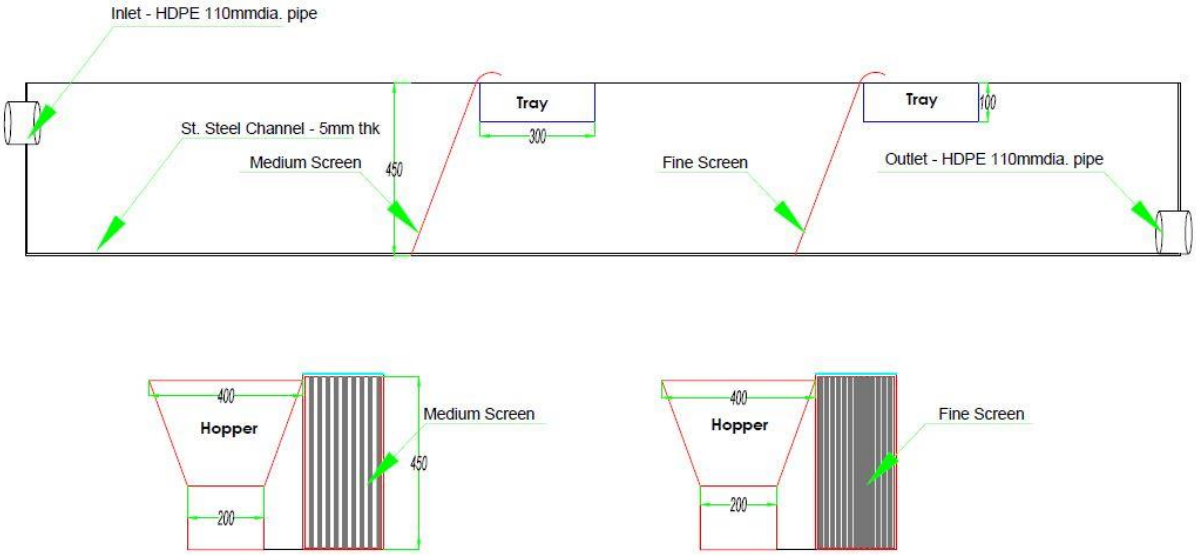


FIGURE 6: DIAGRAM OF CHANNEL AND SCREENS AT THE RECEIVING STATION OF SETP

3.3.2 Settling thickening tank

The settling thickening tank has two sections, inlet section, sedimentation section. The inlet section is designed in a way that, (1) no dead zones are created at the corners of the tank and (2) the velocity of the incoming septage is gradually reduced. A baffle wall helps to separate out the inlet section from the sedimentation section. There are two settling thickening tanks which will be working in batches. The first tank will be loaded for 10 days where 3 days of compaction and 7 days the sludge will be taken out.

In the sedimentation section the velocity of the septage is reduced adequately so as to allow separation of oils-grease-fats and solids particles. The sedimentation section has a slope towards the inlet section where a small sump is created for fixing the sludge pump. This sump ensures that only thick compressed sludge is pumped out of the settling thickening tank. In normal working conditions, approximately 10 m^3/d of thickened sludge needs to be pumped out of the settling thickening tank and sent to screw press for dewatering. Since the screw press will be operated for maximum 4 hours, the screw press capacity is 2.5 m^3/day (Section 3.3.3). The outlet section has outlet pipe of inverted elbow which facilitates removal of only top layer of the water. The lamella plates will be placed at the end of the STT with the covered area of 12 m^2 to increase the settling of solid particles in the tank.

TABLE 11: DIMENSIONS OF SETTLING THICKENING TANK

N°	Dimension	Unit	Value/Description
1	Length	m	10.8
2	Width	m	5
3	Height	m	3.7
4	Area	m^2	54
5	Volume	m^3	199.8

TABLE 12: SPECIFICATIONS OF PUMPS TO BE INSTALLED AT SETTLING THICKENING TANK

N°	Details of equipment	Unit	Value/Description
Sludge pump: From settling thickening tank to feeder of Screw press			
1	Type		2 nos. (1W + 1S) Horizontal centrifugal, self-priming, non-clog Model SP M
2	Solid handling	mm	7
3	Capacity	m^3/h	< 2.5
4	Head	M	12
5	Power	HP	1.0
5	Make		CI body and impeller

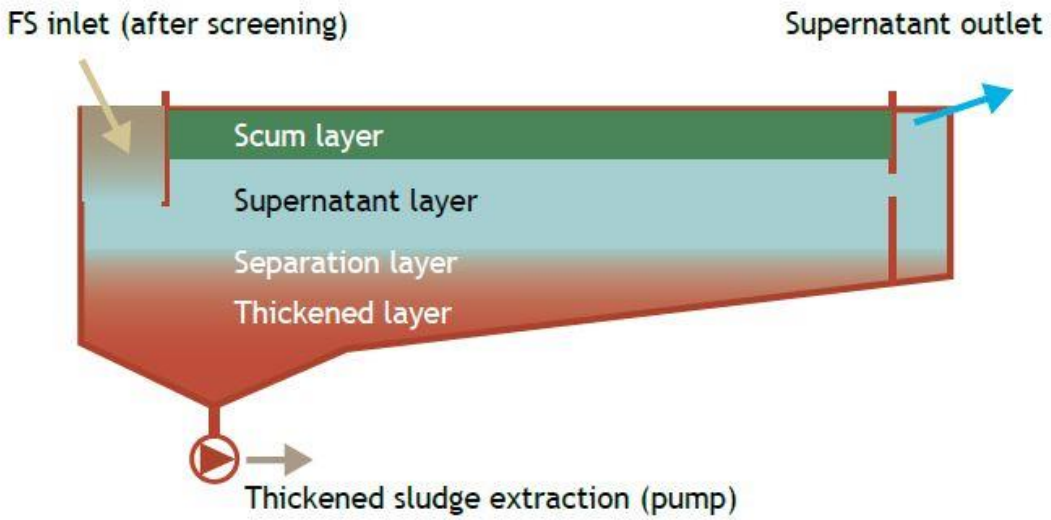


FIGURE 7: DIAGRAM OF SETTLING THICKENING TANK OF SETP (FOR REPRESENTATION PURPOSE ONLY; NOT TO THE SCALE)

3.3.3 Screw press

The thickened sludge from the settling thickening tank will be fed into the screw press. The screw press is integrated with a thickening cum compaction cylinder and flocculation tank. The thickened sludge is pumped to the inlet chamber where flow is regulated (excess flow is returned to sump). A polyelectrolyte (coagulant) is added to the incoming stream and a slow speed agitator is provided in the flocculation tank for mixing and formation of flocks. Polyelectrolyte consumption is between 2.5-3 kg/ton of dry solids and depends on the concentration of the solids in the thickened sludge. Then it passed through the compaction cylinder where in the first section thickening takes place and then filtrate is passed through the gap between rings under gravity after compaction zone. The pitch of screw and gap in the ring decreases towards the sludge discharge at the end of cylinder. The pressure plate at the discharge end increases the internal pressure of cage, thus resulting in formation of the dehydrated cake.

The resultant sludge contains only bound water in the moisture form. This sludge is further sent to rotary dryer in batches.

TABLE 13: DIMENSIONS OF SCREW PRESS

N°	Details of equipment	Unit	Value/Description
1	Flow	m^3/hr	2.5
2	Dimensions	mm	3370 X 1010 X 1700
3	Pedestal Dimension	mm	2520 X 615 X 1700
4	Total power	HP	1.0
5	Solid Content at Inlet	%	8
6	Noise Level		Less than 65 dB
7	Vibration Level		< 50 Microns
8	Feed Pressure at Inlet		Machine does not require any pressure.
9	Power Supply		400 V /50 Hz 3 phase.

TABLE 14: SPECIFICATIONS OF THE SCREW PRESS

N°	Component	Description
THICKNING CUM COMPACTION CYLINDER		
1	Diameter /Length	Dia. 250mm/1632 mm long
2	Material	Nylon in thickening zone and SS-304 in pressure zone
3	Inclination	150 from Horizontal
Screw Motor		
1	Model	Standard TEFC SCR induction motor
2	Make	Kirloskar/ Crompton / Bharat Bijlee / Rotomotive /Siemens
3	Power	0.75 HP/960 rpm
4	Bkw	0.32 kW
5	Absorbed Power	0.5 kW
6	Voltage/Frequency/Phase	415V +/- 10% / 50 Hz +/- 5% / 3 Phase
7	Operation	Controlled by VFD.
Flow Control Tank		
1	Size (L x W x H)	350 x 400 x 700 MM
2	Volume	98 Litre
3	Filter Screen	SS -304
4	Weir Type for flow control	Rinsing Hollow Pipe
Flocculation Tank		
1	Dimensions	600mm X 600mm X 750mm
2	Capacity	220 litres
3	MOC	SS- 304
4	Inlet Ply pressure	0.1 kg
5	Poly Consumption	2.5 to 3.0 Kg / Ton of Dry Solids
6	Concentration of Poly Solution	0.1 %
Flocculation Tank Agitator Motor		
1	Model	TEFC/ SCR induction motor, insulation Class F
2	Make	Kirloskar/ Crompton / Bharat Bijlee / Rotomotive/Siemens
3	Power/ Speed	0.25 HP / 1440 RPM

4	Bkw	0.1 kW
5	Absorbed Power	0.13 kW
6	Voltage/Frequency/Phase	415V +/- 10% / 50 Hz +/- 5% / 3 Phase
7	Speed of Agitation	15-55 RPM
8	Operation	Controlled by VFD
Nozzles		
1	Inlet	65 NB
2	Sludge Return	125 NB
3	Filtrate	125 NB
4	Drain -Flow Control Tank	25 NB
5	Drain – Flocculation Tank	40 NB
6	Poly Dosing	15 NB

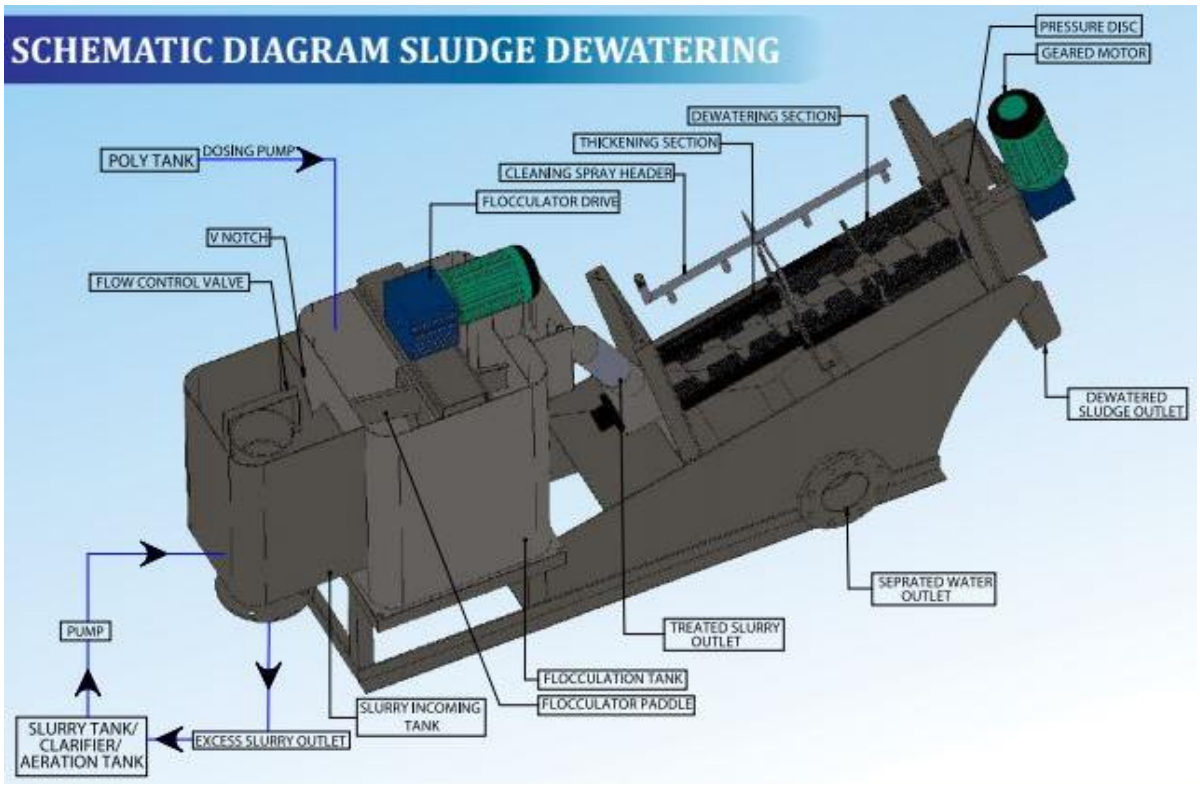


FIGURE 8: DIAGRAM OF SCREW PRESS (FOR REPRESENTATION PURPOSE ONLY; NOT TO THE SCALE)

3.3.4 Rotary dryer

The dewatered sludge from the screw press is fed into the rotary dryer in batches and dried with moisture content between 10-40% depending on the operation time of the dryer. The dryer consists of the arrangement where the drum is heated and rotated and the moisture laden air exists the system. The dried, sterilised sludge comes out of the system. The treated solids are proposed to be stored in the ware house for further reuse.

TABLE 15: SPECIFICATIONS OF THE ROTARY DRYER

N°	Component	Description
Rotary dryer		
1	Total volume	1000 litres
2	Batch volume	400 - 500 litres
3	Capacity	250-300 kg @ 0.6 gm/cm^3 bulk density
4	Make	Contact parts and drum in SS 304
5	Drum size	600 mm diameter and 1200 mm length
6	Electrical	36kW
7	Operational temperature	130 to 160 °C
8	Maximum temperature	200 °C
9	Voltage	415 v AC 3 phase
10	Insulation	100 mm 96 kg/m Cu Rockwool
11	Motor	AC geared 3 HP
12	Control panel	Automatic temperature controlled by PID controller, heater control, speed control by AC frequency drive, Safety controller, ammeter indicating light emergency stop, completed wired electrical cum instrumentation
13	Loading	SS 304 top Silo 200 litres
14	Discharge	Ss 304 bottom discharge

FIGURE 9: PICTURE OF ROTARY DRYER (FOR REPRESENTATION PURPOSE ONLY; NOT TO THE SCALE)

3.4 Description and specification of liquid treatment scheme

3.4.1 Anaerobic Baffled Reactor (ABR)

The dewatered wastewater from settling thickening tank and screw press is fed into the anaerobic baffled reactor for further treatment. ABR is combination of several anaerobic process principles. ABR is ideal for natural wastewater treatment decentralized scale system as it is easy to build and simple to operate. Hydraulic and organic shock loads have little effect on treatment efficiency. Usually a distribution channel or baffle is needed to distribute the water in a uniform way in the chambers. A baffle wall will reduce the velocity. The wastewater flows from bottom to top with the effect that sludge particles settle against the up-stream of the liquid. This provides the possibility of intensive contact between resident sludge and newly incoming liquid.

ABR requires a start-up period of several months to reach full treatment capacity since the slow growing anaerobic biomass first needs to be established in the reactor. To reduce start-up time, the ABR can be inoculated with anaerobic bacteria, e.g., by adding fresh cow dung or septic tank sludge. The added stock of active bacteria can then multiply and adapt to the incoming wastewater. The efficiency of an ABR increases with higher organic load. The hydraulic gradient between inlet and final outlet should be in the range of 15 to 30 cm. The specifications and dimensions of ABR system are given in Table 16. The BOD and COD removal efficiency of ABR is around 80-90%. The lamella plates will be placed at the last two chambers of the anaerobic baffle reactor with the total covered area of 12 m^2 to increase the settling of solid particles in the chamber.

TABLE 16: SPECIFICATIONS AND DIMENSIONS OF ABR SYSTEM

N°	Particulars	Unit	Value / Description
1	Daily average flow	m^3/d	125
2	Influent BOD_5	mg/L	500
3	Influent COD	mg/L	2500
4	Influent TSS	mg/L	1100
5	Number of Baffles	No.	5

6	HRT	hr	20
7	Dimensions/Chamber (L x W x H)	m	1.20 x 5.0 x 3.6
8	Total Area	m^2	30
9	Total Volume	m^3	108
8	Make	-	RCC

3.4.2 Anaerobic Filter (AF)

The treated water from ABR is fed in the AF in continuous flow system. AF includes the treatment of non-settleable and dissolved solids by bringing them in close contact with a surplus of active bacterial mass. Filter material, such as gravel, rocks, cinder or specially formed plastic media blocks provide additional surface area for bacteria to settle and grow. In this system, the plastic media blocks should be used with more than 300 m^2/m^3 surface area.

The length and width required for each of the chambers is derived from the peak hour flow and defined velocity of wastewater within the chamber. Anaerobic filters may be operated as down flow or up flow systems. The up-flow system is preferred and used as the risk of washing out active bacteria is less in this case. An important design criterion is that of equal distribution of wastewater upon the filter area. The baffle walls or pipes (down shaft pipes) ensure the direction of wastewater flow within the tank; it forces the wastewater to flow through the filter media in each of the chamber. The BOD and COD removal efficiency of AF is around 50-60%. The lamella plates will be placed at the last chamber of the anaerobic filter with the total covered area of 6 m^2 to increase the settling of solid particles in the chamber.

TABLE 17: SPECIFICATIONS AND DIMENSIONS OF ANAEROBIC FILTER

N°	Particulars	Unit	Value / Description
1	Daily average flow	m^3/d	125
2	Influent BOD_5	mg/L	100
3	Influent COD	mg/L	250
5	Number of Baffles	No.	3
6	HRT	hr	11
7	Dimensions / Chamber (L x W x H)	m	1.2 x 5.0 x 3.6

8	Total Area	m^2	18
9	Total Volume	m^3	65
8	Make	-	RCC

3.4.3 Horizontal Constructed Wetland

After treatment at AF, the treated water is fed to horizontal constructed wetland system which is a natural wastewater treatment system. The treatment process in horizontal ground filters is complex. The design of a horizontal subsurface flow constructed wetland depends on the treatment target and the amount and quality of the influent. The removal efficiency of the wetland is a function of the surface area (length x width), while the cross-sectional area (width x depth) determines the maximum possible flow. Generally, a surface area of about 5 to 10 m^2 per person equivalent is required.

Pre- and primary treatment is essential to prevent clogging and ensure efficient treatment. The influent can be aerated by an inlet cascade to support oxygen-dependent processes, such as BOD reduction and nitrification. The bed should be water proofed with standard specification as per IS code or lined with an impermeable liner (clay or geotextile) to prevent leaching. It should be wide and shallow so that the flow path of the water in contact with vegetation roots is maximized. A wide inlet zone should be used to evenly distribute the flow. A well-designed inlet that allows for even distribution is important to prevent short-circuiting. The outlet should be variable so that the water surface can be adjusted to optimize treatment performance.

Small, round, evenly sized gravel (3 to 32 mm in diameter) is most commonly used to fill the bed to a depth of 0.5 to 1 m. To limit clogging, the gravel should be clean and free of fines. Sand is also acceptable, but is more prone to clogging than gravel. The water level in the wetland is maintained at 5 to 15 cm below the surface to ensure subsurface flow. Any native plant with deep, wide roots that can grow in the wet, nutrient-rich environment is appropriate. The Canna Indica, Typha phragmites or locally available weeds should be used for the plantation in constructed wetland.

Ground filters are covered by suitable plantation - meaning any plant which can grow on wastewater and whose roots go deep and spread wide. To an extent,

performance may also depend on the species of plant chosen. The micro-environment inside the filter is such that it creates equilibrium between sludge production and sludge "consumption". Such equilibrium is only likely with low loading rates. Plants are normally need to harvest after some period as it grows in smaller periods

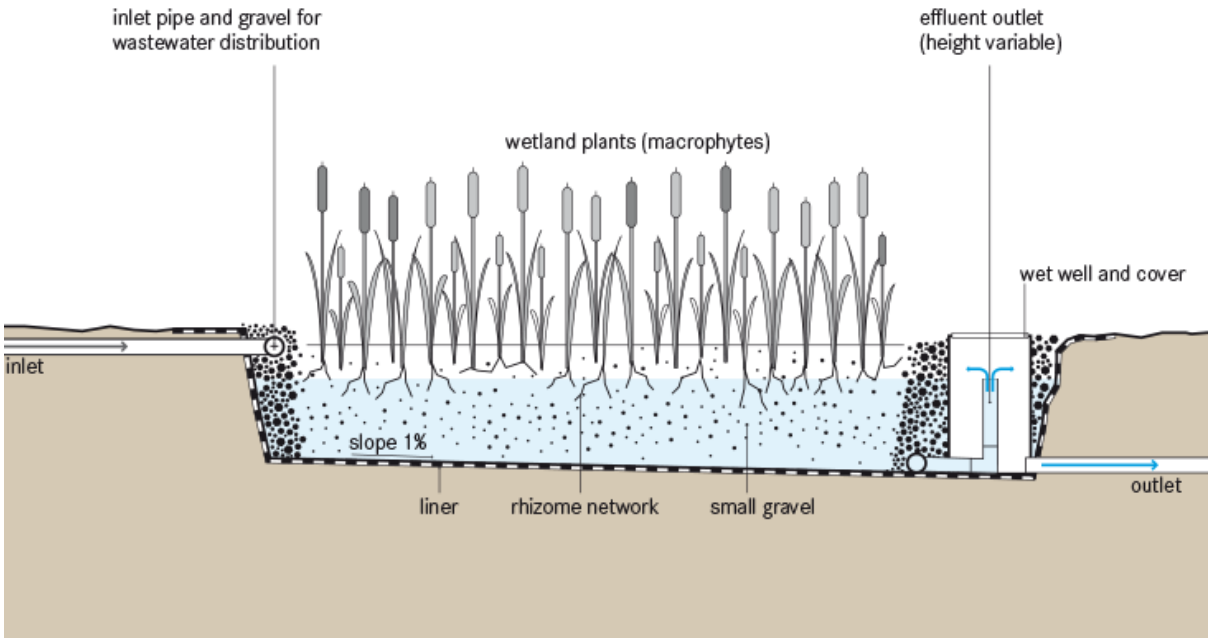


FIGURE 10: SCHEMATIC OF HORIZONTAL CONSTRUCTED WETLANDS (FOR REPRESENTATION PURPOSE ONLY; NOT TO THE SCALE)

TABLE 18: SPECIFICATIONS AND DIMENSIONS OF HORIZONTAL CONSTRUCTED WETLANDS

N°	Particulars	Unit	Value / Description
1	Daily average flow	m^3/d	125
2	Influent BOD_5	mg/L	50
3	Influent COD	mg/L	120
5	Number of sections	No.	2
6	HRT	hr	83
7	Dimensions (L x W x H)	m	21 x 13.8 x 0.9
8	Total Area	m^2	284
9	Total Volume	m^3	261
8	Make	-	RCC

3.4.4 Chlorine Disinfection

The liquid from the intermediate storage tank will be passed through chlorine dosing system and will stored the final treated water in final treated water tank. Chlorine dosing ensures that the treated water is adequately disinfected so that it is fit for human contact. The chlorine dosing will be done online after the water pumped from intermediate treated water tank (TWT-1) to the final storage tank (TWT-2). Chlorine dosing systems are simplest and most widely used disinfection system, worldwide. Chlorine is simple to dose, cost-effective and very efficient as a disinfectant. Diaphragm pumps are commonly used for application of chlorine to treat waters. In addition, plungers and some other types of pumps are also used to dose chlorine. Sometimes chlorine tanks are also to keep the water in contact for a longer period of time. Dosing can be done using liquid or gaseous chlorine as per the requirement. There will be one operation room for chlorine dosing.

FIGURE 11: ONLINE CHLORINE DOSING FILTER (FOR REPRESENTATION PURPOSE)

TABLE 19 SPECIFICATION FOR CHLORINE DOSING FILTER

N°	Particulars	Unit	Value / Description
1	Grade	-	Automatic
2	Power	HP	5
3	Weight	Kg	Approx. 100 kg

5	Voltage	Volt	220 to 440
6	Phase	-	Single
7	Material	-	Mild Steel and Fibre
8	Product Type	-	Dosing System

3.4.5 Treated Water Tank

There are two treated water tanks (TWT-1 and TWT-2) will be constructed at two different locations. The treated water tank (TWT-1) will be after Horizontal constructed wetland where the treated water from horizontal constructed wetland will be stored. From T1 water will flow to chorine disinfection unit and will be stored the treated water in treated water tank (TWT-2). One overflow will be given so that the excess water entering into T1 will dispose of into the closed stormwater drains.

TABLE 20: SPECIFICATION OF TREATED WATER TANK (TWT-1)

N°	Dimensions	Unit	Value/Description
TWT-1			
1	Length	m	3
2	Width	m	2
3	Depth	m	1.2
4	Area of chamber	m^2	6
5	Volume of chamber	m^3	7.2
Pump (P1)			
1	Make		KS 6A-0307
2	Type	-	Submersible Pump
5	Frequency	Hz	50
6	Delivery size (mm)	mm	50
8	Phase	-	Three Phase
9	Power	HP	3.0
10	Discharge Range	LPM	240
11	Quantity	No.	1
12	Discharge	m^3/12 hr.	172.8 (14400 lit/hr)

The treated water tank (TWT-2) will be constructed after chlorine dosing system i.e. after completion of whole treatment process. The treated water from TWT-2 will be further use for flushing at toilet block and for other reuse options.

TABLE 21: SPECIFICATION OF TREATED WATER TANK (TWT-2)

N°	Dimensions	Unit	Value/Description
TWT-2			
1	Length	m	3
2	Width	m	2
3	Depth	m	1.2
4	Area of chamber	m^2	6
5	Volume of chamber	m^3	7.2
Pump (P2)			
1	SKU		KS 6B-0305
2	Type		Submersible Pump
3	Sub Type		Water Drain Pump
5	Frequency	Hz	50
6	Delivery size (mm)	mm	50
8	Phase		Three Phase
9	Power	HP	3.0
10	Discharge Range	LPH	16200
11	Quantity	No.	1
12	Discharge	m^3/12 hr.	194.4 (16200 lit./hr)

3.5 Description and specification: Plumbing

The fixtures and plumbing should be done as per the drawings provided with the DPR.

TABLE 22: USAGE OF PIPES, VALVES FITTINGS ACCORDING TO LOCATIONS

N°	Location	Type of pipe
1	Pump suction, discharge and header lines for sludge	SS Pipe as per IS 1729
2	Pump suction, discharge and header lines for wastewater	UPVC SCH 40

3	Interconnecting gravity lines	UPVC SCH 40
4	Exposed air lines	UPVC SCH 50
5	Gate valve (>65 NB) for treated water	Make: CI, Screwed end
6	Non-return valves (>65 NB) on the for the treated water line near ground floor toilet block	Make: CI, Screwed end

The specifications, advantages and disadvantages of the various pipes and appurtenances used are given in the section below.

3.5.1 UPVC pipes

Specification:

IS15328 deals with non-pressure plasticized polyvinylchloride (PVC) for use in underground piping system. IS9271 deals with the un-plasticized polyvinyl chloride (UPVC) single wall corrugated pipes for drainage.

Advantages:

The chief advantages of UPVC pipe are resistance to corrosion, light weight for transportation, toughness, rigidity, economical in laying, jointing, and maintenance and easy to fabricate.

Disadvantages:

The UPVC pipes are susceptible to buoyancy in high ground water table conditions. To prevent buoyancy the pipes can be tied to poles driven into the ground.

3.5.2 HDPE pipes

Specification:

Standard specifications have been framed by the BIS in IS 14333 for sewerage related application. Methods of joints are usually fusion welded or flange jointed depending on straight runs or fittings.

Advantages:

The advantages of these pipes offering smooth interior surfaces and offering relatively highest resistance to corrosion are recognized and they are available in solid wall. When laid in straight gradients without humps or depressions, they can easily offer longer life cycle.

3.5.3 Non-return valve

A non-return valve can be fitted to ensure that the medium flows through a pipe in the right direction, where pressure conditions may otherwise cause reversed flow. A non-return valve allows a medium to flow in only one direction. The flow through the non-return valve causes a relatively large pressure drop, which has to be taken into account when designing the system.

There are different types of non-return valves, such as spring-loaded, swing type, and clapper type valves.

FIGURE 12: SCHEMATIC REPRESENTATION OF NON-RETURN VALVE (LEFT) CLAPPER TYPE AND (RIGHT) SPRING TYPE

3.5.4 Gate valve

Gate valves are designed for fully open or fully closed service. They are installed in pipelines as isolating valves, and should not be used as control or regulating valves. Operation of a gate valve is performed doing an either clockwise to close (CTC) or clockwise to open (CTO) rotating motion of the stem. When operating the valve stem, the gate moves up- or downwards on the threaded part of the stem.

Gate valves are often used when minimum pressure loss and a free bore is needed. When fully open, a typical gate valve has no obstruction in the flow path resulting in a very low-pressure loss, and this design makes it possible to use a pipe-cleaning pig. A gate valve is a multiturn valve meaning that the operation of the valve is done by

means of a threaded stem. As the valve has to turn multiple times to go from open to closed position, the slow operation also prevents water hammer effects.

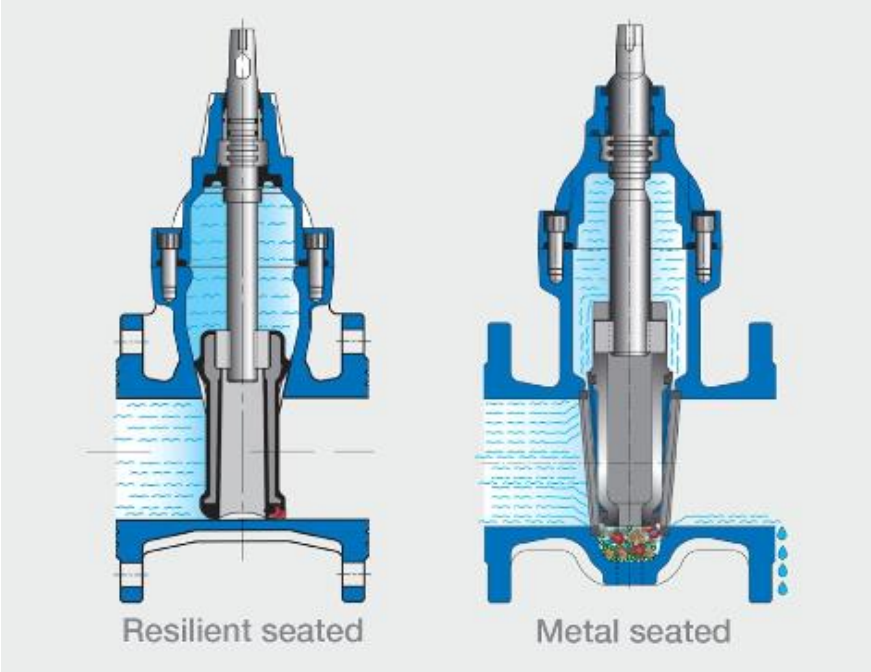


FIGURE 13: SCHEMATIC REPRESENTATION OF GATE VALVE

3.5.5 Slopes of pipes

The slopes of pipes depend on various things, however following table can be used for pipes where gravity flow is expected.

TABLE 23: MINIMUM SLOPES REQUIRED FOR PIPES CONVEYING LIQUIDS (WASTEWATER)

Pipe size (mm)	Minimum slope	
	As percent	As 1 in
150	0.60	170
200	0.40	250
250	0.28	360
300	0.22	450

3.5.6 Manholes

Given the site conditions that the ground water table is as high as manholes is essentially recommended to quicken the work of construction in the roads by adopting precast sections assembled at site. The provisions made in the CPWD item

design and specification shall apply to the design. The entire structure shall at all times be designed to the condition where the ground water is at ground level itself and the inside is empty and there is no superimposed load on the manhole to counter the uplift force and not considering the skin friction of the manhole sidewall with the soil.

3.5.7 Covers and frames

The size of manhole covers should be such that there should be clear opening of not less than 560 mm diameter for manholes exceeding 0.9 m depth. The frames of manhole shall be firmly embedded to correct alignment and level in plain concrete on the top of masonry. The precast frame and cover can also be of steel fibre reinforced concrete (SFRC) conforming to IS 12592 and shall be of approved make. The frame and cover shall be of specified grade, size and thickness as mentioned in the description of the item.

3.6 Non-treatment components of SeTP

3.6.1 Internal road

The 5 m wide internal ring road of around the building and the treatment system has been proposed at the SeTP. A concrete road has been proposed, as it is faster to construct and demonstrates much better performance as compared to a bituminous road. The specification of the road are as follows;

"Design mix cement concrete of M-30 grade, in roads/ taxi tracks/ runways, using cement content as per design mix, using coarse sand and graded stone aggregate of 40 mm nominal size in appropriate proportions as per approved & specified design criteria, providing dowel bars with sleeve/ tie bars wherever required, laying at site, spreading and compacting mechanically by using needle and surface vibrators, levelling to required slope/ camber, finishing with required texture, including steel form work with sturdy M.S. channel sections, curing, making provision for contraction/ expansion, construction & longitudinal joints (10 mm wide x 50 mm deep) by groove cutting machine, providing and filling joints with bitumen hot sealing compound filler and sealants."

3.6.2 Power generator

According to the availability of load line voltage and load line current, it will be possible to setup a separate connection by installing three phase transformers of 50 KvA capacity for the SeTP. It is also recommended to have alternate electric supply for the treatment plant using Diesel Power Generator. Electrical power generators, also known as alternators, transform mechanical energy into electrical energy. They can be used as backup for emergency power or as an alternator on board a vehicle. Generators can produce either AC or DC power and are typically powered by a fuel engine. Generators produce electricity from mechanical inputs through the physical process of electromagnetic induction. In their simplest form, generators harness mechanical energy by rotating a coil through a magnetic field or electromagnets around a fixed coil in order to induce an electrical current.

FIGURE 14: SCHEMATIC REPRESENTATION OF POWER GENERATOR

Diesel is a high-octane fuel that is easy to refine while its shortcoming stems from the amount of pollutants it contains. Diesel generators boast high efficiency producing more energy on a normalized basis when compared to gasoline. Diesel fuel burns hotter, leaving fewer residues on internal combustion chambers, allowing for increased engine life as well. Recent developments to integrate an exhaust scrubber have impacted the efficiency of diesel generators while they still outperform other gensets in energy efficiency.

TABLE 24: TECHNICAL SPECIFICATION OF THE DIESEL POWER GENERATOR

DG Set Model	Rating (kVA)	Canopy Size (LxWxH)	Starting System	Weight (Kg)
--	62.5	2800x1100x1595	12V DC	1420
No. of Cylinders	**Bore (mm)**	**Stroke (mm)**	**Total Displacement (cc)**	**Lube oil Sump Capacity (Ltrs)**
4	96	112	3240	10
Fuel Tank Capacity (Ltrs)	**Engine Model**	**Engine Make**	**Engine Power (bhp)**	**Rated Speed**
150	4R1040TA G1	Kirloskar Green/ KOEL	83	1500
Aspiration	**Cooling System**	**Type**	**Frequency**	**Voltage**
TA	WATER	Brushless, H Class Insulation	50	230/415

3.6.3 Storm water drains

A storm water drain is designed to drain excess rain water from the impervious surfaces such as paved streets, car parks, parking lots etc. Although this is the primary function of a storm water drain, in the case of SeTP, the important function is to avoid water logging and flooding of the site. Since the tanks (for treatment and treated water) are underground it is necessary that the storm water should not enter these tanks and should be drained as quickly as possible. Since the site is located near the river and high rainfall area, a storm water drain has also been suggested along the outer boundary of the SeTP in order to drain all the runoff water from the SeTP Site.

FIGURE 15: SCHEMATIC REPRESENTATION OF STORM WATER DRAIN ALONG THE INTERNAL ROAD

4 Financial estimates

For the budget estimation, there is need of consideration of technical, managerial, administrative, personnel, financial and social aspects. The capital expenditure required for the construction of septage treatment plant (SeTP) components proposed in the above section are detailed out in this chapter.

4.1 Treatment and disposal

4.1.1 Capital Expenditure

Capital expenditure (capex) consists of (1) cost of civil constructions such as receiving station, tanks, rooms, roads, boundary wall, stormwater drains etc., (2) Cost of purchase of electromechanical components such as screw press, rotary dryer, pumps, panels, wiring and plumbing etc. and (3) Establishment cost primarily consist of cost of supervision during implementation phase and shipping, insurance of the equipment etc.

Cost of construction

The cost of construction as suggested above includes cost of all the civil work to be carried out for execution of the project. As per the Annexure 3, is it estimated to be INR 404.65 lakhs.

Cost of purchase

The purchase cost includes cost of all the electromechanical components involved in the execution of the project. As per the Annexure 3, it is estimated to be INR 57.84 lakhs.

Establishment cost

The present practice is to arrive at the establishment cost as a percentage of the project cost as per the age-old practice of PWD, where the establishment charges are taken as anywhere between 12 to 15 %.

Although in our case the treatment modules (Screw Press, Rotary Dryer) will be purchased and installed/assembled, the civil component is still 76% when taken into

consideration civil works other than the treatment system. Also, in this case the establishment cost includes the cost of shipping, insurance and expert man-day cost required during assembly and commissioning of plant. For this purpose, the establishment cost is taken on higher side i.e. 15% of the total cost of construction and purchase which is equivalent to INR 69.37 lakhs.

4.1.2 Operational Expenditure

Human resource costs

Human resource in the form of experts, skilled and unskilled persons are required for proper functioning of any facility. In this case, a team of 2 operators, 2 semi-skilled labourers, 3 unskilled labourers, 4 security guards, a computer operator and a lab incharge are recommended to be posted at SeTP. The Senior Engineer, Junior Engineer from government departments will be coming once a week to check the records and functioning of the SeTP. As per the Annexure 3, it is estimated to be INR 20.32 lakhs per annum.

Energy costs

The energy costs are straightforward calculation based on the running kW, numbers and hours of electrical equipment. Usually, these cannot be worked out in detail at the stage of project proposal. However, the table in Annexure 3, is an attempt to summarise the major electricity consuming equipment used for treatment of FSS.

The annual energy cost when all the electromechanical equipment's are working on full capacities is INR 5.94 lakhs.

Consumables and fuel

Chemical consumption in a SeTP is mainly for conditioning of thickened sludge before dewatering and chlorine in case of disinfection of treated water. This cannot be easily calculated as it might vary depending on the characteristic of the sludge and water from time to time. The requirement of polyelectrolyte is 2.5-4 kg/ton of dry solids. The cost of polyelectrolyte varies from supplier to supplier; however, it estimated to be INR 200/kg. The cost of chlorine is approximately estimated to be INR 20,000 per annum.

As per the Annexure 3, it is estimated that expenditure towards consumables would be INR 2.00 lakhs per annum.

This is in case; fuel will require to run the generator. Assuming that for each working day if the power cut happens for 1 hours, then approximately 21 litres of diesel would be required. This amount to INR 4.13 lakhs per annum. In total the expenditure towards consumables and fuel is INR 6.13 lakhs per annum.

Repairs

The repairs for mechanical and electrical equipment are estimated 10% of the total electro-mechanical capital cost. The estimated cost for repairs is 5.58 lakhs per annum.

The following tables summarises all the costs listed in section 4.

TABLE 25: SUMMARY OF COSTS OF IMPLEMENTATION AND OPERATION OF SETP

N°	Type of expenditure	Cost
A	**CAPEX**	**(lakh INR)**
A1	Cost of construction	₹ 4,04,65,101.00
A2	Cost of purchase	₹ 57,84,560.00
A3	Establishment cost	₹ 69,37,449.00
	TOTAL	**₹ 5,31,87,190.00**
B	**OPEX**	**(lakh INR/annum)**
B1	Human resource cost	₹ 20,32,800.00
B2	Energy cost	₹ 5,94,452.30
B3	Consumables and fuels	₹ 6,13,343.00
B4	Repairs	₹ 5,58,656.00
	TOTAL	**₹ 37,99,251.30**

5 Recommendations

5.1 Treatment

- ✓ It should make sure about the proper O&M of the SeTP. The designated staff should follow the SOPs defined for the system with safely.
- ✓ Ensuring proper O&M of the SeTP helps to keep the risk of breakdown as low as possible and at the same time gives good returns on investment by maintaining the quality of the end products.

5.2 Disposal or Reuse

The treated sludge (biosolids) can be transported to the Solid Waste Management processing site where it can be co-composted with the organic compost. After proper processing, the co-composted (biosolids and organic manure) manure can be properly packaged with appropriate branding. The branded manure can be sale in the market for gardening or farming. Urban local body can regularly check the quality of compost and can monitor it for the regular revenue. Even as per the previous discussions,

The treated water from the SeTP can be reuse as process water for during the treatment of solids. It can also be used for landscaping, flushing of public/community toilets at the SeTP. The remaining treated water can be transport for landscaping to public parks and public spaces or can be sell to constructions for revenue generation.

Detailed Project Report

Annexures

Annexure 1

Effluent Standards, Environment (Protection) Amendment Rules, 2017

रजिस्ट्री सं० डी० एल०-33004/99 REGD. NO. D. L.-33004/99

भारत का राजपत्र
The Gazette of India

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अधिसूचना

नई दिल्ली, 13 अक्तूबर, 2017

सा.का.नि. 1265(अ).—केन्द्रीय सरकार, पर्यावरण (संरक्षण) अधिनियम, 1986 (1986 का 29) की धारा 6 और धारा 25 द्वारा प्रदत्त शक्तियों का प्रयोग करते हुए, पर्यावरण (संरक्षण) नियम, 1986 का और संशोधन करने के लिए निम्नलिखित नियम बनाती है, अर्थात् : —

1. **संक्षिप्त नाम और प्रारम्भ :—**(1) इन नियमों का संक्षिप्त नाम पर्यावरण (संरक्षण) संशोधन नियम, 2017 है ।

   (2) ये राजपत्र में उनके प्रकाशन की तारीख को प्रवृत्त होंगे ।

2. पर्यावरण (संरक्षण) नियम, 1986 की अनुसूची-1 में, क्रम संख्यांक 104 और उससे सम्बन्धित प्रविष्टियों के पश्चात्, निम्नलिखित क्रम संख्यांक और प्रविष्टियां अन्तःस्थापित की जाएगी, अर्थात् :—

क्र. सं.	उद्योग	मानदंड	मानक	
1	2	3	4	
		बहिर्स्राव निस्सारण मानक (निपटान के सभी ढंगों को लागू)		
"105	मल उपचार संयंत्र (एसटीपी)		अवस्थान	सांद्र का निम्नलिखित से अधिक न होना
			(क)	(ख)
		पीएच	देश में कहीं भी	6.5-9.0
		जैव-रासायनिक ऑक्सीजन मांग (बीओडी)	महानगर* अरूणाचल प्रदेश, असम, मणिपुर, मेघालय, मिजोरम, नागालैण्ड, त्रिपुरा, सिक्किम, हिमाचल प्रदेश, उत्तराखंड, जम्मू-कश्मीर राज्यों और	

			अंदमान और निकोबार द्वीप, दादरा और नागर हवेली, दमण और दीव और लक्षद्वीप के सिवाय, सभी राज्यों की राजधानी ।	
			ऊपर उल्लिखित से भिन्न क्षेत्र/प्रदेश	30
		कुल निलंबित ठोस पदार्थ (टीएसएस)	महानगर* अरूणाचल प्रदेश, असम, मणिपुर, मेघालय, मिजोरम, नागालैण्ड, त्रिपुरा, सिक्किम, हिमाचल प्रदेश, उत्तराखंड, जम्मू-कश्मीर राज्यों और अंदमान और निकोबार द्वीप, दादरा और नागर हवेली, दमण और दीव और लक्षद्वीप के सिवाय, सभी राज्यों की राजधानी ।	<50
			ऊपर उल्लिखित से भिन्न क्षेत्र/प्रदेश	<100
		फेकल कोलीफॉर्म (एफसी) (अतिसंभाव्य संख्या प्रति 100 मिलीलिटर एमपीएन/100 मिलीलिटर	देश में कहीं भी	<1000

*मुम्बई, दिल्ली, कोलकाता, चेन्नई, बेंगलूरू, हैदराबाद, अहमदाबाद और पुणे महानगर हैं ।

टिप्पण :

(i) पीएच और फैकल कौलीफॉर्म के सिवाय, मिलीग्राम/लिटर में सभी मूल्य ।

(ii) ये, मानक जलाशयों में निस्सारण और भूमि निपटान/अनुप्रयोगों के लिए लागू होंगे ।

(iii) फैकल कौलीफॉर्म के लिए मानक औद्योगिक प्रयोजनों के लिए उपचारित बहिर्स्राव के उपयोग के सम्बन्ध में लागू नहीं होंगे ।

(iv) ये मानक 1 जून, 2019 को या उसके पश्चात् कमीशन किए जाने वाले सभी मल उपचार संयंत्रों (एसटीपी) को लागू होंगे और पुराने/विद्यमान मल उपचार संयंत्र (एसटीपी) राजपत्र में इस अधिसूचना के प्रकाशन की तारीख से पांच वर्ष की अवधि के भीतर इन मानकों को प्राप्त करेंगे ।

(v) समुद्र में उपचारित बहिर्स्राव के निस्सारण के मामले में, इसे उचित समुद्री मुहाने के माध्यम से किया जाएगा और विद्यमान तट निस्सारण को समुद्री मुहानों में संपरिवर्तित किया जाएगा और उन मामलों में, जहां समुद्री मुहाना निस्सारण के बिन्दु पर 150 गुणा न्यूनतम आरम्भिक तनुकरण और निस्सारण बिन्दु से दूर 100 मीटर के किसी बिन्दु पर 1500 गुणा न्यूनतम तनुकरण प्रदान करता है, तब विद्यमान सन्नियम साधारण निस्सारण मानकों में विनिर्दिष्ट किए गए अनुसार लागू होंगे ।

(vi) उपचारित बहिर्स्राव का पुनःउपयोग/पुनःचक्रण तथा उन मामलों में, जहां उपचारित बहिर्स्राव के भाग का पुनःउपयोग और पुनःचक्रण किया जाता है जिसमें मानवीय सम्पर्क की सम्भावना अन्तर्वलित है, ऊपर यथा विनिर्दिष्ट मानक लागू होंगे ।

(vii) केन्द्रीय प्रदूषण नियंत्रण बोर्ड/राज्य प्रदूषण नियंत्रण बोर्ड/प्रदूषण नियंत्रण समितियां, पर्यावरण (संरक्षण) अधिनियम, 1986 की धारा 5 के अधीन स्थानीय परिवेश को ध्यान में रखते हुए, अधिक कठोर सन्नियम जारी कर सकेगा/कर सकेंगी ।

[फा. सं. क्यू-15017/2/2008/-सीपीडब्ल्यू]

अरुण कुमार मेहता, अपर सचिव

टिप्पण : मूल नियम भारत के राजपत्र, असाधारण, भाग II, खंड 3, उप-खंड (i) में का.आ. सं. 844(अ), तारीख 19 नवम्बर, 1986 द्वारा प्रकाशित किए गए थे और तत्पश्चात् उनमें निम्नलिखित अधिसूचनाओं द्वारा संशोधन किए गए थे, अर्थात् :— का.आ. 433(अ), तारीख 18 अप्रैल, 1987; सा.का.नि. 176(अ), तारीख 2 अप्रैल, 1996; सा.का.नि. 97(अ), तारीख 18 फरवरी, 2009; सा.का.नि. 149(अ), तारीख 4 मार्च, 2009; सा.का.नि. 543(अ), तारीख 22 जुलाई, 2009; सा.का.नि. 739(अ), तारीख 9 सितम्बर, 2010; सा.का.नि. 809(अ), तारीख 4 अक्तूबर, 2010; सा.का.नि. 215(अ), तारीख 15 मार्च, 2011; सा.का.नि. 221(अ), तारीख 18 मार्च, 2011; सा.का.नि. 354(अ), तारीख 2 मई, 2011; सा.का.नि. 424(अ), तारीख 1 जून, 2011; सा.का.नि. 446(अ), तारीख 13 जून, 2011; सा.का.नि. 152(अ), तारीख 16 मार्च, 2012; सा.का.नि. 266(अ), तारीख 30 मार्च, 2012; सा.का.नि. 277(अ), तारीख 31 मार्च, 2012; सा.का.नि. 820(अ), तारीख 9 नवम्बर, 2012; सा.का.नि. 176(अ), तारीख 18 मार्च, 2013; सा.का.नि. 535(अ), तारीख 7 अगस्त, 2013; सा.का.नि. 771(अ), तारीख 11 दिसम्बर, 2013; सा.का.नि. 2(अ), तारीख 2 जनवरी, 2014; सा.का.नि. 229(अ), तारीख 28 मार्च, 2014; सा.का.नि. 232(अ), तारीख 31 मार्च, 2014; सा.का.नि. 325(अ), तारीख 7 मई, 2014; सा.का.नि. 612(अ), तारीख 25 अगस्त, 2014; सा.का.नि. 789(अ), तारीख 11 नवम्बर, 2014; का.आ. 3305(अ), तारीख 7 दिसम्बर, 2015; का.आ. 4(अ), तारीख 1 जनवरी, 2016; सा.का.नि. 35(अ), तारीख 14 जनवरी, 2016; सा.का.नि. 281(अ), तारीख 7 मार्च, 2016; सा.का.नि. 496(अ), तारीख 9 मई, 2016; सा.का.नि. 497(अ), तारीख 10 मई, 2016; सा.का.नि. 978(अ), तारीख 10 अक्तूबर, 2016; और अंतिम बार अधिसूचना संख्यांक सा.का.नि. 1016(अ), तारीख 28 अक्तूबर, 2016 द्वारा संशोधित किए गए थे ।

MINISTRY OF ENVIRONMENT, FOREST AND CLIMATE CHANGE

NOTIFICATION

New Delhi, the 13th October, 2017

G.S.R. 1265(E).—In exercise of the powers conferred by sections 6 and 25 of the Environment (Protection) Act, 1986 (29 of 1986), the Central Government hereby makes the following rules further to amend the Environment (Protection) Rules, 1986, namely:-

1. **Short title and commencement.**—(1) These rules may be called the Environment (Protection) Amendment Rules, 2017.

(2) They shall come into force on the date of their publication in the Official Gazette.

2. In the Environment (Protection) Rules, 1986, in Schedule – I, after serial number 104 and the entries relating thereto, the following serial number and entries shall be inserted, namely:—

Sl. No.	Industry	Parameters	Standards	
1	2	3	4	
		Effluent discharge standards (applicable to all mode of disposal)		
"105	Sewage Treatment Plants (STPs)		Location	Concentration not to exceed
			(a)	(b)
		pH	Anywhere in the country	6.5-9.0
		Bio-Chemical Oxygen Demand (BOD)	Metro Cities*, all State Capitals except in the State of Arunachal Pradesh, Assam, Manipur, Meghalaya Mizoram, Nagaland, Tripura Sikkim, Himachal Pradesh, Uttarakhand, Jammu and Kashmir, and Union territory of	20

			Andaman and Nicobar Islands, Dadar and Nagar Haveli Daman and Diu and Lakshadweep	
			Areas/regions other than mentioned above	30
		Total Suspended Solids (TSS)	Metro Cities*, all State Capitals except in the State of Arunachal Pradesh, Assam, Manipur, Meghalaya Mizoram, Nagaland, Tripura Sikkim, Himachal Pradesh, Uttarakhand, Jammu and Kashmir and Union territory of Andaman and Nicobar Islands, Dadar and Nagar Haveli Daman and Diu and Lakshadweep	<50
			Areas/regions other than mentioned above	<100
		Fecal Coliform (FC) (Most Probable Number per 100 milliliter, MPN/100ml	Anywhere in the country	<1000

*Metro Cities are Mumbai, Delhi, Kolkata, Chennai, Bengaluru, Hyderabad, Ahmedabad and Pune.

Note :

(i) All values in mg/l except for pH and Fecal Coliform.

(ii) These standards shall be applicable for discharge into water bodies as well as for land disposal/applications.

(iii) The standards for Fecal Coliform shall not apply in respect of use of treated effluent for industrial purposes.

(iv) These Standards shall apply to all STPs to be commissioned on or after the 1st June, 2019 and the old/existing STPs shall achieve these standards within a period of five years from date of publication of this notification in the Official Gazette.

(v) In case of discharge of treated effluent into sea, it shall be through proper marine outfall and the existing shore discharge shall be converted to marine outfalls, and in cases where the marine outfall provides a minimum initial dilution of 150 times at the point of discharge and a minimum dilution of 1500 times at a point 100 meters away from discharge point, then, the existing norms shall apply as specified in the general discharge standards.

(vi) Reuse/Recycling of treated effluent shall be encouraged and in cases where part of the treated effluent is reused and recycled involving possibility of human contact, standards as specified above shall apply.

(vii) Central Pollution Control Board/State Pollution Control Boards/Pollution Control Committees may issue more stringent norms taking account to local condition under section 5 of the Environment (Protection) Act, 1986".

[F. No. Q-15017/2/2008-CPW]

ARUN KUMAR MEHTA, Addl. Secy.

Note : The principal rules were published in the Gazette of India, Extraordinary, Part II, Section 3,Sub-section (i) *vide* number S.O. 844 (E), dated the 19th November, 1986 and subsequently amended *vide* the following notifications, namely:—

S.O. 433 (E), dated the 18th April 1987; G.S.R. 176(E) dated the 2nd April, 1996; G.S.R. 97 (E), dated the 18th February, 2009; G.S.R. 149 (E), dated the 4th March , 2009; G.S.R. 543(E), dated the 22nd July,2009; G.S.R. 739 (E), dated the 9th September, 2010; G.S.R. 809(E), dated the 4th October, 2010, G.S.R.

Annexure 2

Sample Manifest Forms

Septage Transporter Permit for _____ Municipality

In accordance with all the terms and conditions of the current _____ Municipality's Rates, Rules and Regulations, the special permit conditions accompanying this permit, and all applicable rules, laws or regulations of Government of Maharashtra, permission is hereby granted to:

NAME OF PERMITTEE:

_____

ADDRESS:_____

_____

For the disposal of septage from domestic septic tank or commercial holding tank at the_____ treatment facility.

This Permit is based on information provided in the Septage Transporter Permit application which constitutes the Septage Management Hauled Permit.

This Permit is effective for the period set forth below, may be suspended or revoked for Permit Condition Non Compliance and is not transferable. The original permit shall be kept on file in the Permittee's office. A copy of this Permit shall be carried in every registered vehicle used by the permittee.

EFFECTIVE DATE:

EXPIRATION DATE:

____ CHECK IF RENEWED PERMIT

Permit is liable to be cancelled in case of violations of any Acts, Rules and Regulations relating to the operation of Septage System or in cases of safety protocols not being adhered to or in case of non-permitted disposal.

[6] Source: Operative guidelines for septage management for urban and rural local bodies in Tamil Nadu.(2014)

Sample Form to be filled by Operator / Transporter of Septage

i. Identification of Waste:

a) Volume _____
b) b) Type: ____ Septic Tank ____ Others
c) c) Source: ____ Residential ____ Commercial ____ Restaurant ____ Portable Toilet ____Others

ii. Details of Waste Generator

a) Name:
b) Phone Number:
c) Address:
d) Pin:
e) Property tax no.:
f) Any kind of deficiencies, missing pipes or fittings, improper manholes or access covers, any other cracks or damage observed: _____

The undersigned being duly authorized does hereby certify to the accuracy of the source and type of wastewater collected and transported.

Date: _____ Signature: _____

iii. Details of Transporter / Operator

a) Company Name:
b) Permit:
c) Vehicle License:
d) Pump out date:

The above described wastewater was picked up and hauled by me to the disposal facility name below and was discharged. I certify that the foregoing is true and correct:

e) Signature of authorized agent and title: _____

iv. Acceptance by _____Municipality's authorized STP

The above transporter delivered the described wastewater to this disposal facility and it was accepted.

Disposal date: _____ Amount Collected from Transporter (if any):_____

Signature of authorized signatory and title: _____

[7] Adapted from operative guidelines for septage management for urban and rural local bodies in Tamil Nadu.(2014)

Annexure 3

Financial Estimates

TABLE 26: COST OF CIVIL WORKS AT SETP

Component	Capacity	Cost
Receiving station	3	₹ 30,80,190.26
Settling Thickening Tank	200	₹ 12,79,856.25
Internal Road + External Roads	353	₹ 88,84,504.00
Solids handling room + Office building	400	₹ 2,02,85,982.21
ABR + AF	180	₹ 29,50,994.56
Constructed Wetland	289.8	₹ 23,40,626.11
Treated water tank	20	₹ 2,56,799.31
Boundary wall + Gate	100	₹ 9,66,667.52
Electrification Work of Office Building	-	₹ 4,19,482.00
	TOTAL	**₹ 4,04,65,101.69**

TABLE 27: PURCHASE COST OF ELECTRO-MECHANICAL COMPONENTS AT SETP

Component	Capacity	Cost
Screw Press + Feeder Pump	1	₹ 32,46,560.00
Screening	1	₹ 60,000.00
Rotary Dryer	1	₹ 15,00,000.00
Compressor (5HP)	1	₹ 50,000.00
Street Light + Control Panel	35	₹ 1,38,000.00
Generator with generator room	1	₹ 5,00,000.00
Pumps	5	₹ 1,90,000.00
Chlorine Dosing Pump	1	₹ 40,000.00
Tools	1	₹ 60,000.00
	TOTAL	**₹ 57,84,560.00**

TABLE 28: OPERATIONAL COST OF SETP

Description		
Operating KLD of SeTP	125 KLD	Monthly pay
Operator	2	₹ 20,000.00
Semi-skilled labourers	2	₹ 10,000.00
Unskilled labourers	3	₹ 8,000.00
Watchman & security	4	₹ 10,000.00
Office computer operator	1	₹ 15,000.00
Chemist	1	₹ 15,000.00
Monthly salary in Rs lakhs	1.54	
Administrative overheads as %	0.1	
Monthly salary in Rs lakhs	1.69	
Annual HR Cost	**₹ 20,32,800.00**	

TABLE 29: COST OF ENERGY CONSUMPTION

Equipment	kW rating	Load factor	Working	Operating load in kW	Running hours	kWh
Sludge pump (Settling thickening tank - Screw Press)	0.75	0.85	1	0.64	4.00	2.55
Screw Press	0.75	0.85	1	0.64	4.00	2.55
Rotary Dryer	36.00	0.85	1	30.60	4.00	122.40
Water pump (Intermediate storage tank - Chlorin Dosing)	1.50	0.85	1	1.28	12.00	15.30
Chlorine dosing pump	0.75	0.85	1	0.64	8.00	5.10
Water pump (Storage Tank to Toilet Block)	1.50	0.85	1	1.28	23.00	29.33
Office Electricity Requirement						309.72
Street Light	1.10	0.85	1	0.94	24.00	22.44
Total	**42.35**					**509.39**

Total electrical consumption in kWh	509.39
Rate of electricity	₹ 3.89
Daily expenditure	₹ 1,981.51
Annual expenditure	**₹ 5,94,452.30**

TABLE 30: COST OF CONSUMABLES AND FUEL FOR SETP

Description	Unit	Value / Cost (In. ₹)
Poly electrolyte	kg/ton	3
Daily requirement	kg	3
Rate	per kg	₹ 200.00
Poly electrolyte	per annum	₹ 1,80,000.00
Chlorine	per annum	₹ 20,000.00
Total consumables	**Cost/per annum**	**₹ 2,00,000.00**

TABLE 31: COST OF REPAIR

Description	Cost (in ₹)
Screw Press + Feeder Pump	₹ 3,24,656.00
Screening	₹ 6,000.00
Rotary Dryer	₹ 1,50,000.00
Compressor (5HP)	₹ 5,000.00
Generator with generator room	₹ 50,000.00
Pumps	₹ 19,000.00
Chlorine Dosing Pump	₹ 4,000.00
Total cost of repair (10%)	**₹ 5,58,656.00**