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A Design of Sewage Treatment Plant for Parbhani City

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Abstract:- *The main objective of this project is carried out to design of sewage treatment plant for a Parbhani city municipality, because it has a developing place due to steady increasing population, which in a results excess of sewage is produced. To avoid this problem, to construct the sewage treatment plant. This project focus on sewage generation in Parbhani city which was estimated 60 MLD considering the population of next 30 years.*

Key Words:- *Sewage treatment plant, ground water, irrigation, fertilizer.*

1. INTRODUCTION

Sewage treatment is the process of removing contaminants from waste water primarily from house hold sewage. Physical, Chemical & Biological process are used to reduce contaminants & produce treated waste water that is safe for environment.

A by-product of sewage treatment is usually semi solid waste or slurry called as sewage sludge. The sludge has to under-go further treatment before being suitable for disposal or application to land. Sewage can be treated close to where the sewage is created, which may be called as decentralized system. The treatment process has a series of treating units which are categorized under primary treatment, secondary treatment & tertiary treatment.

The primary treatment removes suspended & floating solids of raw sewage. It includes screening to trap solid objects & sedimentation by gravity to remove suspended solid. Primary treatment can reduce the BOD of the incoming waste water by 20-30 % & TSS by some 50-60 %. Primary treatment is the first stage of the sewage treatment.

The secondary treatment removes the dissolved organic matter that escapes primary treatment. Secondary treatment is typically performed by indigenous, waterborne micro-organisms in the managed habitat. It requires a separation process to remove micro –organisms from treated water prior to tertiary treatment.

The tertiary treatment is sometimes defined as anything more than primary & secondary treatment in order to allow ejection into highly sensitive ecosystem. The tertiary treatment can remove more than 99% of all the impurities from sewage, producing an effluent of almost drinking water quality Treated water is sometimes disinfected chemically or physically prior to discharge into stream, river & land.

Fig.1 : Location of Parbhani

2. STUDY AREA

Parbhani is the district South-Eastern, Maharastra.

Fig.2: Location of Plant

3. LITERATURE REVIEW

Chakar bhushan et.al. (2017) reviewed about design of sewage treatment plant for lohegaon village, pune. These project studied that social and environmental pollution issue due to sewage is disposed in some part of village and directly sewage drain in open land. It is used for recharging subsurface water level at lohegaon and used for irrigation purpose.

M. Aswathy et.al. (2017) studied on analysis and design of sewage treatment plant of apartment in Chennai. These project is studied that domestic and commercial waste and remove the materials with possess harm from generated public. To produce and environmental sewage fluid waste stream and solid waste suitable from disposal of use.

Puspalatha et.al (2016) reviewed on designed approach for a sewage treatment plant. A case study of shrikakulam greater municipality. The present study involve the analysis of a parameters like BOD, raw sewage, effluent. The construction of sewage treatment plant will prevent the direct disposal of sewage in nagavali river & use of treated water will reduce the surface water & contaminated ground water.

Pramod Sambhaji patil et.al (2016) studied on design of sewage treatment plant for Dhule city. Some treatment units are designed like a screens, grid chamber, storage tank, settling tank, aeration tank & skimming tank. The effluent can also be used for artificial recharge of ground water.

4. METHODOLOGY

Table - 1 : Population Details of Parbhani City

YEAR	ARITHM-ETICAL METHOD	INCREMENTAL INCREASE METHOD	GEOMETRIC PROGRESSION METHOD	AVERAGE OF A.P. , I. I. Method
2019	359918	348027	394518	353973
2029	373105	356590	419990	364848
2039	458821	396146	630749	427483
2049	557723	407106	1008430	482415

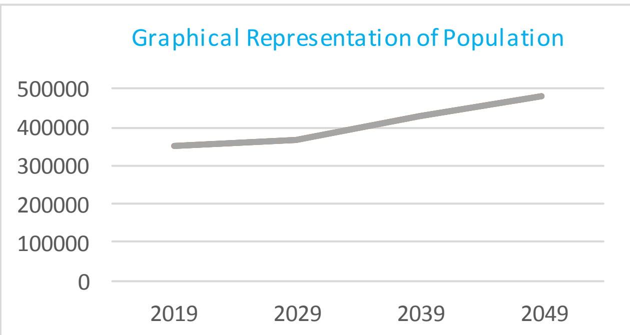

Chart-1 : Graphical Representation of Population

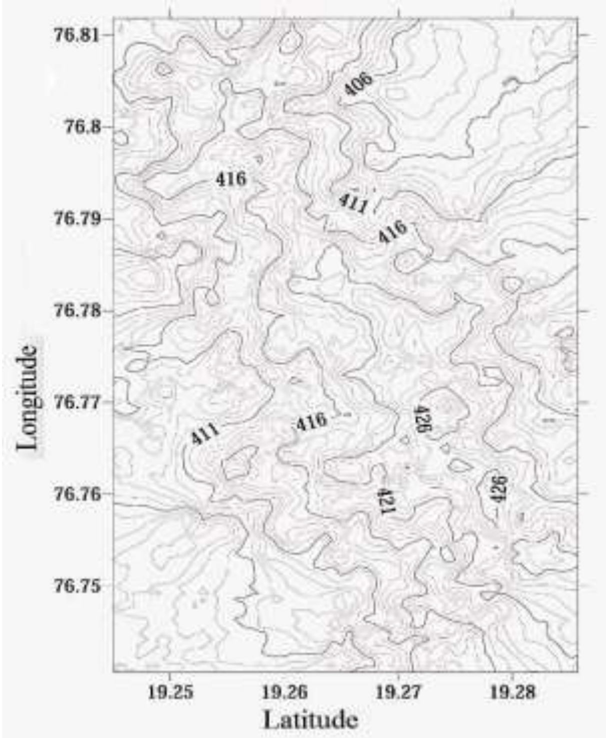

Fig 3 : Contour Map of Parbhani City

5. SAMPLING AND TESTING OF SEWAGE

The first step to examine the sewage is to collect its sample for testing. The constituents of sewage continuously change with time and position in tank. The quantity of sewage reaching disposal work in a morning differs from that reaching in noon or night, therefore, it is very difficult to collect the true sample of sewage.

To overcome this difficulty the sample of sewage are collected over period of 24 hours after 1hours intervals.

Sample colletion

Sample 1 – Zone 1 (MIDC)

Sample 2 – Zone 2

Table – 2: Results of Sample

Zone	Charactersics	Results
Zone 1	PH	7.74
	BOD	240 mg/lit.
	COD	288 mg/lit.
	TDS	1280 mg/lit.
	TSS	450 mg/lit.
Zone 2	PH	7.54
	BOD	160 mg/lit.
	COD	560 mg/lit.
	TDS	940 mg/lit.
	TSS	2570 mg/lit.

6. SEWAGE TREATMENT PROCESS

Types of treatment process:-

Preliminary treatment:- 1) Screen
2) Grit chamber
3) Skimming tank

Primary treatment:- 1) Primary settling tank
2) Aeration tank

Secondary treatment :- 1) Aerated lagoon
2) Secondary settling tank

Tertiary treatment:- 1) Chlorination
2) Sludge digestion tank
3) Sludge drying beds

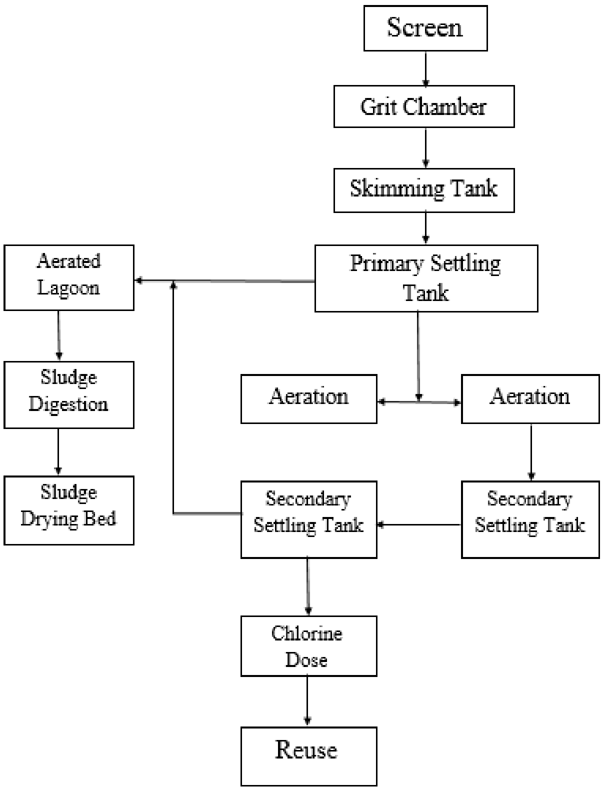

Fig. 4: Systematic Diagram of Sewage Treatment Plant

7. DESIGN OF SEWAGE TREATMENT PLANT

Population in 2019 = 353973

Population in 2049 = 482415

:. Per capita demand = 482415 x 135

= 65126025

Increase in 20% → = 13025205

52100820

:. Total quantity of sewage = 53 MLD = 53000 m^3 /day

:. Factor of safety = 1.15 = 1.15 x 5 = 60 MLD

:. Average sewage per hour = $\frac{60000}{24}$

= 2500 m^3/hr

:. Average daily sewage flow = 0.694 m^3/sec

Max. design of flow = 1.56 m^3/sec.

Pumping of Sewage:-

Population = 482415

Average per capita = 400 lit/capita/day

Velocity in rising main = 1m/sec

1) Average Daily Demand of Town = 400 x 482415 lit/day

2) Maximum Demand of the Town = 2.25 x 400 x 482415

= 4.34 m^3 /sec

3) Maximum Quantity of sewage reaching pumping station = 3.038 m^3 /sec

4) Cross Section Area of Rising main d = 0.39 m

The pump design for 20 min

5) Maximum Quantity of Sewage Collected in

= 3645.6 m^3.

6) Quantity of sewage rising main:

= 2389.18 m^3.

:. Net storage capacity of the sump

= 6034.78 m^3.

7) Size of well Depth = 3.5 m

Surface Area =862.11 m^2.

Diameter of well = 33.13 m.

Total lift of sewage = Height + Losses in Head
= 33.13 + 0.66 = 33.79 m.

Design of Screen :-

Medium Screen = 2.5 cm Clear Spacing

Hourly variation = 2.24

Velocity = 0.8 m/sec < m/s

Net effective aera of the Screen = 1.943 m^2

Providing Depth = 1.2 m.

:. Effective Width = 1.62 m.

Providing 5cm x 1.0cm flat C.I bars

overall width required = 1.41m.

Design of Grit Chamber :-

Length of grit Chamber = 15 m.

Capacity of Chamber = 93.6 m^3.

Area of Chamber = 6.24 m^2.

Width of Chamber = 6.24m.

Design Of Skimming Tank :-

Area of Tank = 1.03 m^2.

Provide Depth of Tank = 3m

Width = 0.34 m.

Length = 32.04 m.

Design of Primary Settling Tank :-

Assume,

Detention period = 1 hr

Depth = 3m

Square Surface Area = 833.33 m^2.

Diameter of Tank = 40m

Surface loading of tank = 47.74 m^3 /m^2 /day -------Safe

:. Volume of sludge produced = 273 kgm/day

Total volume of sludge produced = 2199.6 ≈2200 kgm/day.

Design of Aeration Unit:-

Suspended solids in raw sewage = 1728 ppm

Suspended solids removed in primary treatment unit = 950.4 ppm

Secondary unit have to be remove suspended solids = 604.8 ppm

BOD in the raw sewage = 280 ppm

BOD removed in primary treatment = 92.4 ppm

Secondary unit have to be remove BOD = 159.6 ppm

Provide detention period = 7 hours

Flow of sewage = 2500 m^3 /hr.

Total capacity of aeration unit = 17500 m^3.

Design of Secondary Settling Tank :-

Quantity of effluent to be handle = 60000 x 2.5

(include recirculation effluent) = 150000

Assume detention period = 2hrs

Capacity of tank = 12500 m^3.

Provide 2 tanks of each 3m depth

Capacity of each tank = 6250 m^3

Diameter of tank = 55 m

Surface loading = 31.58 m^3 / m^2 /day ----(Safe)

Design of Aerated Lagoons:-

Quantity of aerated lagoon = 0.133 kgm/sec

Area of Lagoon = 11491.2 m^2.

Provide 2 No.s of square aerated lagoons,

$A = 2 \times B^2$

:. B = 75 m & L = 75 m

Provide Depth = 4 m. deep

Detention Period = 4 days

Design of Sludge Digestion Tank:-

Assume detention period = 30 days

Capacity of Tank = 23846.4 m^3

Provide 6m deep

:. Diameter of Sludge Digestion Tank = 71.14 m.

Chlorine Dose:-

Type of effluent = 12 – 70 ppm chlorine.

Sludge Drying Beds:-

The area will be = Population x 0.0094

= 4534.70 m^2

Provide 8 numbers of sand bed

Area of each bed = 566.83 m^2.

Provide sand beds of 19 x 30 each.

INRODUCTION OF UNITS:-

This deals with the Analysis and Design of sewage treatment plant for the population of Parbhani City. The location of sewage treatment plant should be nearer to the point where sewage is disposed finally.

The designed considerations and parameters for the sewage treatment plant are given below:

- The design period should be in between 30 years
- Estimated population by the year 2049 is 4,82,415 numbers.

Screen:- Sewage contains suspended and floating matters in it. The suspended matters are large sizes such as tree leaves, papers, gravel, timber pieces, etc. as well as small size such as sand, silt, etc. the large size suspended and floating matters can be removed by passing sewage through the screens. The process of removing the large matters from sewage by passing it through screens is called screening.

Grit Chamber:- The main sources of grit are industrial wastes, kitchens storm water, runoff, pumping from excavations & ground water seepage. Grit must be removed before pumping of sewage to other treatment units otherwise it will cause an obstruction to the flow. The grit from the sewage is generally removed by Grit Chambers.

Skimming Tanks:- These tanks are used for removing oil, grease &fats of the sewage. All the lighter matters than water float on its surface. If the sewage is allowed to remain quiescent, then oils, fats, grease etc. will rise to the surface of sewage, where they will form scum, which can be easily removed by hand or mechanically. If the sewage is flowing, then most of these materials will remain in suspension or mixed condition.

Primary Settling Tank:- The suspended matters are removed by sedimentation process, by allowing the sewage to remain quiescent in sedimentation basins. The purpose of the sedimentation of sewage is to separate the settleable solids so that the settled sewage, if discharged into water courses, does not form sludge banks & when used for irrigation, does not lead to excessive organic loading.

Mechanical Aeration Units:- In diffused air units, the quantity of air which is actually utilized for oxidation only 5% of the total quantity of air compressed & the remaining 95% survive the purpose of thoroughly mixing only. Due to this reason, that the air does the part of mixing more some mechanical methods were developed for mixing of sewage. The main object while designing the various mechanical aeration units, was kept to bring every time new surface sewage in-contact with air.

Aerated Lagoon: - An aerated lagoons is an earthen basin about 2.5-4.0 m deep, in which sewage is filled an aerated by means of diffuse air or mechanical aerators. Commonly mechanical aerators are used. The aerated lagoons acts as a settling come aeration tank, where artificial aeration replaces algae oxygenation of waste stabilization tank.

Secondary Settling Tank:- The purpose of secondary settling tank is to achieve a certain degree of effluent quality by using a sewage treatment plant with physical phase separation to remove settleable solids and a biological process to remove dissolved and suspended organic compounds.

Chlorine Dose:- The disinfecting power of chlorine depends on the pH value, temperature, contact time & the concentration of the chlorine. Thus the quantity chlorine required for disinfection depends on these condition.

Sludge Digestion Tank:- In a modern sewage works, the sludge digestion tank are circular in a plan with flat or hopper shaped bottom. These are usually covered from top to retained the heat and odour. If the sludge contains some grit the bottom is given a slope of 1:2. The sufficient space is provided in tank for complete digestion of sludge.

8. RESULTS

Table -3: Design of Units

Sr no.	Units	Dimension	No.
1	Collection Chamber Pumping Station	--	1
2	Bar Screening	L=1.2m, b=1.62m	2
3	Grit Chamber	L=15m, b=6.24m, d=1m	1
4	Skimming Tank	d=3m, --	1
5	Primary Settling Tank	d=40m, h=3m	1
6	AerationTank	d=50m, h=5m	2
7	Secondary Settling Tank	d=55m, h=3m	2
8	Aerated Lagoons	d=3.5m,	1
9	Sludge Digestion Tank	d=71.14m, h=6m	1
10	Sludge Drying Bed	--	8
11	Chlorine Tank	--	1

9. CONCLUSIONS

1. The project deals with design parameters of sewage treatment plant.

2. The design has been done for predicted population of 30 years (2019-2049).

3. Although the project and the data helps in DESIGN OF SEWAGE TREATMENT PLANT in future.

4. The plant is designed perfectly to meet the needs and demands of appropriate 482415 population with a very large time period.

5. The treated sewage water is further used for the irrigation, if it is sufficiently clean, it can be used for ground water recharge.

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