DESIGN OF SEWERAGE SYSTEM AND STP FOR A PROPOSED LOCALITY IN PRATAPGARH, RAJASTHAN

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CERTIFICATE

This is to certify that the work titled "DESIGN OF SEWERAGE SYSTEM AND STP FOR A PROPOSED LOCALITY IN PRATAPGARH, RAJASTHAN" submitted by "Shubham gupta (111704)" in partial fulfilment for the award of degree of B. Tech in Civil Engineering of Jaypee University of Information Technology, Waknaghat has been carried out under my supervision. This work has not been submitted partially or wholly to any other University or Institute for the award of this or any other degree or diploma.

Signature of Supervisor

Name of Supervisor: Dr. Rajiv Ganguly

Date:

Place:

ACKNOWLEDGEMENT

I have taken sincere efforts in this project. However, it would not have been possible without the kind support and help of many individuals and organizations. We would like to extend our sincere thanks to all of them.

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I would like to thank **Municipal Corporation, Pratapgarh** for providing us the rightful information for this project.

Our thanks and appreciations also go to our colleague in developing the project and people who have willingly helped us out with their abilities.

ABSTRACT

The main purpose of this project is to design a new sewerage system of capacity 8 mld sewage treatment plant based on cyclic activated sludge process or SBR technology located in Pratapgarh district (Rajasthan).

The Sewage Treatment involves Preliminary, Primary, Secondary, Tertiary and Advanced Treatment include Unit Operations and Unit Processes to remove physical, chemical and biological contaminants. The treated effluent can be discharged into a stream or used in irrigating agricultural farms for growing animal fodder and in landscape irrigation in Pratapgarh. The stabilized sludge can be used as a soil conditioner. Samples are collected regularly at the plant inlet as well as before and after each treatment process. The raw sewage is characterized by high dissolved solids, medium strength BOD, and low COD/BOD ratio, high concentration of chloride, sulphate and sulfide due to septic sewage. These are typical characteristics of the sewage in this region. The plant is designed, operated and maintained so as to ensure safety and reliability in the treated effluent quality. Any overloading of the treatment processes is handled effectively. The reclaimed water quality meets the international standards and guidelines for landscape irrigation and farming.

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CHAPTER 1

INTRODUCTION

Pratapgarh falls in Chittorgarh district of Rajasthan and is a newly formed district head quarter. It is located in southern part of Rajasthan close to Madhya Pradesh on Malwa plateau. Pratapgarh is 112 km from District Headquarter Chittorgarh and 180 kms from Udaipur, the Divisional Headquarter. It is well connected with Chittorgarh, Banswara, Udaipur, Bhilwara, Ajmer etc. in Rajasthan and Neemach, Mandsaur and Ratlam in MP.

Pratapgarh is administrative sub divisional headquarters having Pratapgarh, Arnod, Bari Sadri and Chhoti Sadri tehsils under it. It is located on Jaipur – Banswara State Highway number 4. Pratapgarh is, however, not linked by rail network. Pratapgarh is located at 24.03° N 74.78° E.

1.1 Components

The following work has been carried out under this programme:

I. Designing of Sewerage System
   a) Collection
   b) Treatment and
   c) Disposal Facilities
II. Process Equipment
III. Environmental Impact Assessment Studies

1.2 Criteria for selection of the process

The selection of process for STP will be done on the basis of following criteria:

a) Reuse of treated water.
b) Ease of construction
c) Ease of operation and maintenance
d) Simplicity of system (minimum equipment)
e) Trouble free service (O & M)
f) Reliability of process
   I. Well established design criteria
   II. Proven process worldwide

III. Ability to absorb shock loads (Hydraulic/Organic)

a) Need for skilled/unskilled staff required for O&M

b) Presence/absence of nuisance potential from mosquito/fly/odour

c) Ease of access to components of the system for repairs and maintenance

d) Safety/ Hazardous conditions at the plant.

1.3 Need of this project

Upper income group of house have septic tanks/soakage wells for the disposal of excreta but the lower income group and public living on the periphery of the town defecate in the jungle. Liquid waste is being disposed of into surface drains wherever available or disposed in the streets where drains are absent. In the absence of proper drainage system, wastewater is getting collected at several local depressions in the town and there by creating unsanitary conditions and health hazard. At present there is no proper drainage system in town for disposal of storm water. It gets collected in local depressions through the open drains meant for wastewater, wherever they are present and through flow over the surface of streets, where there are no drains. During last years, all the local depressions, which are already with storm water causing flooding of streets and houses, almost two third of town submersed up to 3-4 feet water. This creates very unhygienic conditions and loss to the property to the affected households After execution of sewerage system by providing underground sewer pipe line network followed by sewerage treatment plant the public of Pratapgarh would find great relief from unhealthy and unhygienic environment.

1.4 The main objectives of the project are :-

i) Designing of Sewerage System:

a) Design and detailing of Coarse Screen Bar rack, Aerated grit chamber, Equalization tank, Aeration tank, Claritube-Settler tank, Chlorination tank.

b) Collection

c) Treatment and

d) Disposal Facilities

ii) Process Equipment

iii) Environmental Impact Assessment Studies

1.5 Field Investigations : -

Before preparing these proposals the detailed surveys in respect of following items have been carried out.

Topographical surveys

a) Topographical survey of the town.

b) Leveling with auto level survey instrument of complete Municipal boundary area of Pratapgarh town

c) Details of existing drainage system

d) Details of existing sewerage disposal

e) Fixing of bench marks.(List of bench mark with value is enclosed)

f) Topographical Survey of STP Land.

g) Soil strata determination by bore hole (location shown on map)

Survey of Wards

- Ward wise population projections
- Area and Population Density of ward

CHAPTER 2

OVERVIEW OF DIFFERENT TREATMENT PROCESSES FOR SEWAGE

2.1 Sewage Treatment & Selection Of Treatment Process

Sewage Treatment is the process of removing contaminants from wastewater. It includes Unit Operations and Unit Processes to remove physical, chemical and biological contaminants. Typically, Sewage Treatment involves Preliminary, Primary, Secondary, Tertiary and Advanced Treatment. The final effluent can be discharged into a stream or on land.

2.2 Treatment Stages

2.2.1 Primary Treatment

Primary sewage treatment is a relatively uncomplicated physical process that mainly removes solids. The sewage first passes through screens that filter out large debris such as pieces of wood or cardboard. It then flows to a grit chamber where sand and other heavy particles are removed.

Primary sewage treatment removes 40-60% of suspended solids and about 30% of organic matter. In plants that provide no further level of treatment, the water is chlorinated to kill any remaining pathogens and returned to the environment at this point. Primary sewage treatment alone is no longer considered sufficient.

2.2.2 Secondary Treatment

Secondary treatment is designed to substantially degrade the biological content of the sewage such as are derived from human waste, food waste, soaps and detergent. The majority of municipal and industrial plants treat the settled sewage liquor using aerobic biological processes. For this to be effective, the microorganism requires both oxygen and a substrate on which to live. There are number of ways in which this is done. In all these methods, the bacteria and protozoa consume biodegradable soluble organic contaminants (e.g. sugars, fats, organic short-chain carbon molecules, etc.) and bind much of the less soluble fractions into flocs. Secondary treatment systems are classified as fixed film or suspended growth. Fixed-film treatment process including Trickling Filter and Rotating Biological Contactors where the biomass grows on media and the sewage passes over its surface. In suspended growth systems—such as activated sludge—the biomass is well mixed with the sewage and can be operated in a smaller space than fixed-film systems that treat the same amount of water. However, fixed-film systems are more able to cope with drastic changes in the amount of biological material and can provide higher removal rates for organic material and suspended solids than suspended growth systems.

Roughing filters are intended to treat particularly strong or variable organic loads, typically industrial, to allow them to then be treated by conventional secondary treatment processes. Characteristics include typically tall, circular filters filled with open synthetic filter media to which wastewater is applied at a relatively high rate. They are designed to allow high hydraulic loading and a high flow-through of air. On larger installations, air is forced through the media using blowers. The resultant wastewater is usually within the normal range for conventional treatment processes.

A trickling filter is a type of wastewater treatment system. It consists of a fixed bed of rocks, lava, coke, gravel, slag, polyurethane foam, sphagnum peat moss, ceramic, or plastic media over which sewage or other wastewater flows downward and causes a layer of microbial slime (biofilm) to grow, covering the bed of media. Aerobic conditions are maintained by splashing, diffusion, and either by forced air flowing through the bed or natural convection of air if the filter medium is porous.

The terms trickle filter, trickling biofilter, biofilter, biological filter and biological trickling filter are often used to refer to a trickling filter. These systems have also been described as roughing filters, intermittent filters, packed media bed filters, alternative septic systems, percolating filters, attached growth processes, and fixed film processes.

The result of effective primary plus secondary treatment is removal of about 90% of the organic matter, virtually all pathogens, and most solids. Between 10% and 20% of the nitrogen is also automatically removed because the decomposer bacteria require this much for their own growth.

2.2.2.1 Selection of Secondary Treatment Process

The selection of a particular type of treatment will depend upon the techno-economic feasibility of the process selected for the treatment. The techno-economical feasibility can be attributed to the following parameters:

1. Degree of treatment required
2. Capital and Operation & Maintenance cost
3. Mechanical equipment requirement
4. Power requirement
5. Land requirement

The various treatment options considered for the treatment are considered to find out the techno-economically best suitable treatment scheme to suit wastewater characteristics, climate and land available for the STP.

The various treatment options considered for techno-economic evaluation are us under:-

1. Cyclic Activated Sludge Technology System
2. Activated sludge process
3. UASB
4. Waste stabilization pond
5. Fluidized Aerobic Bioreactor Process (FAB Technology)

2.3 Treatment Options

2.3.1 Sequential Batch Reactor (SBR) /Cyclic Activated Sludge Technology System

Sequential Batch Reactor (SBR) / Cyclic Activated Sludge Technology is an advanced technology for sewage treatment, which offers high treatment efficiency. The technology derives its process design from the concepts of activated sludge process. It uses deep RCC basins, and very efficient oxygen transfer equipments (diffused aeration mechanism) to achieve highest possible treatment in a single tank with 14 – 20 HRS. retention only (Metcalf &Eddie, 2013).

Sequential Batch Reactor (SBR) / Cyclic Activated Sludge Technology operates in a cycle of batches. Two or more modules are provided to ensure continuous treatment of wastewater. The complete process including removal of organics, N and P reduction takes place in a single reactor, within which all biological treatment steps take place sequentially.

One cycle / sequence of operation consists of 3 steps – Filling & Aeration, settling and Decantation. The settled sludge from the basin shows SVI < 120 and excellent settling characteristics (By Metcalf &Eddie,2013). The excess sludge wasted from the basin is fully digested and can be used as manure directly after dewatering.

Sequential Batch Reactor (SBR) / Cyclic Activated Sludge Technology is fully automated using PLC, various transmitters and analysers, VFDs and automated valves. The entire treatment process including incoming flows, cycle duration and regulation between aeration basins, process parameters, Dissolved Oxygen levels, air flow rates to basin, growth of micro – organisms, decanting rates, etc. are controlled, monitored online and are adjusted automatically based on varying incoming flow and organic load conditions. It offers consistent and optimized performance of plant with excellent outlet quality even under varying incoming conditions.

Disadvantages:

a) The technology is quite new. It was introduced in India 2 years back. Since then, one large 28 MLD STP is working at Goa and some other plants are in currently under installation stage (HPCL, Vizag and Pharamacity).
b) Requirement of Skilled Operational staff
c) Higher power consumption
d) Lack of reputed Indian Suppliers
e) High cost of import of technology
f) Lack of reference Sewage Treatment Plants in India.

2.3.2 Activated Sludge Process (Metcalf &Eddie, 2013)

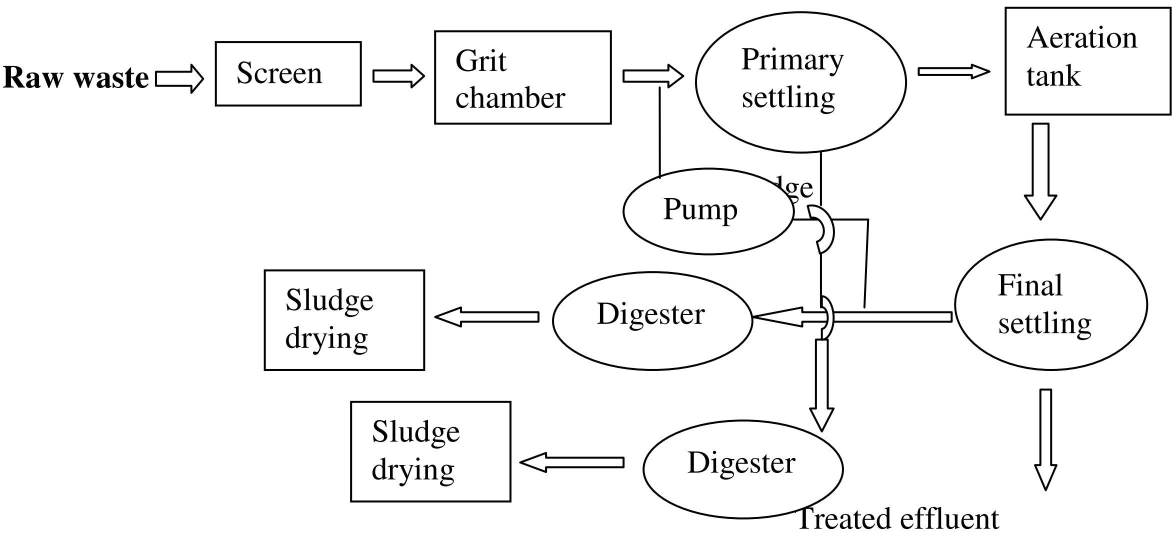


Fig 2.1 Flow chart of Activated sludge process

An Activated sludge process (ASP) is a type of Aerobic Suspended Growth system. The ASP plant essentially consists of the following:

a) Aeration Tank containing micro-organisms in suspension in which the reaction takes place,
b) +Activated sludge recirculation system to maintain the sufficient micro-organisms in aeration tank,
c) Excess sludge washing and disposal facilities,
d) Aeration system to transfer oxygen,
e) Secondary settling tank to separate and thicken activated sludge.
f) Gas Digester for gas production and Gasholder for gas storage

This option consists of the following treatment units:-

a) Inlet chamber
b) Fine Screen Channel,
c) Detritor Tank/Grit Channel,
d) Primary Clarifier,
e) Aeration Tank,
f) Secondary Clarifier,
g) Sludge Pumping Station,
h) Filtrate Pumping Station,
i) Digester
j) Centrifuge

Raw sewage will be received in the inlet chamber and then passed to the screen channel and subsequently to the detritus tank. In screen channel floating matters are trapped and removed whereas in detritus tank, grit is removed. After screening and grit removal the wastewater is taken into a primary clarifier. This is provided for the removal of suspended solids before taking wastewater for further biological treatment. The sludge generated as a result of primary settling is taken for digestion. A sludge digester and pumps are provided for this purpose.

After primary settlement of the suspended solids, the wastewater is taken to aeration tank containing micro-organisms in suspension in which the biological degradation takes place. Further, a secondary clarifier is provided to separate the activated sludge. 60% of the incoming flow is re-circulated upstream of the aeration tank (Metcalf &Eddie, 2013). A tapping is provided on this line to lead the excess sludge to the primary sludge sump. Form here the sludge is pumped up to the digester.

A digester is provided for sludge degradation. The detention time in the digester is 32-38 days.(Metcalf &Eddie, 2013). Mixers are provided to operate a completely mixed regime in the digester. It is proposed to use Centrifuge for sludge dewatering prior to sludge disposal.

Advantages:

- Land requirement lesser than Waste Stabilisation Ponds.
- Good quality effluent
- Loss of head is small
- Low installation cost

Disadvantages:

- Sludge disposal is required on large scale
- Skilled supervision is required to check that return sludge remains active
- High Capital Cost
- High Maintenance Cost

2.3.3 UASB Technology

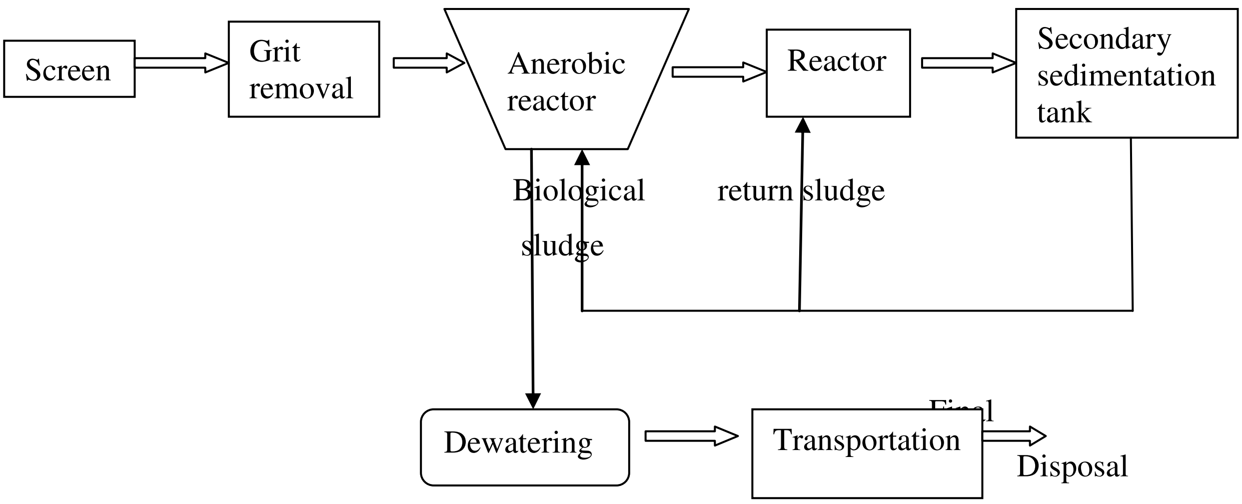


Fig 2.2 Flow chart of UASB technology

The development of the Up Flow Anaerobic Sludge Blanket (UASB) reactor dates back from early 1970's. Pre-sedimentation, anaerobic wastewater treatment and final sedimentation including sludge stabilisation are essentially combined in one reactor making it most attractive high-rate wastewater treatment option. It produces high value by products viz.

a) Treated wastewater usable for gardening purpose or for pisci-culture after a simple post treatment.
b) Methane enriched biogas having high calorific value is converted into a usable energy resource like heat energy, electricity etc., and
c) Mineralized excess sludge produced in UASB reactor for its usage as manure for agricultural purpose.

UASB initially was developed for the anaerobic treatment of industrial wastewater with a moderate to high COD and BOD concentrations. The basic idea is flocculent or granular sludge developed in the reactor depending on the wastewater characteristics and operational parameters will tend to settle under gravity when applying moderate upward velocities in the reactor. In this way no separate sedimentation basin is necessary. Anaerobic bacteria are developed in the reactor and are kept in the biological reaction compartment for sufficient time. Organic compounds present in the wastewater are absorbed or adsorbed on the sludge particles in the reaction zone during its passage through the sludge bed. Organic compounds there after get anaerobically biodegraded converting it into methane-enriched biogas and a small part into the new bacterial mass. Biogas consists of Methane CH_4, Carbon dioxide CO_2, Hydrogen H_2, Hydrogen Sulphide H_2S and traces of Ammonia NH_3 and Nitrogen N_2 (Metcalf &Eddie, 2013).

A Gas, liquid and solids separator (GLSS) is provided below the gas collectors in order to provide an opportunity to the sludge particles to which biogas bubbles are attached to lose biogas and settle back into the reaction compartment. In between two gas collectors as settling zone is provided where virtually no gas bubbles are present in the liquid. The sludge particles carried along with the wastewater flow are settled in the settling zone and slide down into the biological reaction zone (Metcalf &Eddie, 2013). Wastewater enters the UASB reactor from the bottom and travels through the reactor in the upward direction. In order to ensure sufficient contact between the incoming wastewater and the anaerobic bacterial mass present in the reactor, the wastewater is fed uniformly all over the bottom of the reactor.

Further mixing in the reaction zone is achieved by the production of the biogas travelling in the upward direction, settling velocity of the sludge particles and the density currents in the sludge mass.

With proper seed material available at the time of start-up of the UASB reactor, the microbial population is developed within three months period. Proper care is taken while designing the UASB reactor to absorb estimated shock loads in terms of hydraulic and organic contents in the wastewater. The reactor is having the following zones:

a) Gas Collection Zone
b) Clarification Zone
c) Sludge blanket Zone

Advantages:

a) Minimal power consumption
b) reduction of CO2 emissions due to low demand for foreign (fossil) energy and surplus energy production
c) Large numbers of plants have been constructed on this process in India.
d) Less land requirement as compared to Waste Stabilisation Ponds.

Disadvantages:

a) Requires second stage aerobic treatment
b) Economically not feasible in colder climates with sewage temperature lower than 15°C
c) sensitivity towards toxic substances
d) insufficient pathogen removal without appropriate post-treatment

CHAPTER 3

LITERATURE REVIEW

3.1 C TECH System (Metcalf &Eddie, 2013)

SBR/Cyclic Activated Sludge Technology is an advanced technology for sewage treatment, which offers high treatment efficiency. The technology derives its process design from the concepts of activated sludge process. It uses deep RCC basins, and very efficient oxygen transfer equipment's(diffused aeration mechanism) to achieve highest possible treatment in a single tank with 14-20 hours retention only.

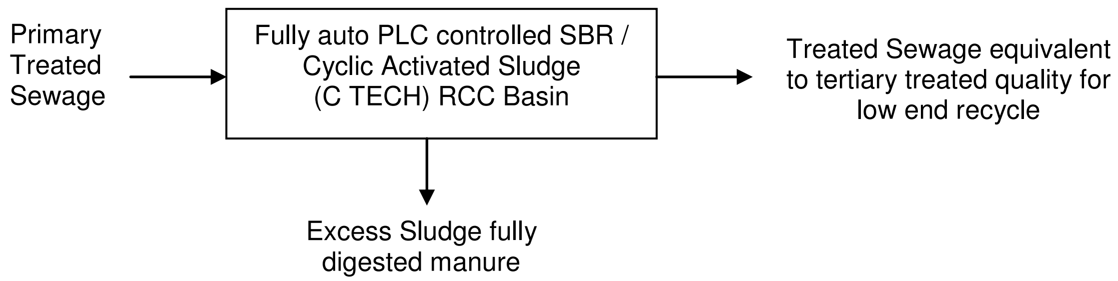


Figure 3.1 Flowchart for Operation Processes of C-TECH System

SBR/Cyclic Activated Sludge Technology operates in a cycle of batches. Two or more modules are provided to ensure continuous treatment of wastewater. The complete process including removal of organics, N and P reduction takes place in a single reactor, within which all biological treatment steps take place sequentially.

One cycle/sequence of operation consists of 3 steps - Filling & Aeration, Settling and Decantation. The settled sludge from the basin shows SVI < 120 and excellent settling characteristics (Metcalf &Eddie, 2013). The excess sludge wasted from the basin is fully digested and can be used as manure directly after dewatering.

SBR/Cyclic Activated Sludge Technology is fully automated using PLC (Programmable logic controller) , various transmitters and analysers, VFDs (variable frequency drive) and automated valves. The entire treatment process including incoming flows, cycle duration and regulation between aeration basins, process parameters, Dissolved Oxygen levels, air flow rates to basin, growth of micro-organisms, decanting rates, etc. are controlled, monitored online and are adjusted automatically based on varying incoming flow and organic load conditions. This offers consistent and optimized performance of plant with excellent outlet quality even under varying incoming conditions.

3.2 Up flow Anaerobic Sludge Blanket Process (Metcalf & Eddie , 2013)

Raw effluent after screening and grit removal is directly fed into UASB reactors. The reactor maintains a high concentration of anaerobic biomass through formation of highly settleable microbial aggregates (Metcalf &Eddie, 2013). Untreated sewage inside the reactor flows upward through a layer of sludge while getting treated for organics, converting them into methane gas. At top of the reactor, phase separation between gas-solid-liquid takes and treated water is taken out form the reactor. This process is very sensitive to operating conditions like temperature, pH, incoming load and recirculation rate hence treatment efficiency keeps fluctuating. At best operating conditions, the process offer 50 – 70% treatment efficiency, therefore requires second stage biological treatment downstream (Metcalf &Eddie, 2013).

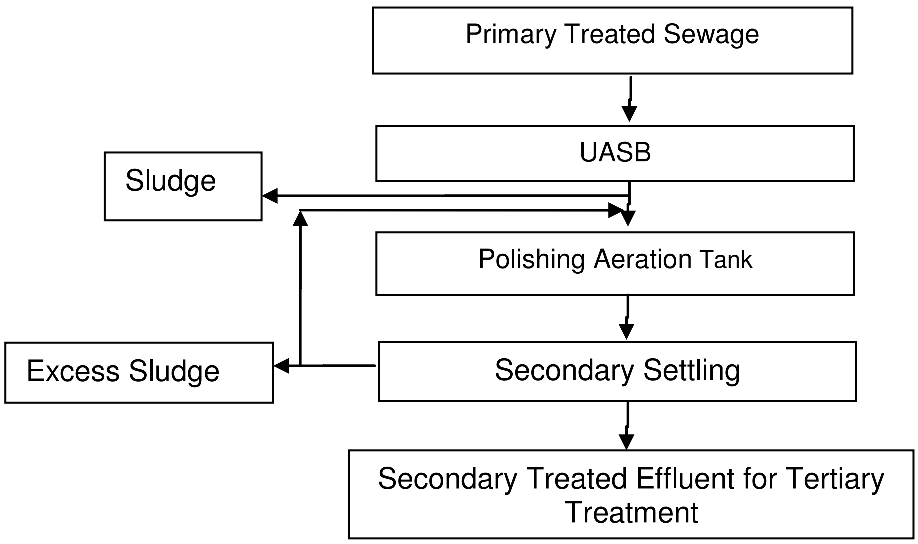


Figure 3.2 Flow-chart for Operating Processes of UASB System

Table 3.1 Comparison between Operation Processes of Cyclic Activated Sludge Technology and Anaerobic Process (Metcalf & Eddy, 2013)

SR. NO.	ITEM	C TECH SYSTEM	UASB PROCESS
1	**Treatment efficiency, process performance and odor generation**	C TECH process gives 98 % BOD removal efficiency, Sewage can be treated to recycle quality of turbidity < 10 NTU, COD < 20 ppm, BOD < 5 ppm, TN < 5 ppm, TP < 1 ppm in a single stage of treatment using Batch process. Complete nitrification and de nitrification along with biological removal of phosphorous takes place. There is NO odor problem as complete process is aerobic and generates fully digested sludge, which is excellent manure and can be directly applied as manure to plants.	Anaerobic process has very slow growth rates of microorganism and hence these systems have poor treatment efficiencies of only 50-70%. In order to achieve disposal outlet quality of treated sewage, second stage aerobic biological units are required. Typical outlet quality from anaerobic reactors is suspended solids 50 ppm, COD: 200 ppm, BOD 100-120 ppm. There is no inbuilt provision for removal of Total Nitrogen and Phosphorous. The system generates bad odor, as process releases gases like H_2S and methane.
2	**Process control and simplicity in operation**	C TECH is based on activated sludge process. It is a very simple and sturdy process, which gives consistent outlet results irrespective of feed quality variation by 0-250%. The basic reaction is a single step process, in which organics are directly converted into CO_2	Anaerobic process is very difficult to control. It requires consistent feed quality as well as flow rates. The process of degradation is a 3 step fermentation process comprising different sets of bacteria, to generate methane gas and CO_2 Hydrolysis

		and H_2O using aerobic bacteria. The process works between wide ranges of temperature ranging from 5 – 35 degree temperature. No heating is provided during winter months.	Acidogenisis Methanogenisis It requires constant monitoring of acidogenesis and methano genesis phases in the anaerobic reactor. The process is pH sensitive. Methanogenisi reaction occurs in a pH range of 6-7.5 only, while during acidogenisis phase the ph may drop to 2.0 also due to formation of complex acids. This disturbs the complete equilibrium and further reduces treatment efficiency. Temperature dependent: The process works in the range of 18–38^{0}C. During winter season when ambient temp Drops to 1-2 degree, provision has to be made to heat the entire contents of the reactor or else treatment efficiency drops drastically.
3	**Fully automatic operation**	The complete process is fully automatic PLC controlled and can be monitored and operated from anywhere in the world using internet connectivity. All process parameters are constantly measured and controlled to provide consistent and utmost treatment using lowest power. The plant can	There is No control on any process parameters. The plants run continuously at all times including low flow/ Nil flow conditions Plant is manually controlled and difficult to monitor. It is susceptible to variation in inlet conditions BOD, COD, sulphide levels, pH and temp condition, which

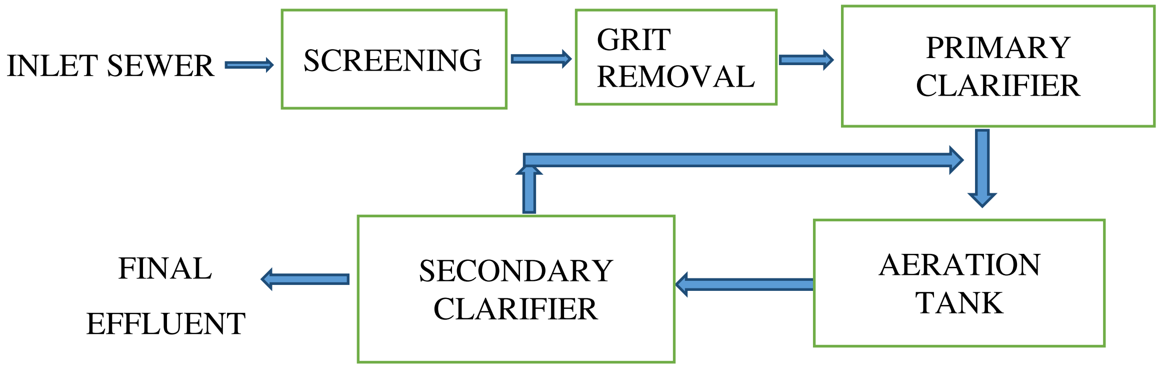
		automatically shut off during low/nil flow conditions and can automatically adjust power consumption proportional to present flow rate and concentration of pollutant load. This drastically reduces power consumption.	directly influences treatment efficiency as well as quantity of gas generation.
4	**Variation in input flow rate as well as quality**	Normally city sewage treatment plants are designed for higher flow rates depending on minimum future 20 years population prediction. In the initial years the plant works at 50-60 % flows only. With C TECH process power consumption is directly proportional to the initial influent load only. Complete operation gets automatically optimized to input condition.	It is a point load design. The design cannot handle sudden peak flow variation, which is expected for any large-scale city sewage system. Normally 0-250% flow variation is present for any sewage treatment plant.
5	**Gas generation and utilization**	As the process is completely aerobic there is NO gas generation, hence does not require extra gas holding tanks, flare system etc.	Gas can be generated; however process is not economical for low strength effluents like sewage where input BOD is less than 300 ppm. Furthermore for financial viability it is important to utilize the gas either directly in boilers or households. In case power is to be generated it again requires capital investment by putting duel fuel engines. Also

			provision has to be made for gas storage facility with flare system installed at site. Gas production is not consistent, and varies in case there is any disruption in the process.
6	**Material of construction and maintenance cost**	In this process pH is always in neutral condition, yet all under water submerged parts are provided in SS304/SS316 to ensure no corrosion problem. Life of all equipments is much longer as no acidic condition prevails.	Due to Process chemistry acids are generated, pH in anaerobic reactors varies from 2-7, which essentially requires SS domes and FRP lining of complete tank internals. Problem of internal corrosion is very high and cost of maintenance is very high.
7	**Space requirement**	C TECH uses deep RCC tanks, with diffused aeration mechanism, which drastically reduces the space requirement. Further there is no need to provide secondary clarifiers, gas storage tanks, flare system or power generation units. This process uses minimum 50 % less space as compared to anaerobic process.	As this process essentially needs second stage aerobic treatment comprising aeration tanks and secondary clarifier, to get good outlet quality, plant area is very high as compared to C TECH process. Also additional space is required to store the generated gas, power generation device, flare towers, diesel holdup tanks etc., which increases the space requirement.
8	**Capital cost**	On a like to like comparison of outlet requirement, land cost, material of construction and automation, this technology has the lowest capital cost.	Initial capital cost is much higher, as it requires many additional units like nitrification and denitrification tanks, post polishing treatment, tertiary treatment, gas storage, and power

			generation units etc. to achieve the same quality from the system.
9	**Operating cost**	The Cyclic activated sludge technology has a very low power consumption of only 0.7 Rs. per m^3 of raw sewage. Overall operating cost is in the range of 1.2 –1.5 Rs./m^3	Power consumption is low. Typical power consumption are comparable to Cyclic activated sludge process. The 1st stage Anaerobic process does not require any power; however 2nd stage aerobic polishing units require power, which works out to approx. 0.7 Rs per m^3. Other costs like maintenance and manpower are much higher than C TECH process. Overall operating cost range from 1.8 Rs /m^3 to 3 Rs/m^3.

CHAPTER 4

DESIGN OF SEWAGE TREATMENT PLANT



4.1 Population projection

4.1.1 Population data/Projections

As per 2011 census the total population of municipal area of Pratapgarh is 41993 and total design population is workout to 73644 for year 2046. It is proposed to take up the base year as 2015 and expected completion of the project by year 2016 the design period is kept as 30 years and therefore, the whole system has been designed for the year 2046. The .population projection with various methods is tabulated below:

4.1.1.1 Arithmetic Increase Method :-

This method is suitable for large and old city with considerable development. If it is used for small, average or comparatively new cities, it will give low result than actual value. In this method the average increase in population per decade is calculated from the past census reports. This increase is added to the present population to find out the population of the next decade. Thus, it is assumed that the population is increasing at constant rate.

Hence, $dP/dt = C$ i.e. rate of change of population with respect to time is constant.

Therefore, Population after n^{th} decade will be $\mathbf{P_n = P + n.C}$

Where, P_n is the population after n decade and P is present population.

4.1.1.2 Geometric Method :-

In this method the percentage increase in population from decade to decade is assumed to remain constant. Geometric mean increase is used to find out the future increment in population. Since this method gives higher values and hence should be applied for a new industrial town at the beginning of development for only few decades. The population at the end of n^{th} decade 'P_n' can be estimated as:

$P_n = P\ (1+ I_G/100)^{\ n}$

Where, I_G = geometric mean (%)

P = Present population

N = no. of decades.

4.1.1.3 Increamental Increase Method :-

This method is modification of arithmetical increase method and it is suitable for an average size town under normal condition where the growth rate is found to be in increasing order.

While adopting this method the increase in increment is considered for calculating future population. The incremental increase is determined for each decade from the past population and the average value is added to the present population along with the average rate of increase.

Hence, population after n^{th} decade is

$\mathbf{P_n = P+ n.X + \{n\ (n+1)/2\}.Y}$

Where, P_n = Population after n^{th} decade

X = Average increase

Y = Incremental increase

POPULATION PROJECTION

S. No	Year	Projected population			
		Geometric Method	**Incremental Increase Method**	**Arithmetic Increase Method**	**Average**
1	2001	35422	35422	35422	35422
2	2011	41993	41993	41993	41993
3	2013	43892	43202	43090	43395
4	2016	46912	45086	44735	45578
5	2021	52407	48413	47477	49432
6	2026	55846	51974	50219	53580
7	2029	62570	54223	51864	56219
8	2031	65404	55769	52961	58045
9	2046	91186	68558	61187	73644

Average of above methods has been recommended/ proposed i.e. 73644 persons for year 2046.

Population and flow projection for design period: The flow projection as per population for year 2016, 2026, 2031 and design year 2046 is also tabulated below

S.No.	Description	Proposed for 2016	Proposed for 2026	Proposed for 2031	Proposed for 2046
(i)	Population	45578	53580	58045	73644
(ii)	Water Flow (MLD)	6.15	7.23	7.86	9.94
(iii)	Sewage Flow (MLD) as per CPHEEO manual (80% of Water supply	4.92	5.78	6.288	7.65
	Total sewage flow including 5% Infiltration	5.166	6.069	6.60	8.03

4.1.2 Population Graph

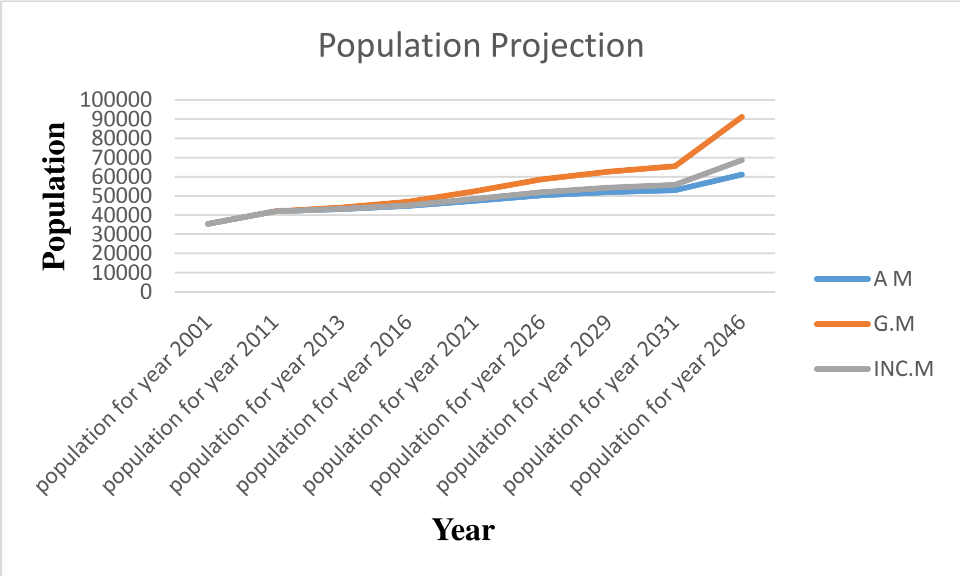


Figure 4.1 Graph for Prediction of future Population

4.2 Design of Coarse Screen Bar

4.2.1 Screens

een is the first unit operation in wastewater treatment plant. This is used to remove larger ticles of floating and suspended matter by coarse screening. This is accomplished by a set inclined parallel bars, fixed at certain distance apart in a channel. The screen can be of :ular or rectangular opening. The screen composed of parallel bars or rods is called a rack. : screens are used to protect pumps, valves, pipelines, and other appurtenances from nage or clogging by rags and large objects. Industrial wastewater treatment plant may or y not need the screens. However, when packing of the product and cleaning of packing bottles/ containers is carried out, it is necessary to provide screens even for industrial wastewater treatment plant to separate labels, stopper, cardboard, and other packing materials. The cross section of the screen chamber is always greater (about 200 to 300 %) than the incoming sewer. The length of this channel should be sufficiently long to prevent eddies around the screen.

4.2.2 Coarse screen

Bar screen is a set of inclined parallel bars, fixed at a certain distance apart in a channel. These are used for removing larger particles of floating and suspended matter. The wastewater entering the screening channel should have a minimum self-cleaning velocity of

0.375 m/sec. Also the velocity should not rise to such extent as to dislodge the screenings from the bars. The slope of the hand-cleaned screens should be between 300 and 450 with the horizontal and that of mechanically cleaned screens may be between 450 and 800. The submerged area of the surface of the screen, including bars and opening should be about 200% of the c/s area of the extract sewer for separate sewers and 300% for combined sewers. Clear spacing of bars for hand cleaned bar screens may be from 25 to 50 mm and that for mechanically cleaned bars may range from 15 mm to 75 mm. The width of the bars, facing the flow may be 8 mm to 15 mm and depth may vary from 25 mm to 75 mm, but sizes less than 8 x 25 mm are normally not used.

4.2.2.1 Advantage of Coarse screen

The advantage of course screen are :-

1. Coarse screen is to remove material to damage subsequent process equipment.
2. To reduce overall treatment process.
3. To contaminate waterways

4.2.3 Calculation of Coarse Screen

Inputs	**Value**	**Unit**	***Adjusted Values***	
Bar Size				
Length =	1.9	m		
Width =	1.7	m		
Depth =	2	m		
Height of Channel excluding freeboard, **h** =	0.4	m	0.40	m
Clear Space Between openings, **s** =	20	mm		
Slope from Horizontal =	60	degree		
Approach Velocity, **v** =	0.7	m/s		
Avg. volume flow per day =	8	MLD		
Thickness of bar provided	10	mm		
Output Parameter				
Volume Max., $\mathbf{Q_{max}}$ =	0.208	m^3/s		
Area, **A** =	0.30	m^2		
Width, **W** =	0.74	m	0.75	m
Total Number of Bars, **N** =	33.6		33.0	
Total Width of screen chamber, $\mathbf{W_t}$ =	0.75	m	0.74	m
Effective width of Channel, $\mathbf{W_e}$ =	0.6939	m		
Effective Cross-Secional Area of Screen, $\mathbf{A_e}$ =	0.27756	m^2		
Approach velocity Through Screen, **V** =	0.75	m/s		
Head Loss through Bar Screen, $\mathbf{h_L}$ =	0.01	m		

Equations used for Calculations:
$h_L = 0.0729\ (V^2 - v^2)$
$V = Q_{max} / A_e$
N = (W*1000 - s) / (s + width of bar)
W_t = N*width of bar + (N + 1)*s
$W_e = W_t$ - width of bar*N
$A_e = W_e * h$

Table 4.1 Design Criteria For Mechanically Cleaned Bar Screens (Arcadio P. Sincero & Gregoria A. Sincero , 2012)

Parameter	Design Criteria
Bar width	5 - 15 mm
Bar depth	25 – 40 mm
Clear spacing between bars	15 – 75 mm
Slope from vertical	0 - 30 degrees
Approach velocity	0.6 - 1.0 m/s
Allowable Headloss	150 - 600 mm

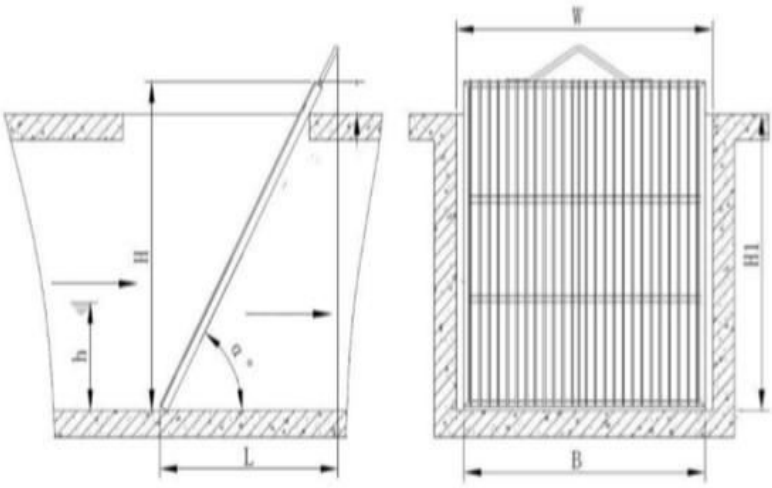


Figure 4.2 Cross – Section and Front View of Coarse Bar Screen

4.3 Design of Aerated Grit Chamber

4.3.1 Grit Chamber

Grit chamber is the second unit operation used in primary treatment of wastewater and it is intended to remove suspended inorganic particles such as sandy and gritty matter from the wastewater. This is usually limited to municipal wastewater and generally not required for industrial effluent treatment plant, except some industrial wastewaters which may have grit. The grit chamber is used to remove grit, consisting of sand, gravel, cinder, or other heavy solids materials that have specific gravity of 2.65 and much higher than those of the organic solids in wastewater. Grit chambers are provided to protect moving mechanical equipment from abrasion and abnormal wear; avoid deposition in pipelines, channel, and conduits; and to reduce frequency of digester cleaning.

4.3.2Aerated Grit Chamber

Excessive wear of grit handling equipment and necessity of separate grit washer can be eliminated by using aerated grit chamber. It is designed for typical detention time of 3 minutes at maximum flow. Grit hopper about 0.9 m deep with steeply sloping sides is located along one side of tank under air diffusers. The diffusers are located at about 0.45 to 0.6 m from the bottom. The size of particles removed will depend upon velocity of roll or agitation. The air flow rate can be easily adjusted to control efficiency and 100% removal of grit can be achieved. Wastewater moves in the tank in helical path and makes two or three passes across the bottom of the tank at maximum flow (and more at less flow). Wastewater is introduced in the direction of roll in the grit chamber. The expansion in volume due to introduction of air must be considered in design. The aerated grit chambers are equipped with grit removal grab buckets, traveling on monorails over the grit collection and storage trough. Chain and bucket conveyers can also be used. Two grit chambers in parallel are used to facilitate maintenance.

4.3.2.1 Advantages of aerated grit chamber

1. An aerated grit chamber can also be used for chemical addition, mixing and flocculation ahead of primary treatment.
2. Wastewater is freshned by air, thus reduction in odours and additional removal of BOD5 may be achieved.
3. Minimal head loss occurs through the chamber.
4. Grease removal may be achieved if skimming tank is provided.

4.3.3 Calculation of Grit Chamber

Design flow = 8*2.25/24*3.6 =.208 m

Surface loading = 959 m^3/sqm/day

Area required = 18000/959 = 18.76 sqm

Provide 4.5 *4.5 chamber

Detention time = 60 sec

Volume = peak flow *detention time / no of chamber

Increase the length by 25 %

Adjust length = 1.25 *4.5 =5.63

Take the value of Air supply from the table 4.2

Assume Air supply = 0.3 m^3/min*m

Air supply provided = 0.3 * 5.63 = 1.69 m

Now ,we take the value of quantity of grit per 1000 m3 = .015 m^3

Volume of grit = .015 * .208 *60*60*24/1000 = .27 m^3/min

Inputs	**Value**	**Unit**
Average Flow per day =	8	MLD
Peak Flow =	0.208	m^3/s
Avg. Detention Time =	60	sec
Number of Chambers =	1	
Width	4.5	m
Length	4.5	m
Depth =	0.9	m
Air Supply Provided =	0.3	m^3/min*m
Quantity of Grit per 1000m^3 =	0.015	m^3
Calculations		
For 1 Chamber*:*		
Aerated Chamber Volume =	12.50	m^3
Adjusted Length =	5.63	M
Air Required length basis =	1.69	m^3/min
Volume of Grit =	0.27	m^3/day

Table 4.2 Typical Design Information for Aerated grit chamber (Metcalf &Eddy , 2013)

Particulars	**Range**	**Typical**
Detention time (mins) at max flow	2-5	3
Dimension		
Depth (m)	2-5	
Length (m)	7.5-20	
Width (m)	2.5-7	
Width – Depth ratio	1:1-5:1	1.5:1
Length – Width ratio	3:1-5:1	4:1
Air supply (m3/min/m of length)	0.2-0.5	
Grit quantities (m3/1000m3)	0.004-0.20	0.015

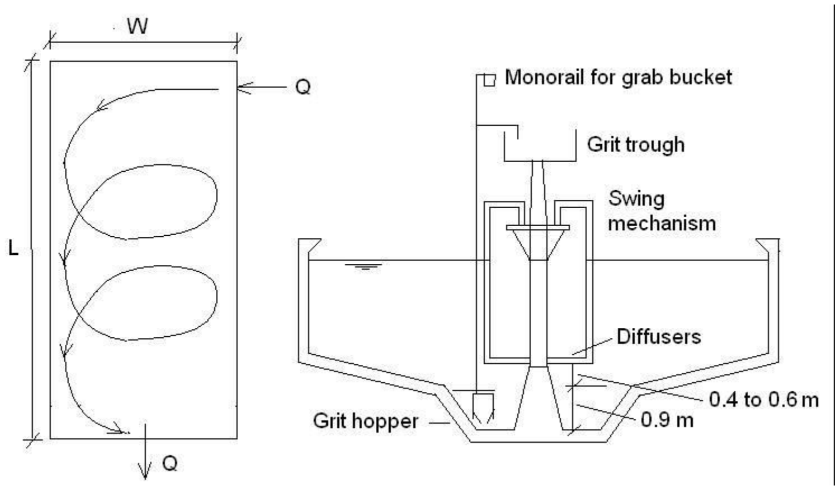


Figure 4.3 Aerated grit chamber (first figure showing the helical flow pattern of the wastewater in grit chamber and second showing cross section of grit chamber)

4.4 Design of Aeration Tank

The volume of aeration tank is calculated for the selected value of F:M by assuming a suitable value of MLSS concentration, X.

Flow rate = 8000 m3/day

Total entering BOD = 300 mg/lt

Volume of aeration tank can be designed by assuming a suitable value of MLSS and F:M ratio

Lets us assume MLSS = 4700 mg/lt (3000-4000 mg/Lt)

F:M ratio = 0.108 (Between .18 to .108)

With the help of MLSS value we can find MLVSS ,which is 70 % of MLSS

MLVSS = 0.7 * 4700 = 3290 mg /Lt

Aeration tank volume = flow rate * efffluent BOD / F:M * MLVSS

HRT time = 24 * effluent BOD / Flow rate

= 24 *300/3290 = 20.3 hr (lie between 10 to 25 hr)

So this tank is extended aeration

Inputs				**Calculations**			
Prim. Effl. Flow Rate,**Q**	=	8,000	m^3/d	(Design Based on Volumetric Loading)			
Prim. Effl. BOD, $\mathbf{S_o}$	=	300	mg/m^3	Aeration tank volume, **V**	=	6,754	m^3
Aeration tank MLSS, **X**	=	4700	mg/m^3	Check on other design parameters:			
Aeratio tank MLVSS , X*	=	3290					
Aeration tank F:M	=	0.108		Aeration tank **HRT**	=	20.3	Hr

Equations used for Calculations:
$V = (S_o * Q_o) / F:M * X$
$HRT = 24 * V_{MG} / Q_o$

Table 4.3 Activated Sludge Design Parameters – Typical Ranges (Metcalf & Eddy, 2013)

Activated sludge Process	**Volumetric Loading** **Lb BOD/Day 1000 ft3**	**Kg BOD/Day m3**	**F:M Kg BOD/day Kg MLVSS**	**HRT hours**
Conventional Plug Flow	20-40	0.3-0.7	0.2-0.4	4-8
Complete Mix	20-100	0.3-1.6	0.2-0.6	3-5
Extended Aeration	5-15	0.1-0.3	0.04-0.1	20-30

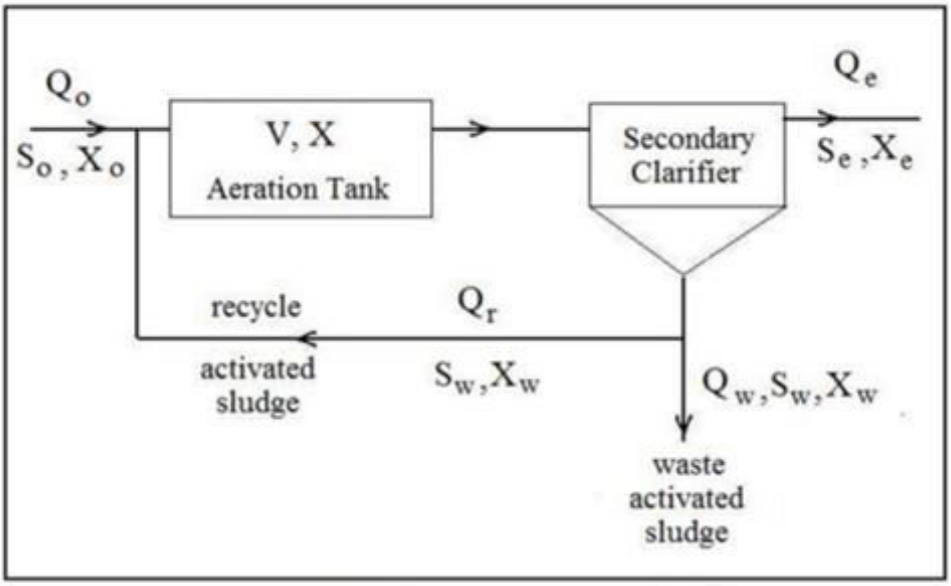


Figure 4.4 Activated Sludge Flow Diagram and Parameters

4.5 CLARITUBE SETTLER

Clarifiers are settling tanks built with mechanical means for continuous removal of solids being deposited by sedimentation. A clarifier is generally used to remove solid particulates or suspended solids from liquid for clarification and (or) thickening. Concentrated impurities, discharged from the bottom of the tank are known as sludge, while the particles that float to the surface of the liquid are called scum.

Tube settlers are commonly used in rectangular clarifiers to increase the settling capacity by reducing the vertical distance a suspended particle must travel. High efficiency tube settlers use a stack of parallel tubes, rectangles or flat pieces separated by a few inches (several centimeters) and sloping upwards in the direction of flow. This structure creates a large number of narrow parallel flow pathways encouraging uniform laminar flow as modeled by stokes law. These structures work in two ways:

1. They provide a very large surface area onto which particles may fall and become stabilized.
2. Because flow is temporarily accelerated between the plates and then immediately slows down, this helps to aggregate very fine particles that can settle as the flow exits the plates.

4.5.1 Calculation of claritube settler

To calculate the recycle activated sludge we assume some parameter,

Total suspended solid = 600 mg/ m^3

Sludge suspended solid = 400 mg/ m^3

Volume we calculated from aeration tank = 6754 m^3

Due to extended aeration Take sludge retention time = 12 days

Reacted activated sludge flow rate = flow rate *(MLSS- TSS)/(SS-MLSS)

= 8000*(4700-600)/(400-4700)

=7628 m^3/d

Waste activated sludge flow rate = volume*MLSS / SRT *SS

= 6754*4700/12*400

=6613 m^3/d

F:M ratio = flow rate * effluent BOD / volume * MLSS

= 8000*300/6754*4700

= .08

Inputs				**Calculations**		
Prim. Effl. Flow Rate, Q_o =		8,000	m^3/d	Recycle Activated		
				Sludge Flow Rate, Q_r =	(7,628)	m^3/d
Prim. Effl. BOD, S_o =		300	g/m^3			
				Waste Activated Sludge		
Prim. Effl. TSS, X_o =		600	g/m^3	Flow Rate, Q_w =	6613	m^3/d
Waste/recycle activated				Aeration tank **F:M** =	0.08	
sludge SS conc., X_w =		400	g/m^3	(kg BOD/day/kg MLVSS)		
Aeration tank vol., **V** =		6,754	m^3			
Aeration tank MLVSS, **X** =		4700	g/m^3			
% volatile MLSS, **%Vol** =		75%				
Sludge ret. time, **SRT** =		12	days			

EQUATIONS USED FOR CALCULATIONS:

$$Q_r = Q_o(X - X_o)/(X_w - X)$$

$$Q_w = (V*X)/(SRT*X_w)$$

$$F:M = (S_o*Q_o)/(\%Vol*X*V_{MG})$$

Activated sludge process	**SRT** **DAYS**	**MLSS** **g/m3**	**F:M** **Kg BOD/day** **Kg MLVSS**	**Qr / Qo** **%**
Conventional sludge flow	3-15	1000-3000	0.2-0.4	25-75
Complete mix	3-15	1500-4000	.2-.6	25-100
Extended aeration	20-40	2000-4000	.04-.1	50-150

Table 4.4 Activated Sludge Operational Parameters – Typical Ranges (Metcalf & Eddy, 2013)

4.6 PROCESS EQUIPMENT

1 DESIGN BASIS

Average Flow (Qav)	=	8.00	MLD
	=	333.33	m^3/hr
	=	0.09	m^3/s
Peak Flow Factor = (Qpk / Qav)	=	2.25	
Peak Flow (Qpk)	=	18.00	MLD
	=	750.00	m^3/hr
	=	0.21	m^3/s

2 INLET PARAMETERS

BOD_5 @ 20^o C	=	300.00	mg/l
COD	=	650.00	mg/l
Total Suspended Solids	=	650.00	mg/l

3 OUTLET PARAMETERS

BOD_5 @ 20^o C	≤	10.00	mg/l
COD	≤	100.00	mg/l
Total Suspended Solids	≤	10.00	mg/l

4	**STILLING CHAMBER**			
	Unit to be designed for Averge Flow	=	8.00	MLD
		=	333.33	m^3/hr
		=	0.09	m^3/s
	And to be checked for Peak Flow	=	18.00	MLD
		=	750.00	m^3/hr
		=	0.21	m^3/s
	HRT at Peak Flow	=	60.00	sec
	Volume required	=	12.50	m^3
	SWD provided	=	2.50	m
	Side of Squre Chamber required	=	2.24	m
	Length/Width provided	=	2.50	m
	Volume provided	=	15.63	m
	Freeboard provided	=	0.50	m
5	**BASIN SIZING**			
A	Volume of Sewage treated	=	8000.00	m^3/d
B	BOD removed (Inlet BOD – Outlet BOD)	=	300.00	mg/l
C	MLSS	=	4700.00	mg/l
D	MLVSS	=	3290.00	mg/l
E	F/M	=	0.11	
F	Total Volume of C-Tech Basins = (A x B) / (D x E)	=	6754.47	m^3
G	No. of Basins Provided	=	2.00	Nos.
H	Volume per Basin = F / G	=	3377.24	m^3
I	Side Water Depth (SWD) of C-Tech Basins	=	6.00	m
J	Radius of C-Tech Basins	=	13.39	m
K	Volume provided per C-Tech Basin = $Pi*J^2*I$	=	3377.24	m^3
L	Total Volume offered = L x G	=	6754.47	m^3
M	Freeboard provided	=	0.50	m
N	Total Depth of C-Tech Basin = I + N	=	6.50	m
O	Providing Recirculation Ratio	=	**0.25**	

P	Feed Flow to each Basin	=	333.33	m^3/hr
Q	Recirculation Flow	=	83.33	m^3/hr
R	Recirculation Pump flow provided	=	85.00	m^3/hr

6	**OXYGEN CALCULATION AT PEAK FLOW CONDITIONS**			
A	Volume of Sewage treated	=	8000.00	m^3/d
B	O_2 required as per Sewage Manual	=	1.20	kg/kg BOD
C	Safety Factor considered	=	0.00	%
D	O_2 required	=	1.20	kg/kg BOD
E	Inlet BOD_5 @ 20^0 C	=	300.00	mg/l
F	Outlet BOD_5 @ 20^0 C	=	10.00	mg/l
G	BOD_5 removed	=	290.00	mg/l
H	BOD removed in a day = A x G	=	2320.00	kg/d
I	O_2 required for above BOD Load = D x H	=	2784.00	kg/d
J	Inlet Total Kjeldhal Nitrogen assumed	=	55.00	mg/l
K	Outlet Ammoniacal Nitrogen	=	1.00	mg/l
L	Outlet Nitrate Nitrogen	=	3.00	mg/l
M	NH_3-N removed in a day = J – K	=	54.00	mg/l
N	Kg O_2 required per Kg of NH_3-N	=	4.33	kg/ kg NH_3-N
O	NH_3-N removed in a day = A x M	=	432.00	kg/d
P	O_2 required for NH_3-N removal = O x N	=	1870.56	kg/d
Q	Kg O_2 released per Kg of Nitrate-Nitrogen during denitrification	=	2.86	kg/NO_3-N
R	Kg of Nitrate-Nitrogen generated = A x J x 75%	=	330.00	kg/d
S	Kg of Nitrate Nitrogen in the Treated Sewage = A x L	=	24.00	kg/d
T	Quantity of Nitrate Nitrogen that is denitrified = R – S	=	306.00	kg/d
U	O_2 released during Denitrification = T x Q	=	875.16	kg/d
V	Total O_2 required/day = I + P – U	=	3779.40	kg/d
W	Consider Safety Factor for Aeration	=	0.00	%
X	Total O_2 required per day considering Safety Factor = V x (1 + W)	=	3779.40	kg/d

7	**AIR REQUIREMENTAT AT PEAK FLOW CONDITIONS**			
A	Total Theoretical O_2 required per day	=	3779.40	kg/d
B	Alpha	=	0.65	
C	Beta	=	0.95	
D	Standard O_2 required at field conditions = A / (B x C)	=	6120.49	kg/d
E	No. of Basins	=	2.00	Nos.
F	Standard O_2 required at field conditions per Basin = D / E	=	3060.24	kg/d/Basin
G	Standard Oxygen Transfer Efficiency (SOTE) of Diffuser per m Depth of Submergence	=	28.58	% / m
H	Liquid Level in C-Tech Basin during Average Flow	=	6.00	m
I	Height at which Diffusers are kept	=	0.25	m
J	Effective Aeration Depth = H - I	=	5.75	m
K	SOTE for the above effective aeration depth = G x J	=	164.34	%
L	Fraction of O_2 in Air	=	23.20	%
M	Specific Gravity of Air	=	1.29	
N	Air required at field condition per basin = F / (K x L x M)	=	6203.03	Nm^3/d/Basin
O	Aeration Time per Basin per day	=	12.00	hrs/d/Basin
P	Air required per hour per Basin = N / O	=	516.92	Nm^3/hr/Basin
Q	Number of Operating Air Blowers per Basin	=	2.00	Nos.
R	Capacity of Air Blowers required = P / Q	=	258.46	Nm^3/hr
S	Safety Factor considered	=	0.00	%
T	Capacity of Air Blowers with Safety Factor = R x (1 + S)	=	258.46	Nm^3/hr
U	Capacity of Air Blowers offered	=	300.00	Nm^3/hr
V	No. of Basins aerating at any given time	=	2.00	Nos.
W	No. of Operating Blowers = Q x V	=	2.00	Nos.
X	No. of Standby Blowers per set of Operating Blowers	=	1.00	Nos./Set
Y	Number of Standby Blowers = V x X	=	1.00	Nos.

8	**SLUDGE WASTING**			
A	Excess sludge generated	=	1.15	kg/kg BOD
B	BOD	=	2400.00	kg/d
C	Excess Sludge generated per day = A x B	=	2760.00	kg/d

D	No. of Basins	=	2.00	Nos.
E	Sludge Wasted/Basin = C / D	=	1380.00	kg/d/Basin
F	No.of Cycles per day per Basin	=	8.00	Cycles/d/ Basin
G	Sludge Wasted per cycle per basin = E / F	=	172.50	kg/d
H	Sludge Solids Consistency	=	0.01	
I	Volume of Sludge Wasted per cycle per Basin = G / (H x 1000)	=	21.56	m^3/Cycle
J	Pump Running Time / Cycle	=	30.00	minutes
K	Pump Capacity required= (I x 60) / J	=	43.13	m^3/hr
I	Pump Capacity provided	=	45.00	m^3/hr
9	**CHLORINATION TANK**			
	Volume of Sewage treated	=	8000.00	m^3/d
	Treated Sewage Flow Rate	=	666.67	m^3/hr
	HRT in Chlorination Tank	=	30.00	minutes
	Volume required	=	333.33	m^3
	SWD provided	=	2.50	m
	Width provided	=	7.00	m
	Length provided	=	19.05	m
	Volume provided	=	333.38	m^3
	Freeboard provided	=	0.30	m
10	**CHLORINATOR**			
	Volume of Sewage treated	=	8000.00	m^3/d
	Treated Sewage Flow Rate	=	666.67	m^3/hr
	Design Chlorine Dosage	=	5.00	ppm
	Chlorine Dosage Rate	=	3.33	kg/hr
	Chlorinator Capacity provided	=	2.00	kg/hr
	No. of Working Chlorinators provided	=	1.00	No.
	No. of Standby Chlorinators provided	=	1.00	No.
11	**SLUDGE SUMP**			
	Volume of Sludge generated in a day	=	345.00	m^3/d
	Sludge Flow Rate	=	14.38	m^3/hr

	HRT of Sludge Sump	=	6.00	hrs
	Volume of required	=	86.25	m^3
	SWD provided	=	2.50	m
	Length provided	=	6.00	m
	Width provided	=	6.00	m
	Volume provided	=	90.00	m^3
	Freeboard provided	=	0.50	m
12	**SLUDGE SUMP AIR BLOWER**			
	Volume of Sludge Sump	=	90.00	m^3
	Design Air Agitation requirement in Sludge Sump	=	**1.20**	$m^3/hr/m^3$
	Capacity of Air Blower required	=	108.00	m^3/hr
	Capacity of Air Blower offered	=	110.00	m^3/hr
	No. of Working Air Blowers offered	=	1.00	No.
	No. of Standby Air Blowers offered	=	1.00	No.
	Side Water Depth of Sludge Sump	=	2.50	m
	Head of Air Blowers offered	=	0.30	kg/cm^2
13	**CENTRIFUGE**			
	Volume of Sludge generated in a day	=	345.00	m^3/d
	Maximum Running hours considered	=	18.00	hrs/day
	Sludge Flow Rate	=	19.17	m^3/hr
	No. of Working Centrifuges considered	=	1.00	Nos.
	Capacity required for each Centrifuge	=	19.17	m^3/hr
	Capacity of Centrifuge offered	=	20.00	m^3/hr
	Hours of Operation	=	17.25	hrs/day
	No. of Standby Centrifuge offered	=	1.00	No.
14	**CENTRIFUGE FEED PUMPS**			
	Volume of Sludge generated in a day	=	345.00	m^3/d
	Sludge Flow Rate	=	19.17	m^3/hr
	No. of Working Centrifuge Feed Pumps considered	=	1.00	Nos.
	Capacity required for each Pump	=	19.17	m^3/hr

Capacity offered	=	20.00	m^3/hr
Hours of Operation	=	17.25	hrs/day
No. of Standby Pump offered	=	1.00	No.

15 DWPE DOSING SYSTEM

Quantity of Sludge generated	=	2.76	Ton/day
DWPE Dosing Rate	=	1.20	kg/Ton of day Solids
DWPE reqd	=	3.31	kg/day
Hours of Operation	=	17.25	hrs/day
DWPE Dosing Rate	=	0.19	kg/hr
Solution Strength	=	0.00	
DWPE Dosing Rate	=	192.00	LPH
No. of Working DWPE Dosing Pumps offered	=	1.00	Nos.
Capacity of DWPE Dosing Pumps offered	=	200.00	LPH
No. of Standby Pump offered	=	1.00	No.
Volume of DWPE Dosing Tank reqd assuming 8 hours RT	=	1.15	m^3
SWD offered	=	1.50	M
Length/Width required	=	0.88	M
Length/Width offered	=	1.00	M
Free Board provided	=	0.50	M
Volume of DWPE Dosing Tank offered	=	1.50	m^3
No. of DWPE Dosing Tank offered	=	2.00	Nos.
Capacity of Agitator provided	=	1.00	HP
No. of Agitators provided	=	2.00	No.

4.7 CO-CURRENT NITRIFICATION AND DENITRIFICATION

C Tech process allows co-current Nitrification and Denitrification (N/DN) to occur in the same basin simultaneously.

Nitrification :-

There are two groups of chemoautotrophic bacteria that can be associated with the process of nitrification. One group (Nitrosomonas) derives its energy through the oxidation of ammonium to nitrite, whereas the other group (Nitrobacter) obtains energy through the oxidation of nitrite to nitrate. Both the groups, collectively called Nitrifiers, obtain carbon required, from inorganic carbon forms.

$$NH_3 \longrightarrow NH_4 \xrightarrow{\text{Nitrosomonas}} NO_2 \xrightarrow{\text{Nitrobacter}} NO_3$$

Denitrification :-

When a treatment plant discharges into receiving stream with lowavailable nitrogen concentration and with a flow much larger than the effluent, the presence of nitrate in the effluent generally does not adversely affect stream quality. However,if the nitrate concentration in the stream is significant, it may be desirable to control the nitrogen content of the effluent, as highly nitrified effluents can still accelarate algal blooms.

Biological Reactions:

1. Biodegradation (aerobic):
   Organics (BOD) + O_2 + Nutrients + Bacteria = New Bacteria + $C0_2$ + H_20
2. Nitrification (aerobic):
   NH_3-N + O_2 + Nitrosomonas = NO + O_2 + Nitrobacter = NO_3
3. De nitrification (anoxic):
   NO_3 + organic substrate + Heterotrophic = N_2 + CO_2 + H_2O + New cells
4. Phosphorous removal (anoxic/anaerobic/aerobic):
   VFA (organics) + Acinetobactor = release O-P O-P + Bacteria + O_2= new cells + cell maintenance.

In the C-tech basin, excess oxygen is provided to oxidize ammonical nitrogen into nitrates. This is an aerobic process. The biological process is regulated in such a way that the biofloc profile allows for nitrification at the peripheral sections and denitrification at the inner parts of the flocs.

Ammonical nitrogen (NH_4-N) is converted into nitrates (NO_3-N) during the aeration process. Aeration is then stopped to allow for settling of the biomass. During this time, anoxic conditions set in which allow for denitrification of the nitrates (NO_3N) into nitrogen (N_2) and carbon di oxide (CO_2) gas. Also at the start of each cycle, part of the settled biomass is recycled into the selector zone using the RAS pumps, where in raw effluent is also fed. The raw effluent acts as a substrate for the denitrification bacteria and under the influence of, anoxic conditions denitrification occurs. Elemental oxygen is release during this phase. This process of co Nitrification and Denitrifictaion result in complete removal of Nitrogen from the effluent.

4.8 PROPOSED LOCATION OF STP

The location for the proposed C-Tech Based STP of capacity 8 MLD has been taken along the existing UASB based STP of capacity 18 MLD. It is the low lying area in the pratapgarh city hence it is adopted for existing STP and we are considering the surrounding area for our Proposed STP.

4.9 LAYOUT OF ERAGE NETWORK

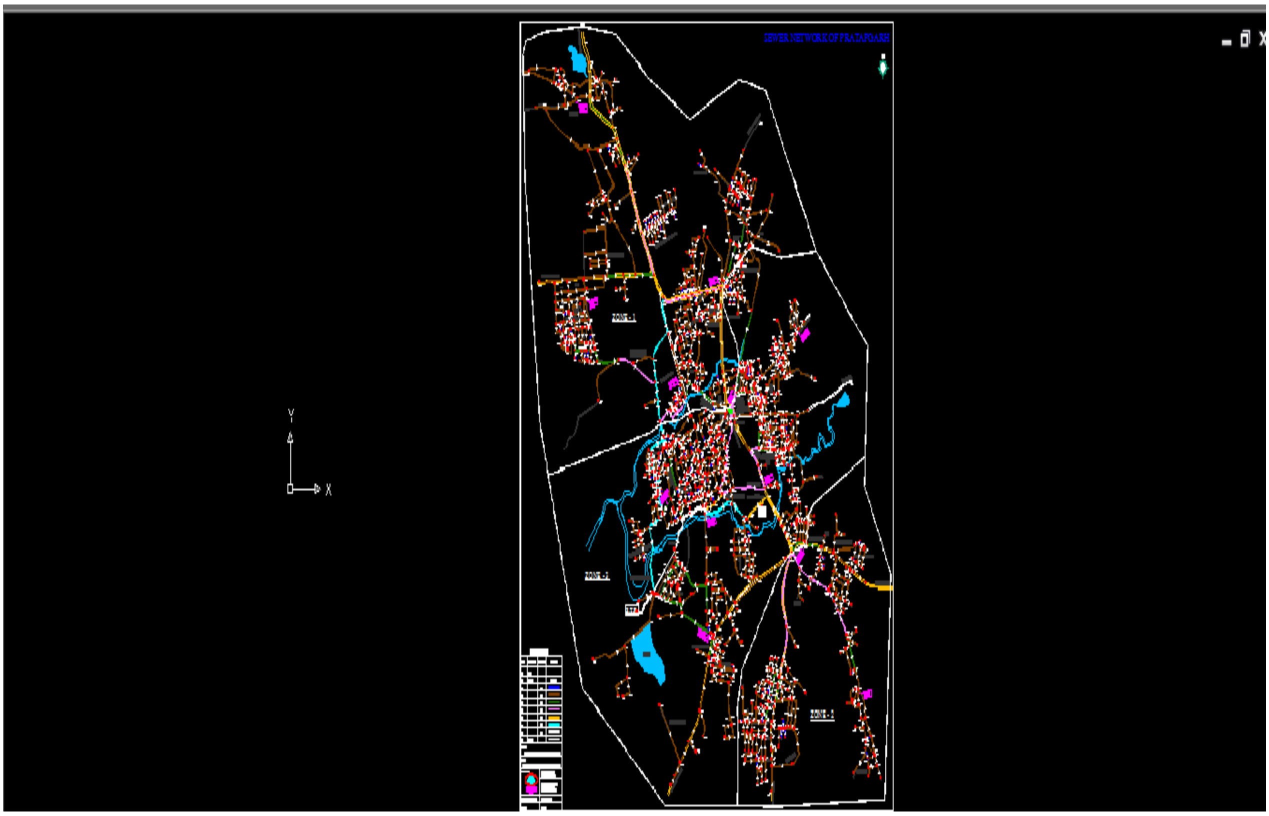


Plate 4.1 AutoCAD drawing for laying of proposed sewer

4.10 Equation used for Designing Sewer Network

Manning's Formula has been used in designing of sewerage network

- $v = (1/n)^* R^{2/3} S^{1/2}$
- $Q = A^* v$

Where, v = Velocity of flow (m/s)

Q = Discharge (cumec)

R = Hydraulic mean depth (m)

S = Slope (m/m)

Why we use manning formula :-

a) Values of the n coefficient to be used with the Manning formula vary greatly.

b) It dependent upon the materials and conditions of the channel walls and bottom together with the prevailing flow conditions (material and lies between 0.011 and 0.015. For brick sewer it could be 0.017 and 0.03 for stone facing sewers.)

Note: Self Cleansing Velocity of 0.6 m/s should be obtained atleast once in a day.

CHAPTER 5

DESIGN OF SEWER

5.1 Design Statement of Main Sewer

Node Number		Surface Level				For Year 2018			
From	To	Upper	Lower	Surface Gradient	Length	Population / Domestic Area(Cm^2	Pop.	cum. Pop.	Peak Flow
		mtr	mtr		in Meter		on Reach	UpTo Node	[LPS]
1	3	117.7	115.68	0.006	337	333	333	333	1.311
2	3	117.95	115.68	0.007	305	301	301	301	1.185
3	5	115.68	115.015	0.013	50	49	49	683	2.689
4	5	114.965	115.015	-0.001	40	40	40	40	0.158
5	9	115.015	114.65	0.008	46	45	45	768	3.024
6	8	114.775	113.865	0.01	94	93	93	93	0.366
7	8	114.663	113.865	0.009	89	88	88	88	0.347
8	9	113.865	114.65	-0.021	38	38	38	219	0.862
9	14	114.65	113.42	0.013	98	97	97	1084	4.268
10	12	118.245	115.75	0.009	293	289	289	289	1.138
11	12	114.37	115.75	-0.017	83	82	82	82	0.323
12	15	115.75	113.45	0.017	136	134	134	505	1.988
13	14	114.335	113.42	0.007	130	128	128	128	0.504
14	15	113.42	113.45		65	64	64	1276	5.024
15	18	113.45	113.44		122	121	121	1902	7.489
16	18	113.125	113.44	-0.001	268	265	265	265	1.043
17	18	113.92	113.44	0.007	67	66	66	66	0.26
18	33	113.44	104.33	0.03	301	297	297	2530	9.962
19	21	108.76	108.295	0.005	100	99	99	99	0.39
20	21	112.005	108.295	0.067	55	54	54	54	0.213
21	23	108.295	108.545	-0.01	26	26	26	179	0.705

For Year 2046			Size of	Size of		Provide		Slope	capacity
Pop.	cum. Pop.	Peak Flow	Size of Sewer	Sewer as per Capacity	Max. of Node	Size of Sewer	Slope if Less	1-IN	1-LPS
on Reach	UpTo Node	[LPS]	in MM					Adopted Slope	
333	333	1.311	200	200			160	160	30.65
301	301	1.185	200	200			120	120	35.392
49	683	2.689	200	200	200		120	120	35.392
40	40	0.158	150	150			200	200	12.73
45	768	3.024	200	200	200		200	200	27.414
93	93	0.366	200	200			100	100	38.77
88	88	0.347	200	200			100	100	38.77
38	219	0.862	200	200	200			230	25.564
97	1084	4.268	200	200	200			230	25.564
289	289	1.138	200	200			110	110	36.965
82	82	0.323	200	200				230	25.564
134	505	1.988	200	200	200		200	200	27.414
128	128	0.504	200	200			120	120	35.392
64	1276	5.024	200	200	200			230	25.564
121	1902	7.489	200	200	200			230	25.564
265	265	1.043	200	200			180	180	28.897
66	66	0.26	200	200			120	120	35.392
297	2530	9.962	250	250	200		60	60	90.748
99	99	0.39	200	200			180	180	28.897
54	54	0.213	200	200			40	40	61.3
26	179	0.705	200	200	200			230	25.564

Velocity					Invert Level		Depth of Sewer		
Full	Present	Actual	Conn Factor	Initial Depth	Upper	Lower	Upper	Lower	Avg. Depth
m/sec.	m/sec.	m/sec.			Mtr.	Mtr.	Mtr.	Mtr.	Mtr.
0.976	0.503	0.503		0.9	116.8	114.694	0.9	0.986	0.943
1.127	0.538	0.538		0.9	117.05	114.508	0.9	1.172	1.036
1.127	0.678	0.678	2	0.9	114.508	114.091	1.172	0.924	1.048
0.72	0.178	0.178		0.9	114.065	113.865	0.9	1.15	1.025
0.873	0.585	0.585	2	0.9	113.815	113.585	1.2	1.065	1.133
1.234	0.245	0.245		0.9	113.875	112.935	0.9	0.93	0.915
1.234	0.22	0.22		0.9	113.763	112.873	0.9	0.992	0.946
0.814	0.39	0.39	2	0.9	112.873	112.708	0.992	1.942	1.467
0.814	0.608	0.608	2	0.9	112.708	112.282	1.942	1.138	1.54
1.177	0.546	0.546		0.9	117.345	114.681	0.9	1.069	0.985
0.814	0.202	0.202		0.9	113.47	113.109	0.9	2.641	1.771
0.873	0.519	0.519	2	0.9	113.109	112.429	2.641	1.021	1.831
1.127	0.293	0.293		0.9	113.435	112.352	0.9	1.068	0.984
0.814	0.632	0.632	2	0.9	112.282	111.999	1.138	1.451	1.295
0.814	0.711	0.711	2	0.9	111.999	111.469	1.451	1.971	1.711
0.92	0.451	0.451		0.9	112.225	110.736	0.9	2.704	1.802
1.127	0.197	0.197		0.9	113.02	112.462	0.9	0.978	0.939
1.849	1.238	1.238	3	0.9	110.686	103.169	2.754	1.161	1.957
0.92	0.234	0.234		0.9	107.86	107.304	0.9	0.991	0.946
1.951	0.131	0.131		0.9	111.105	107.33	0.9	0.965	0.933

Table 5.1 Design of Main Sewer

5.2 Abstract Of Depthwise, Diawise Quantity Of Pipe / Manholes

Zoone : 0						
DIA (mm)	**DEPTH/ CATEGORY**	**DEPTH (m)**	**LENGTH (r**	**M. H. (No.**	**NP3 (m)**	**NP4 (m)**
150	1	0.6	146	6		146
150	2	0.9	4763	198	4763	
150	3	1.2	479	23	479	
150	4	1.5	70	5	70	
150	5	1.8	9	1	9	
150	6	2.1	21	1	21	
150's Total			**5488**	**234**	**5342**	**146**
200	1	0.6	971	35		971
200	2	0.9	37635	1338	37635	
200	3	1.2	11618	440	11618	
200	4	1.5	7074	261	7074	
200	5	1.8	4644	174	4644	
200	6	2.1	3283	123	3283	
200	7	2.4	2906	109	2906	
200	8	2.7	1319	51	1319	
200	9	3.0	742	32		742
200	10	3.3	605	22		605
200	11	3.6	247	10		247
200	12	3.9	155	7		155
200	13	4.2	244	9		244
200	14	4.5	117	4		117
200	15	4.8	17	1		17
200	17	5.4	35	1		35
200	18	5.7	60	2		60
200	19	6.0	8	1		8
200's Total			**71680**	**2620**	**68479**	**3201**
250	1	0.6	11	1		11
250	2	0.9	159	6	159	
250	3	1.2	978	36	978	
250	4	1.5	544	20	544	
250	5	1.8	445	16	445	
250	6	2.1	449	18	449	
250	7	2.4	726	26	726	
250	8	2.7	377	14	377	
250	9	3.0	324	12		324

Table 5.2 Design Of Quantity Of Pipe

5.3 Trench Excavation

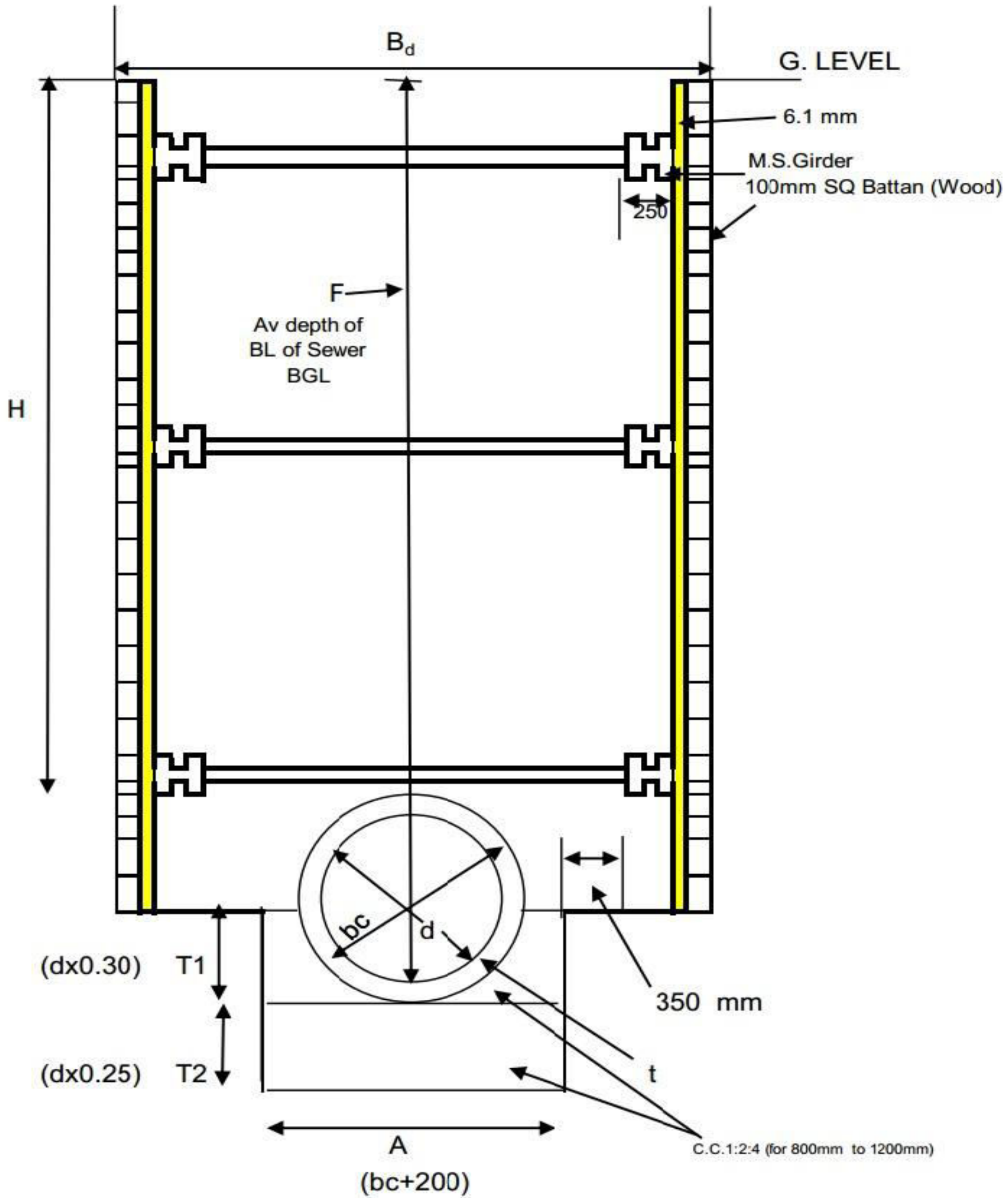


Figure 5.1 Typical Cross Section for Laying R.C.C. Pipe with Confined Cut Excavation

5.3.1 Standard Values for Trench Excavation

Table 5.3 Dimension Values for excavating a trench

SIZE IN MM (d)	DIMENSIONS IN MM							
	t	bc	T1	T2	A	F	E	B_d
450	75	600	135	112.5	800	3000	2940	2212
600	85	770	180	150	970	3540	3445	2382
700	85	870	210	175	1070	3930	3805	1782
800	95	990	240	200	1190	4200	4055	2602
900	100	1100	270	225	1300	4530	4360	2712
1000	115	1230	300	250	1430	4870	4685	2842
1100	115	1330	330	275	1530	5030	4815	2942
1200	120	1440	360	300	1640	5290	5050	3052

5.3.2 Quantity of Cement Concrete Required per m for Bedding of RCC NP pipes

Table 5.4 Volume of Concrete Required in bedding for particular RCC NP Pipe

Size/ Dia in mm	**All Dimensions in m**								C.C cum / m	C.C. cum / ft
	A	B	C	d Outer dia	d1	D	T	h		
400	0.750	0.100	0.238	0.550	0.454	0.400	0.075	0.120	0.142	0.043
450	0.800	0.113	0.263	0.600	0.501	0.450	0.075	0.135	0.165	0.050
500	0.850	0.125	0.288	0.650	0.548	0.500	0.075	0.150	0.190	0.058
600	0.970	0.150	0.343	0.770	0.652	0.600	0.085	0.180	0.254	0.077
700	1.070	0.175	0.393	0.870	0.745	0.700	0.085	0.210	0.316	0.096
800	1.190	0.200	0.448	0.990	0.849	0.800	0.095	0.240	0.397	0.121
900	1.300	0.225	0.500	1.100	0.947	0.900	0.100	0.270	0.480	0.146
1000	1.430	0.250	0.558	1.230	1.056	1.000	0.115	0.300	0.587	0.179
1100	1.530	0.275	0.608	1.330	1.149	1.100	0.115	0.330	0.677	0.206
1200	1.640	0.300	0.660	1.440	1.247	1.200	0.120	0.360	0.783	0.239

A = Outer dia + .2

B = DX0.25 /1000

h = D X 0.30 / 1000

D = internal dia of pipe

d = outer dia of pipe

Qty of C.C. 1:4:8 (under bed of R.C.C. Pipe / m) = A X C - (2/3 X d1 X h)

To evaluate d1 i.e. upto top of Base concrete.

$$\boxed{(od/2)^2 - (od/2 - h)^2 = (d_1/2)^2}$$

od = outer Diameter of pipe

Table 5.5 Calculation of d_1

Size/ Dia in mm	**od/2**	**(od/2 -h)**	**$(od/2)^2$**	**$(od/2 -h)^2$**	**$d_1^2 /2$**	**d_1**
400	0.275	0.155	0.02	0.08	0.05	0.45
450	0.3	0.165	0.03	0.09	0.06	0.50
500	0.325	0.175	0.03	0.11	0.08	0.55
600	0.385	0.205	0.04	0.15	0.11	0.65
700	0.435	0.225	0.05	0.19	0.14	0.74
800	0.495	0.255	0.07	0.25	0.18	0.85
900	0.55	0.280	0.08	0.30	0.22	0.95
1000	0.615	0.315	0.10	0.38	0.28	1.06
1100	0.665	0.335	0.11	0.44	0.33	1.15
1200	0.72	0.360	0.13	0.52	0.39	1.25

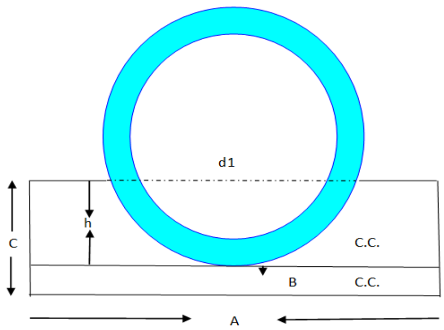


Figure 5.2 Cross – Section of bedding

5.4 Computation of Loads

5.5.1 Loads on Conduit Due to backfill

$$W_c = C_d * w * B_d^2$$

where, Wc = load on the pipe in Kg per linear meter

w = Unit weight of backfill soil in kg/m^3

B_d = Width of trench at the top of the pipe in m

C_d = Load coefficient which is a function of a ratio of height of fill to width of trench (H/B_d) and of the friction coefficient between the backfill and the sides of the trench.

5.5.2 Loads on Conduit Due to Superimposed Loads

$$W_{sc} = C_s(PF/L)$$

W_{sc} = Load on the conduit in kg/m

P = Concentrated load in kg acting on the surface

F = Impact factor (1.0 for air field runways, 1.5 for highway traffic , 1.75 for railway traffic) and

C_s = Load coefficient which is a function of

$\frac{B_c}{2H}$ and $\frac{L}{2H}$

where,

H = Height of the top of the conduit to ground surface in m

B_c = Outside width of conduit in m, and

L = Effective length of the conduit to which the load is transmitted (m)

5.5 Type of Bedding for RCC NP-3 Pipe

5.5.1 For Pipe Diameter 400 mm

Table 5.6 Calculation of total load on conduit for pipe diameter 400 mm

Size in mm(d)	Dimensions in mm					
	t	bc	T1	T2	A	B_d
400	75	550	120	100	750	2250

H (mm)	H/B_d	C_d	Loading on Pipe due to backfill (kg/m)	C_s	Loading on Pipe due to Superimposed load (kg/m)	Bedding Factor	Type of Bedding
1000	0.44	0.46	4322.16	0.21	3535.43	4.02	Class Ad
1200	0.53	0.49	4545.72	0.15	2616.30	3.67	Class Ad
1400	0.62	0.56	5216.40	0.12	2000.70	3.70	Class Ad
1600	0.71	0.63	5887.08	0.09	1573.20	3.82	Class Ad
1800	0.80	0.70	6557.76	0.07	1265.40	4.01	Class Ad
2000	0.89	0.78	7228.44	0.06	1043.10	4.24	Class Ad

5.5.2 For Pipe Diameter 600 mm

Table 5.7 Calculation of total load on conduit for pipe diameter 600 mm

Size in mm(d)	Dimensions in mm					
	t	bc	T1	T2	A	B_d
600	85	770	180	150	970	2350

H (mm)	H/B_d	C_d	Loading on Pipe due to backfill (kg/m)	C_s	Loading on Pipe due to Superimposed load (kg/m)	Bedding Factor	Type of Bedding
1000	0.43	0.46	4714.89	0.28	4702.50	4.82	Class Ad
1200	0.51	0.47	4796.18	0.21	3532.86	4.26	Class Ad
1400	0.60	0.54	5527.80	0.16	2718.90	4.22	Class Ad
1600	0.68	0.61	6178.13	0.13	2151.18	4.26	Class Ad
1800	0.77	0.68	6909.75	0.10	1744.20	4.43	Class Ad
2000	0.85	0.74	7560.08	0.08	1441.53	4.61	Class Ad

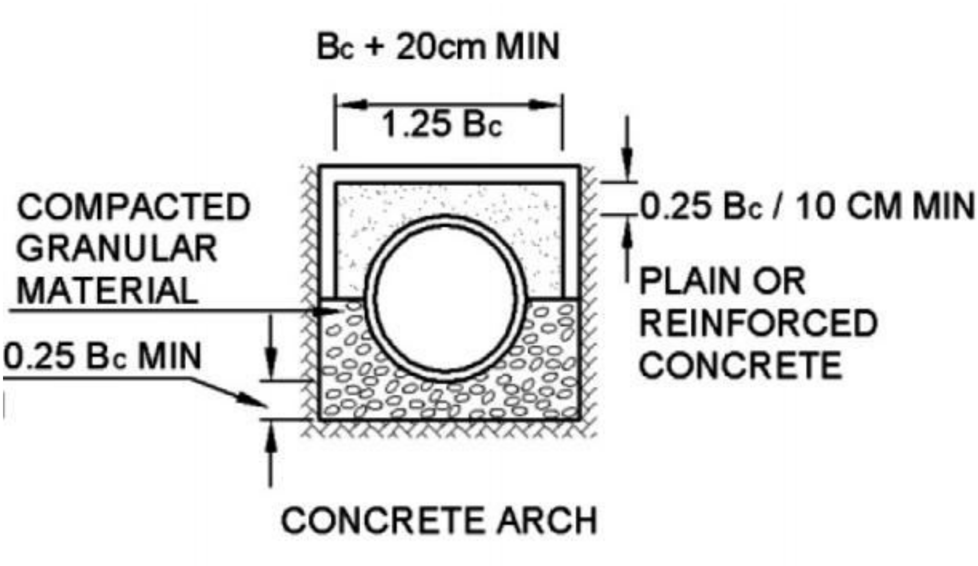


Figure 5.3 Bedding Type Ad Concrete arch

CHAPTER 6

ENVIRONMENTAL IMPACT ASSESSMENT

6.1 Introduction

Execution of a project is likely to bring changes in existing environment and social scenario in the project area / region. These changes are both negative and positive in nature. The project aims at achieving positive changes in the environment and to minimize the negative impacts by change is design and methodology of execution. The ultimate objective of environment assessment is making the project environment friendly and people friendly.

6.2 Impact on Environment Resources

6.2.1 Water environment

There would be positive effect on water environment of the area due to execution of the project as the treated water discharges into stream or it can be utilized for restricted irrigation purpose (BOD <30).

6.2.2 Land environment

There is no likely adverse change in the land use pattern and quality of land in the project area.

6.2.3 Air environment

There is no likely adverse change in the air environment and quality of air in the project area.

6.2.4 Impact on Ecological Resources

There is no adverse impact on vegetation, wild life, and biodiversity due to execution of the project. No trees are required to be cut for execution of the project.

6.3 Social Impact

The project is basically comprehensive sewage project. Infrastructural development, in whatever form, brings development in the area. Development of sound sewage system is foremost necessity for an area and the instant project is also that of improving the hygienic conditions of the town Pratapgarh.

The project would facilitate easy disposal of waste water and would remove flooding and unhealthy environmental conditions in the town.

6.4 Need for EIA

Environmental Impact Assessment (EIA) is a study of the possible impacts that a proposed project may have on the environment, which may affect natural, social and economic aspects in and around the project area. The purpose of the assessment is to make the project proponent to enhance the environmental quality of the project site during planning and execution of the project. The International Association for Impact Assessment (IAIA) defines an Environmental Impact Assessment as "the process of identifying, predicting, evaluating and mitigating the biophysical, social, and other relevant effects of development proposals prior to major decisions being taken and commitments made."

This Present report elucidates the existing environmental scenario of the project site and the predicted impacts due to installation of the proposed Sewage Treatment Plant. It evaluates the impacts during the preconstruction, construction and operation phases of the project. Both positive and negative impacts are being considered and reported. The Environmental Management Plan (EMP) is also aimed at mitigating the possible adverse impact of the project and ensuring the existing environmental quality gets enhanced

6.5 Objectives of this Report

The objectives of the report are:

- To identify and assess any potential negative environmental and social impacts and to facilitate the planning of preventive and remedial measures.
- To identify possible environmental enhancements in the project setting and lay down the action plans.
- To develop a set of environmental monitoring and management plans compliant with the relevant codes, statutes and social norms.

6.6 Environmental Legislations

Salient features of some of the major laws that are applicable are given below:

6.6.1 Water (Prevention and Control of Pollution) Act, 1974

The basic objective of this Act is to maintain and restore the wholesomeness of the country's aquatic resources by prevention and control of pollution. Consequently, the Water Act, a Central law, was enacted under Article 252(1) of the Constitution, which empowers the Union Government to legislate in a field reserved for the States. All the States have approved implementation of the Water Act. As during operation, it is likely that the ground water quality and surface water quality may be altered. Therefore this act is applicable to the proposed project.

6.6.2 Air (Prevention and Control of Pollution) Act, 1981

The Union Government under Article 253 of the Constitution passed this Statute. This Act provides for the prevention, control and abatement of air pollution and confers powers to the Central and State Pollution Control Board with a view to carry out the aforesaid purposes. This act is applicable to the proposed project.

6.6.3 Environment (Protection) Act, 1986

The Union Government under Article 253 of the Constitution passed this Statute. The Environment (Protection) Act, 1986 seeks to achieve the objective of protection and improvement of environment and for matters connected therewith. This legislation enables the co-ordination of activities of the various regulatory agencies; setting up of an authority or authorities with advocate powers for environmental protection etc., This Act is applicable to the proposed project.

Objective of this Act is to provide the protection and improvement of environment (which includes water, air, land, human being, other living creatures, plants, microorganism and properties) and for matters connected therewith.

6.6.4 Municipal Solid Waste (Management & Handling) Rules, 2000

This notification by Ministry of Environment & Forest lay down the methods of handling Municipal Solid Waste (MSW) and its scientific disposal. It bans incineration of MSW. Municipal Solid Waste (Management & Handling) Rules, 2000 are applicable to every municipal authority responsible for collection, segregation, storage, transportation, processing and disposal of Municipal Solid Waste. The Rules contains four Schedules namely;

Schedule	Activity
I	Relates to implementation schedule
II	Specifications relating to collection, segregation, storage, transport, processing and disposal of Municipal Solid Waste
III	Specifications for land filling, indicating site selection, facilities at site, specifications for and filling, Pollution prevention, water quality monitoring, ambient air quality monitoring, Plantation at landfill site, closure of landfill site and post care
IV	Indicate waste processing options including; standards for composting, treated lactates and incinerations

6.7 World Bank Policies

Following are the Operation Policy & Directorate of the World Bank.

6.7.1 Environmental Assessment OP/BP 4.01

This requires the borrower to screen projects upstream in the project cycle for potential impacts. Thereafter, an appropriate EA approach to assess, minimize / enhance and mitigate potentially adverse impacts is selected depending on nature and scale of project. The EA needs to be integrated in the project development process such that timely measures can be applied to address identified impacts. The policy requires consultation with affected groups and NGOs to recognize community concerns and the need to address the same as part of EA.

6.7.2 Cultural Property - OP 11.03

Requirements - World Bank's Operational Policy Note11.03 which aims at preserving and avoiding the elimination of structures having archaeological (prehistoric), paleontological, historical, religious and unique natural values. Projects that could significantly damage non-replicable cultural properties are declined for funding and the Bank will in turn assist protection and enhancement of cultural properties encountered in the project rather than leaving that protection to chance.

6.7.3 Natural Habitats – OP/BP 4.04

This policy sets out the World Bank's policy on supporting and emphasizing the precautionary approach to natural resource management and ensuring opportunities for environmentally sustainable development. As per this policy, projects that involve significant conversion or degradation of critical natural habitats are not supported by the Bank.

6.7.4 Forests – OP/BP 4.36

This sets out specific policy on protection of forests through consideration of forest related impacts of all investment operations, ensuring restrictions for operations affecting critical forest conservation areas, and improving commercial forest practice through use of modern certification systems. The policy requires consultation with local people, the private sector and other stakeholders in forest area.

6.8 Predicted Impacts and Mitigation Measures

When identifying the potential impacts of a new project on the existing environment, such as the proposed Sewage Treatment Plant in Pratapgarh, it is necessary that it should be measured against the existing baseline conditions. Construction of sewer line with sewage treatment plant and there after operation of this system, if undertaken without a proper understanding of the relationships inherent in environmental function, can be accompanied by disruptions to the environment, from which it may take a long time to regain equilibrium. In human terms, this may mean that generations must function in a debilitated environment and suffer many possible associated socio-economic hardships and financial losses.

Some of the major environmental impacts of sewerage system include damage to local ecosystems, loss of productive agricultural lands, demographic change, accelerated urbanization, and introduction of disease. The need of development and growth in the area must be matched with the conservation of the existing natural resources.

In general, construction of a new sewage treatment plant will have a positive environmental impact on the town.

6.8.1 IMPACT EVALUATION

6.8.1.1 Air quality

This section presents an assessment of air quality impacts associated with the construction and operation of the proposed STP activity at Pratapgarh, Raja. Major sources of air pollution have been identified namely construction dust emission and road traffic emissions. The sources of air pollutants at the different phases of the development are categorized as follows:

• Construction Phase: Construction works include site clearance, site formation, STP units & administration building works. The major temporary air pollution is dust generated as a result of these construction works. Cutting and welding operation, loading-unloading, operation is mainly responsible for the release of SPM, SO2, NO_x, etc. However the overall impact may be rated as direct, short-term, adverse, and reversible.

• Operational Phase: The primary emission sources during the operations phase would include compressor and pumping station operations, vehicular traffic, carbon dioxide and a small quantity of Hydrogen sulphide may be produced in Aerobic Tank.

6.8.1.2 Water Quality

• Construction Phase: The construction of the proposed sewage treatment plant will facilitate improvement of water quality in and around the site by avoiding the unhygienic disposal of the raw sewage in the vicinity.

• Operational Phase: There will not be any adverse impact on the ground water quality since the treated effluent will be within the standards prescribed by the CPCB / PPCB.

6.8.1.3 Soil Quality

• Construction Phase: Topsoil shall be stripped to a depth of 200 mm from areas proposed to be occupied by buildings, roads, paved areas and external services.

6.8.1.4 Solid Waste Handling

• Construction Phase: Solid waste generated during site preparation and construction work would include cut vegetation and typical construction waste (e.g. wasted concrete, steel, wooden scaffolding and forms, bags, waste earth materials, etc.). This waste would negatively impact the site and surrounding environment if not properly managed and disposed of at an approved dumpsite.

• Operation Phase: Grit, screenings and the sludge generated from the treatment plant will be the major source of solid waste generation.

6.8.1.5 Cultural and Socio-Economic Impacts

• The construction of proposed sewage treatment plant is a mark beneficial socio-economic aspect since it leads to safe and hygienic disposal of the treated effluent.

• It enhances the existing environment as the untreated raw sewage disposal will be ceased.

• Also, the project will provide employment to the people during the constructional and operational phase hence creating a positive impact due to this project.

6.8.2 PROPOSED MITIGATION MEASURES

6.8.2.1 Air Quality

• The fugitive emissions and dust from the proposed site during construction phase can be reduced by sprinkling of water.

• The release of volatile organic compound, Carbon di oxide and H2S may take place during the operational phase which will be mitigated by implementing Environmental Management Plan.

• DG sets are operated only during power failures and the D.G sets are proposed to provide 200 KVA as required suitable power back up to run the plant. The emissions from the D.G sets will have marginal impact on the existing air quality, however adequate Stack height of 10 m is provided as per the CPCB norms to combat the effect on the air quality and also to facilitate proper dispersion.

6.8.2.2 Water Quality

• Adequate care will be taken to the leakages in the plant and leak proof joints are already proposed for the construction.

• The treated and chlorinated sewage will disposed off to the disposal site by closed RCC pipe or DI pipe.

• All underground-buried mild steel piping will be protected by the application of hot coal tar enamel and fiberglass wrapping. The coating will consist of one coal tar primer one coat, wrapping of fiber glass one more coat of enamel and the final wrap of enamel impregnated fiber glass.

6.8.2.3 Soil Quality

• Top soils shall be stockpiled to a height of 400 mm in pre-designated areas for preservation and shall be reapplied to site during plantation of the proposed vegetation.

• Top soil shall be separated from sub-soil debris and stones larger than 50 mm diameter. So that, the soil erosion can be prevented and proper construction procedure will be done.

6.8.2.4 Solid Waste Handling

• Grit and screenings will be immediately removed and taken to municipal solid waste dump site in consultation with the municipality.

• The sludge from the Treatment Plant shall be collected in a sludge sump where it is aerated continuously for mixing. The aerated sludge shall be treated through mechanical dewatering system by aeration, digestion and thickening.

• Before dewatering, the sludge shall be aerated and polyelectrolyte is to be added for best settlement of sludge.

6.9 ENVIRONMENTAL MANAGEMENT PLAN

Environmental Management Plan (EMP) is aimed at mitigating the possible adverse impact of a project and ensuring the existing environmental quality. The EMP converse all aspects of planning, construction and operation of the project relevant to environment. It is essential to implement the EMP right from the planning stage continuing throughout the construction and operation stage. Therefore the main purpose of the Environmental Management Plan (EMP) is to identify the project specific activities that would have to be considered for the significant adverse impacts and the mitigation measure required.

6.9.1 EMP during Construction Phase

The environmental impact during the construction phase will be of short term and reversible nature and will gradually eliminate after the construction activity is over. Further the area of the unit is small in size. Still the following measures will be considered on priority basis to minimize the impacts.

6.9.1.1 Mitigation for Modification of Drainage Pattern

• Rainwater harvesting prevents the flooding of low-lying areas in the project premises.

• A basic surface drainage system can be provided for the site to avoid water runoff on to the surrounding properties and roads, especially during the monsoon months.

• If during excavation, water accumulates in the excavated areas, then it should be pumped out and disposed off either in the municipal storm water drain or into recharge soak pits of drybore wells.

6.9.1.2 Air and Noise Environment

a) Site clearance, excavation and earthmoving

• The working area for the uprooting of shrubs or vegetation or for the removal of boulders or temporary or permanent structures shall be sprayed with water or a dust suppression chemical immediately before, during and immediately after the operation so as to maintain the entire surface wet.

b) Construction equipment's

• All machineries to be used for construction purpose will be of highest standard of reputed make and compliance of noise pollution control norms by these equipment's will be emphasized by company.

• Transport vehicles and construction equipment's / machineries will be properly maintained to reduce air emissions.

• Equipment's will be periodically checked for pollutant emissions against stipulated norms.

• Exhaust vent of DG set will be kept at proper height to ensure quick dispersal of gaseous emissions.

c) Excavation and earth moving

• The working area of any excavation or earth moving operation should be sprayed with water or a dusty suppression chemical immediately before, during and immediately after the operation so as to maintain the entire surface wet.

6.9.1.3 Mitigation Measures for Water Environment

• Excavation can be avoided during monsoon season

• Check dams shall be provided to prevent construction runoff from the site to the surrounding water bodies.

• Pit latrines and community toilets with temporary soak pits and septic tanks shall be constructed on the site during construction phase to prevent wastewater from entering the ground water or surrounding water bodies.

• To prevent surface and ground water contamination by oil/grease, leak proof containers shall be used for storage and transportation of oil/grease.

6.9.1.4 Mitigation Measures for Biological Environment

• The dust emissions will be suppressed by spraying water and then the activities will be carried out.

• Emissions from D.G sets and vehicles will be minimized by proper maintenance and by avoiding use of adulterant fuel sand will be maintained below the standard limits prescribed by competent authority.

• Important species of trees will be identified and marked and will be merged with landscape plan.

6.9.1.5 Construction Waste Disposal

• A site waste management plan should be prepared by the contractor prior to commencement of construction work. This should include the designation of appropriate waste storage areas, collection and removal schedule, identification of approved disposal site, and a system for supervision and monitoring. Preparation and implementation of the plan must be made the responsibility of the building contractor with the system being monitored independently.

• Special attention should be given to minimizing and reducing the quantities of solid waste produced during site preparation and construction. To reduce organic waste, softer vegetation may be composted onsite and used for soil amendment during landscaping.

• Most of the construction materials like soil, bricks, concrete will be reused in the backfilling, road construction and sub-grade reparation etc. works. Metals, word scraps & bitumen junks will be recycled either within site or outside with help of the local authority. The measures like reusing materials on-site and /or donating /selling salvaged items reduces waste, virgin material use and disposal cost.

• Vegetation and combustible waste must not be burnt on the site.

• Reusable inorganic waste (e.g. excavated sand) should be stockpiled away from drainage features and used for in filling where necessary.

• Unusable construction waste, such as damaged pipes, formwork and other construction material, must be disposed of at an approved dumpsite.

6.9.2 EMP during Operation Phase

During the operation phase, the plant will contribute to environmental pollution in the following manner:

• Atmospheric emission
• Noise Pollution
• Solid Waste Disposal

6.9.2.1 Management of Atmospheric Emissions and Noise Pollution

There is no source of air or noise pollution except the DG sets to be used as standby only. In addition there may be release of volatile compounds from the aeration tank. The emissions from the D.G sets will have marginal impact on the existing air quality, however adequate Stack height of 10 m is provided as per the CPCB / PPCB norms to combat the effect on the air quality and also to facilitate proper dispersion. Proper acoustic enclosure will be provided so that there will not be any vibrations and incremental noise in significant level.

6.9.2.2 Solid Waste Disposal

The main source of solid waste is sludge generated during operational activity.

• The sludge from the Treatment Plant shall be collected in a sludge sump where it is aerated continuously for mixing. The aerated sludge shall be treated through mechanical dewatering system by aeration, digestion and thickening.
• Before dewatering, the sludge shall be aerated and polyelectrolyte is to be added for best settlement of sludge.
• The sludge cake from the centrifuge pump will be moved to the composting yard through trucks.
• During transportation sludge will be covered in tarpaulin sheets.
• The sludge will be removed at frequent intervals in order to avoid accumulation inside the site

CONCLUSION

In this project, I got the population data from Municipal Corporation of Pratapgarh. Using the population data I designed screen ,grit chamber ,aeration tank & claritube settler.I have used the Loop Version software to calculate head loss, velocity, level and depth of sewer & dimensions of sewer pipe to be designed. According to the results I've interpreted ,I've used SBR process.

Keeping in view above parameters and comparisons, various alternatives are feasible for construction of STPs at Pratapgarh . However, because of following reasons SBR is the best alternative for proposed STPs at Pratapgarh,advantages of SBRs are that , primary clarification, biological treatment, and secondary clarification can be achieved in a single reactor vessel. These advantages can reduce the treatment area and cost. It reduces many disadvantages of ASP and UASB technologies as it requires less land and electricity for operations.

SBR offers high treatment efficiency in single step biological process.SBR uses deep RCC basins, and very efficient oxygen transfer equipments (diffused aeration mechanism) to achieve highest possible treatment in a single tank with **14 – 20 hrs** retention only as comparative to other technology.

In Grit chamber, quantity of grit comes out to be within the limit of design criteria.

In aeration tank , we design the aeration tank with **F:M ratio 0.108** then the detention time comes out within permissible limit . The result shows high BOD removal efficiency of 96.65%.

There would be positive effect on the water of the area due to execution of the project as the treated water can be discharged into the stream or it can be utilized for restricted irrigation purpose as there is no adverse affect on the vegetation or wildlife. Development of sewage system is foremost necessity of this area so the project is of improving the hygienic conditions of the Pratapgarh town.

APPENDIX

A.1 Values of C_d for calculating loads on pipes in trenches

Ratio H/B_d	Safe working Values of C_d				
	Minimum possible without cohesion**	Maximum for Ordinary Sand***	Completely Top Soil	Ordinary maximum for clay****	Extreme maximum for clay*****
0.5	0.455	0.461	0.464	0.469	0.474
1.0	0.830	0.852	0.864	0.881	0.898
1.5	1.140	1.183	1.208	1.242	1.278
2.0	1.395	1.464	1.504	1.560	1.618
2.5	1.606	1.702	1.764	1.838	1.923
3.0	1.780	1.904	1.978	2.083	2.196
3.5	1.923	2.075	2.167	2.298	2.441
4.0	2.041	2.221	2.329	2.487	2.660
4.5	2.136	2.344	2.469	2.650	2.856
5.0	2.219	2.448	2.590	2.798	3.032
5.5	2.286	2.537	2.693	2.926	3.190
6.0	2.340	2.612	2.782	3.038	3.331
6.5	2.386	2.675	2.859	3.137	3.458
7.0	2.423	2.729	2.925	3.223	3.571
7.5	2.454	2.775	2.982	3.299	3.673
8.0	2.479	2.814	3.031	3.366	3.764
8.5	2.500	2.847	3.073	3.424	3.845
9.0	2.518	2.875	3.109	3.476	3.918
9.5	2.532	2.898	3.141	3.521	3.983
10.0	2.543	2.918	3.167	3.560	4.042
11.0	2.561	2.950	3.210	3.626	4.141
12.0	2.573	2.972	3.242	3.676	4.221
13.0	2.581	2.989	3.266	3.715	4.285
14.0	2.587	3.000	3.283	3.745	4.336
15.0	2.591	3.009	3.296	3.768	4.378
Very Great	2.599	3.030	3.333	3.846	4.548

A.2 Values of load coefficients, C_s for concentrated and distributed superimposed loads vertically centered over conduits

$\frac{D}{2H}$ or $\frac{B_c}{2H}$	$\frac{M}{2H}$ or $\frac{L}{2H}$													
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.2	1.5	2.0	5.0
0.1	0.019	0.037	0.053	0.067	0.079	0.089	0.097	0.103	0.108	0.112	0.117	0.121	0.124	0.128
0.2	0.037	0.072	0.103	0.131	0.155	0.174	0.189	0.202	0.211	0.219	0.229	0.238	0.244	0.248
0.3	0.053	0.103	0.149	0.190	0.224	0.252	0.274	0.292	0.306	0.318	0.333	0.345	0.355	0.360
0.4	0.067	0.131	0.190	0.241	0.284	0.320	0.349	0.373	0.391	0.405	0.425	0.440	0.454	0.460
0.5	0.079	0.155	0.224	0.284	0.336	0.379	0.414	0.441	0.463	0.481	0.505	0.525	0.540	0.548
0.6	0.089	0.174	0.252	0.320	0.379	0.428	0.467	0.499	0.524	0.544	0.572	0.596	0.613	0.624
0.7	0.097	0.189	0.274	0.349	0.414	0.467	0.511	0.546	0.584	0.597	0.628	0.650	0.674	0.688
0.8	0.103	0.202	0.292	0.373	0.441	0.499	0.546	0.584	0.615	0.639	0.674	0.703	0.725	0.740
0.9	0.108	0.211	0.306	0.391	0.463	0.524	0.574	0.615	0.647	0.673	0.711	0.742	0.766	0.784
1.0	0.112	0.219	0.318	0.405	0.481	0.544	0.597	0.639	0.673	0.701	0.740	0.774	0.800	0.816
1.2	0.117	0.229	0.333	0.425	0.505	0.572	0.628	0.674	0.711	0.740	0.783	0.820	0.849	0.868
1.5	0.121	0.238	0.345	0.440	0.525	0.596	0.650	0.703	0.742	0.774	0.820	0.861	0.894	0.916
2.0	0.124	0.244	0.355	0.454	0.540	0.613	0.674	0.725	0.766	0.800	0.849	0.894	0.930	0.956

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