Future Forecasting of Storm Water Management in NHCE Campus as Case Study

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Abstract - **The New Horizon College of Engineering, is one of the most important educational institutes in Bangalore city with large number of laboratories of various departments, residential units, Academic Blocks and numbers of hostels. A study of wastewater characterization of treatment plant will be performed followed by the design of sewage treatment plant. The whole project study involves the analysis of pH value, turbidity, total solids, chlorides, sulphates, nitrite, fluoride, iron, Total Alkalinity, Total Acidity, BOD, COD, DO, Coliform, residual chlorine.**

Keywords —biological oxygen demand, chemical oxygen demand, dissolved oxygen, sewage treatment plant

I. INTRODUCTION

A sewage treatment plant is quite necessary to receive hostels, college and laboratory wastes and remove the materials which pose harm for general public. Our objective is to treat the sewage produced in the college and use it for various purposes such as gardening, flushing, lawn watering & washing of pathways etc., In order to do that we are designing the new

PROPOSED SITE IN COLLEGE

Sewage Treatment Plant since the old STP is not sufficient enough to treat the total sewage produced. Also, the storing capacity of treated water and its Quality of effluent is low. The storing capacity and Quality of treated water is increased. The existing sewer line is re-designed and also Stormwater Management is also done.

METHODOLOGY

The objective in domestic wastewater treatment is to provide a low-cost process that is reliable meeting effluent quality standards. The contaminants in wastewater are removed by physical, chemical, and biological means. The individual methods usually are classified as physical unit operations, chemical unit processes, and biological unit processes. These operations and processes occur in a variety of combinations in treatment systems, it has been found advantageous to study their scientific basis separately because the principle involved do not change. Traditional design procedures for wastewater treatment systems attempt to minimize total capital cost by considering steady state concepts for unit processes and design guidelines.

Recent work has minimized capital as well as operation and maintenance costs using a single objective function and steady state models which are flawed because plant inputs vary as much as seven-fold during a 24-hour period.

This paper presents the technical aspects of the design for a sewage treatment plant with a capacity of 3500 cubic meters (m3) per day in New Horizon College of Engineering.

II. LITERATURE REVIEW

2.1. Analysis and design of sewage treatment plant of Apartments in Chennai: (by Ashwathy M, Hemapriya (International Journal of Pure and Applied Mathematics) (Volume 116 No. 13 2017, 157-163) Designed an STP for an Apartment in Chennai. This paper involves the analysis of water sample parameters such as pH, Total solids, Total Dissolved Solids, Alkalinity, Hardness, Flouride, Iron, Ammonia, Nitrite, Phosphate and Residual Chlorine, design of treatment such as Screening, Grit Chamber, Sedimentation tank, Sludge digestion tank, where the treated water is re-used for various purposes such as water to gardening, toilet flushing, farming etc.…,

2.2 ***Design of Sewage Treatment Plant:*** (by Swati Shree Samal (IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 13, Issue 5 Ver. V (Sep. - Oct. 2016), PP 25-31 www.iosrjournals.org)) This paper involves the design of a STP for a Metro Satellite City as per the future Population. The plant is designed perfectly to meet needs and demands of approximate 10000 populations with a very large period of time. The project consists of the design of complete Sewage treatment plant components starting from receiving chamber, screening, grit chamber, skimming tank, sedimentation tank, secondary clarifier, activated sludge tank and drying bed for sewage.

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2.3 Design and Analysis of Sewage Treatment Plant:(by Deep Gupta, Abhishek Ghildiyal, Neeraj Rana, Abhishek Kumar, Ishank Goyal, 6Gagan Goswami 1,2,3,4,5,6, 2Department of Civil Engineering, College of Engineering Roorkee, Roorkee)(The Engineering Journal of Application & Scopes, Volume 2,Issue 1, February 2017). This paper involves the Analysis of water sample parameters such as pH, Turbidity, Alkalinity, Acidity, Total Hardness, DO, BOD & COD. The Existing waste-water treatment plant failed to fulfill the desired outlet quality of water, so the STP is redesigned to meet the present and future wastewater treatment requirements of the college.

2**.4 Analysis and Design of Sewage Treatment Plant (A Case Study on Vizianagaram Municipality):**

(by M. Bhargavi, E. Ananta Rao, T.Pravallika, Y. Sri Teja)(SSRG International Journal of Civil Engineering (SSRG - IJCE) – Volume 5 Issue 4–April 2018) This project deals with the Analysis and Design of sewage treatment plant for the population of vizianagaram town. The plant is designed perfectly to meet the needs and demands of appropriate 300000 population with a very large time period. The treated sewage water is further used for the irrigation, fire protection, and toilet flushing in public, commercial and industrial buildings and if it is sufficiently clean, it can be used for ground water recharge.

2.5 Design of Sewage Treatment Plant units for ST. JOHN College Campus:

(by Yashashri Patil, Parnika Raut , Yash Patil , Swati Dhurve)(International Journal of Scientific Research Engineering & Technology (IJSRET), ISSN 2278 – 0882 Volume 7, Issue 3, March 2018) . This paper involves the analysis of water sample parameters such as pH, Total Suspended solids, Total Dissolved Solids, Hardness, BOD & COD, design of treatment UNITS such as Screening, Grit Chamber, Imhoff Tank, Sand Filter, Sedimentation Tank, Open Sludge drying beds, where the treated water is re-used for various purposes such as water to gardening, toilet flushing,

2.6 Modelling of Short Duration Rainfall IDF Equation for Bangalore City: (by Shivakumar J Nyamathi, and Anila Arelt, Water Resources Engineering, Department of Civil Engineering, UVCE, Bangalore University, Bangalore -560056, India.) (ISSN: 2319-9873)((International Conference and Exhibition on Integrated Water, Wastewater, and Isotope Hydrology – 2013) This paper gave an IDF empirical formula to estimate the rainfall intensity for any duration and any return period with minimum effort. Daily rainfall data for the year 1976 to 2010 was collected from Indian Meteorological Department (IMD) and the IMD empirical reduction formula was used to estimate the short duration rainfall using different probability distributions. It is seen in this paper that equation $i = x * td^{-y}$ with parameter „x" varying from 612 to 647 whereas the parameter „y" remains a constant of 0.6667 is the best IDF empirical formula.

III. METHODOLOGY

The objective in domestic wastewater treatment is to provide a low-cost process that is reliable meeting effluent quality standards. The contaminants in wastewater are removed by physical, chemical, and biological means. The individual methods usually are classified as physical unit operations, chemical unit processes, and biological unit processes. These operations and processes occur in a variety of combinations in treatment systems, it has been found advantageous to study their scientific basis separately because the principle involved do not change. Traditional design procedures for wastewater treatment systems attempt to minimize total capital cost by considering steady state concepts for unit processes and design guidelines.

Recent work has minimized capital as well as operation and maintenance costs using a single objective function and steady state models which are flawed because plant inputs vary as much as seven-fold during a 24-hour period.

This paper presents the technical aspects of the design for a
1. STORAGE TANKS –
T1- CAPACITY - 2.5 LAKHS 20X10X8 FT
(BETWEEN WOMENS HOSTEL)
T2- CAPACITY – 5 LAKH LITRES CAPACITY 40X10X8 FT
(NEAR GYM)
T3- CAPACITY – 2.5 LAKHS LITRES 20X10X8 FT
CHATRAPATHI SIVAJI BLOCK BASEMENT (UNDER GROUND)
T4 - CAPACITY – 2 LAKH LITRES15X10X10 FT
(VISVESVARAYYA BLOCK) T5 - CAPACITY – 5000 LITRES 8 NOS
(MANAGEMENT BLOCK (SYNTAX TANK)

2. SEWAGE TREATMENT PLANTS
CAPACITY – 3 TANKS (6 LAKHS LITRES/DAY)
INPUT – 2 LAKHS LITRES (CARRIED OUT IN 3 SHIFTS)

3. KAVERI WATER STORAGE

KAVERI TANK 54X44 FT PUMPS – 3 NO (10 HP)

4. RO PLANT
VISVESVARAYYA BLOCK
FILTRATION RATE-1 LAKH LITRE/HR(1 NO) TOP OF MESS
FILTRATION RATE----1 LAKH LITRE/HR (2 NOS)

5.TREATED WATER RCC STORAGE TANK

ON TOP OF SIVAJI BLOCK CAPACITY 1 LAKH LITRES (2 NO)

sewage treatment plant with a capacity of 3500 cubic meters (m3) per day in New Horizon College of Engineering.

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PARAMETERS UNIT
1. pH 6.2 6.5-8.5
2. Turbidity NTU 117 15
3. Total Solids mg/l 746 500-2000
4. Chlorides mg/l 190 250-1000
5. Sulphates mg/l 35.4 250-400
6. Iron mg/l 0.2 0.3
7. Total Alkalinity mg/l 170 200-600
8. Total Acidity mg/l 56 -
9. BOD mg/l 380 -
10. COD mg/l 512 -
11. Residual Chlorine mg/l 1.9 1-1.5
12. Total ColiformMPN/100 ml 500 0

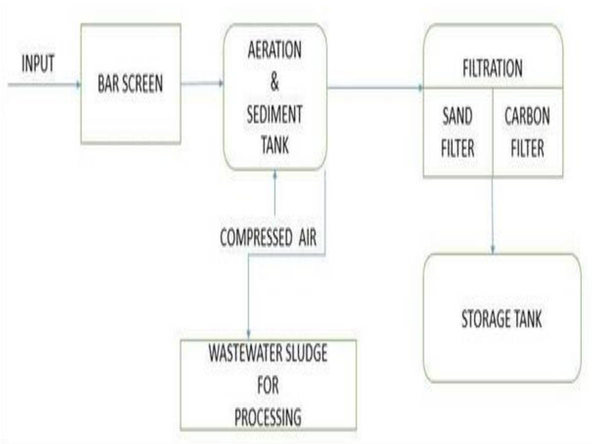
3.1NEED OF STUDY

The Sewage treatment plant of NHCE was designed in 2000 to treat the wastewater and sewage produced by the population at that time. The population of the college since 1999 has gone through a big increment in terms of no. of students (including hostellers as well as day scholars), no. of faculties and number of workers. Although the sewage treatment plant was designed for keeping in mind the future population growth yet the designed plant has failed due to high increment in population and the high demand of waste-water treatment thus increasing the total load on the plant.

3.2 SCOPE OF STUDY

The population for which the plant was designed was about the one-fourth to one-sixth of the present population. That's why the plant presently has failed to treat the water as per the standards laid according to the Indian Standards and Central Pollution Control Board (CPCB). The plant presently needs a serious attention towards its methodology as well as its treatment units. The plant is presently treating the waste water which is about four or five times more than its designed capacity. Thus, the waste water at effluent has almost same parameters as influent. The hydraulic loading rate is also more than its peak capacity for which it was designed. Hence the treatment plant needs major checks to be performed to keep the waste-water at effluent to meet the standards and laws set up by the government and various authorities responsible for environment protection

FLOW DIAGRAM OF EXISTING TREATMENT PLANT



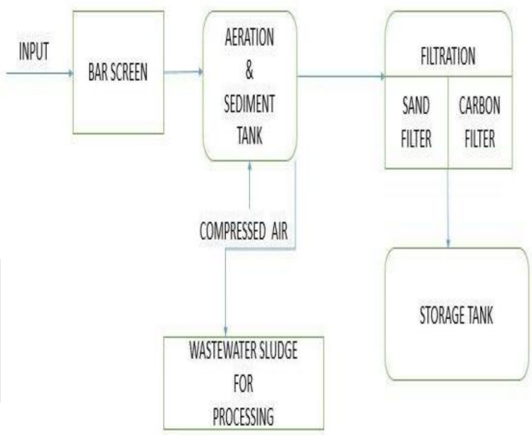
3.4.1 DETAILS OF EXISTING FEATURES

1. storage tanks
2. sewage treatment plants
3. kaveri tank
4. ro plant
5. treated water rcc storage tank
6. sewer

IV. DESIGN OF STP

4.1 DESIGN OF TREATMENT UNITS

4.1.1 POPULATION FORECASTING



College population = 10,000 Nos. Total population = 10,000 Nos.
Per capita sewage=80-85% of per capita water supplied According to IS 1172:1993(Re-Affirmed 2007)
*for an Educational Institution Water Demand (135 lpcd)
*per capita Sewage production= 85
100x 135 = 115 lpcd
Quantity of sewage = 115 x 10000
(24 x 60 x 60 x 1000)
$Qavg$ = 0.0133 = 0.0133 m3/sec
= 1149 kld
$Qavg$ = 1.149 mld
$Qavg$ = 47.875 m3/hr Peak factor=3 (CPHEEO manual 1991)
$Qmax$ = 0.0133 x 3 = 0.0399 m3/sec
$Qmax$ = 3.45 mld ≈ 3.5 mld
$Qmax$ = 47.875 X 3 4.1.4 DESIGN OF GRIT CHAMBER
$Qmax$ = 0.0399 $m3$/sec
Assume horizontal velocity as 0.2m/sec (<0.228m/sec)
Detention period = 1min=60sec
Length of grit chamber =velocity X detention time=0.2X60=12m
Area of grit chamber = discharge / velocity
=0.0399/0.2=0.19 $m2$ ≈ 0.2 $m2$
Provide width of chamber=1m
Depth=0.2 m
Provide 25% additional length to accommodate inlet and outlet zones (i.e. 1+((25/100) X1)=1.25)

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Length of grit chamber = 12 x 1.25 = 15m
Provide 0.3m free board and 0.25m grit accumulation zone depth Total depth = 0.2 + 0.3 + 0.25 = 0.75 m
Dimension of grit chamber = 15(L) x 1(W) x 0.75(D) m

4.1.5 DESIGN OF MOVING BED BIO-REACTOR

$Qavg$ = 1.149 mld
= 1149 kld Hydraulic retention time =2-3hr (assume 2hr)
Inlet water BOD =Yi=380ppm
Desired outlet BOD Yo=10ppm and Tss=10ppm
BOD due to SS=10ppm X0.8X0.68X1.42
=7.72ppm
BOD due to SS =SS in outlet X (MLVSS/MLSS) X0.68X1.42 Inlet BOD=300ppm
=143.62 m3/hr

4.1.2 DESIGN OF COLLECTION TANK

Retention time = 4hr
$Qavg$ = 47.875 m3/hr
Avg design flow = 47.875 m3/hr Capacity of collection sump = 4X 47.875
= 191.5 m3
Assume liquid depth=5m
Area required for collection pit = 191.5/5

4.1.3 DESIGN OF SCREEN CHAMBER

Assume
$Qmax$ = 0.0399 m3/sec
Shape of bar= MS Flat Size=10mmX50mm
Clear spacing between the bars =20mm Inclination=80*
Avg. velocity($Vavg$) = 0.8m/sec
At peak flow, net inclination area required= $Qmax$
$Vavg$
0.0399
=
0.8
=0.0498 $m2$
Gross inclined area = 0.0498 x 1.5
=0.0748 $m2$
Gross vertical area=0.0748 X sin80*
=0.0736 $m2$
Provide submergence depth=0.3m
Width of channel=(n X thickness) + (n-1) clear spacing No. of bars=
(n X0.10) +(n-1)0.20=0.60
N=20nos
Provide 20 nos bars of 10mmX50mmat clear spacing screen chamber will be 60mm wide
Liquid depth
=0.0736 = 0.12 m
0.60
Provide free board=0.3m
Total depth of screen chamber=0.3+0.12
=0.42 ≈ 0.45 m
Size of channel= 0.6(W) x 0.45(D) m
Total BOD applied =380 X 1149000
= 436620000 mg/day
= 436620000
1000 x 1000
= 436 kg
BOD loading rate =3kg/m3/day (by CPHEO manual)
Volume of MBBR tank = $Total\ applied\ BOD$
$BOD\ Loading\ Rate$
= 436 = 145 $m3$= 150 $m3$
3
Consider side water depth=4m
Area of MBBR tank=volume/depth=150/4=37.5 $m2$
Area = 37.5 $m2$
For better process performance MBBR tank should be 4 compartment Area of each compartment=38/4 = 9.5 m = 9.5 $m2$
Area = 2m (L) x 4.75 (B) m
Length of each MBBR compartment -1.8 m Width of each compartment = 5.3 m
Side water depth of each MBBR compartment=4+0.5=4.5m
Free board=0.5m
Dimension – No. of compartment=4 nos Each compartment=1.8 m x 5.3 m x 4.5m
Let surface area of media =350 $m2/m3$
Protected surface area=350 X 0.84 = 294 $m2/m3$
Media organic loading = (BOD loading rate/protected surface loading)
=3/294=0.01kg BOD/$m2$/day
Quantity of media required= $Total\ applied\ BOD$
($media\ required\ x\ given\ Surface\ area\ of\ media$)
Quantity of media required = 380
(0.01 x 350)
= 108.57 $m3$= 110 $m3$

4.1.6 DESIGN OF PRIMARY SEDIMENTATION TANK

$Qavg$= 0.0133 $m3$/sec Detention period=2 to 4hr
Capacity of the tank = Sewage flow X detention period
=0.0133 X (2 X 60 X 60)
Volume=95.76 $m3$= 96 $m3$
Let depth =4m Area =96/4=24 $m2$
$\pi D2$ = 24 =>D = 5.52 m ≈ 5.3 m
4
depth=4m
free board=0.5m total depth=4.5m
Dimension=5.3 m dia X 4.5m depth

4.1.7 DESIGN OF SECONDARY SEDIMENTATION TANK

$Qavg$= 0.0133 $m3$/sec Detention period=2 to 4hr

Capacity of the tank = Sewage flow X detention period n = Co-efficient of Roughness for pipes Minimum (Self - cleaning) velocity

For, Sanitary sewers = 0.6 m/sec Storm Sewer = 1.0 m/sec

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Maximum velocity

The Maximum velocity in the Sewer pipes should not exceed more than 2.4 m/sec.

Minimum Sewer Size

225 mm is taken as the minimum Sewer size.

6.1 DIAMETER OF SEWER

Discharge = area x velocity Q = A X V
0.0406 = A X 0.6 0.0406
0.6
$\pi D2/4$
= 0.0677 $m2$
D = 0.29 m
D = 0.30 m =300 mm
Selection of Sewer Material = UPVC Manning's constant (n) for UPVC Sewer = 0.01

6.2 SLOPE OF SEWER

According to IS 1172:1993

Minimum velocity = 0.6 m/sec

Use Manning's formula for determining slope
=0.0133 X (2 X 60 X 60)
Volume=95.76 $m3$= 96 $m3$
Let depth =4m Area =96/4=24 $m2$
$\pi D2$ = 24 =>D = 5.52 m ≈ 5.3 m
4
depth=4m
free board=0.5m total depth=4.5m
Dimension=5.3 m dia X 4.5m depth
Flow rate =1149 kld = 1149 $m3$/day Total BOD feed = 380 mg/l
Total bod at outlet =20 mg/l
Sludge generated per day = (1149 x 360)/1000
= 413 kg Solid content in the feed = 3% Specific gravity of the sludge = 1.015
413
Volume of sludge = 0.03
(1000 x 1.015)= 13 $m3$
For NHCE weather condition the bed gets dried out about 7 days No. of cycles per year = 365/7
Period of each cycles = 7 days
Volume of sludge per cycle = 13 x 7 = 91 $m3$
Spreading 1.3 m layer per cycle
Area of bed required required = 91/1.3= 70 $m2$
Hence, Sludge drying bed Dimensions = 10(L) X 7(W) X 1.3(D) m

5.1 FACTORS GOVERNING THE SELECTION OF SEWER PIPE MATERIALS

The Selection of material for the sewer pipe is governed by following factors:

- Carrying capacity of the Pipe.
- Durability, Strength and Life of the Sewer Pipe.
- Impervious and weight.
- Resistance to Corrosion and Abrasion.
- Type of Sewage to be conveyed and its possible corrosive effect on the Sewer Pipe material.
- Cost and availability of funds, maintenance cost and repairs, etc...,

DESIGN OF SEWER LINE

Discharge (Q) = Peak Sewage Flow + Infiltration (5% of average flow)
= 0.0399 + (6.65 x 10−4)
= 0.0406 $m3/sec$

DESIGN EQUATION

1) Manning's Equation is used for Sewers Flowing Under gravity
Where,
V = Velocity of flow in m/sec
R = Hydraulic mean depth (A) = D/P
S = Slope of the Sewer

V. RESULTS AND DISCUSSIONS

- The New Sewage Treatment Plant is designed for flow capacity of 3.5 MLD for a Design period of 10 years.
- The project is designed perfectly to meet the needs and demands of appropriate 10000 populations with a large time period.
- The Designed Treatment plant removes efficiently 95% BOD, 90% COD, 95% Total Solids, 98%colliform bacteria.
- The treated sewage is further used for toilet flushing, fire protection, lawn watering, gardening, pathway washing etc...,
- The sludge remaining in the tank are transferred to drying beds and converted to manure and used for gardening.
- The proposal for new sewage treatment plant is completed.
- The proposal of sewer line is completed.
- The Stormwater management for the campus is completed.

5.1 WASTEWATER SAMPLE TEST RESULTS COLLECTED AT OUTLET

1. pH 6.2 6.5-8.5
2. Turbidity NTU 117 15
3. Total Solids mg/l 102 500-2000
4. Chloride's mg/l 190 250-1000
5. Sulphates mg/l 35.4 250-400
6. Iron mg/l 0.2 0.3

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7. Total Alkalinity mg/l 170 200-600
8. Total Acidity mg/l 56 -
9. BOD mg/l 38 -
10. COD mg/l 25.6 -
11. Residual Chlorine mg/l 1.2 1-1.5
12. Total ColiformMPN/100 ml 0 0

VI. CONCLUSIONS

1. The ultimate goal of wastewater treatment is the protection of the environment in a manner commensurate with public health and socio-economic concerns.

2. Based on the nature of wastewater, it is suggested whether primary, secondary and tertiary treatment will be carried out before final disposal.

3. The project work has been carried out revolves around the analysis of the available waste- water treatment plant and the sewage characteristics at influent and effluent,

4. Comparing the values obtained from testings against the standard values of treated waste- water to keep a check over the disposal of effluent and sludge.

5. After comparing the values, the waste-water treatment plant failed to fulfill the desired outlet quality of water, so the STP is redesigned to meet the present and future wastewater treatment requirements of the college.

6. Taking into consideration the Indian Standards codes for the designing of various parts of the treatment unit the plant is redesigned for peak flow capacity of 3.5 MLD (Million Litres per Day) for the total population of college around 10K.

7. Taking into consideration of IS 1742:1983, IS 1742:1993, IS 4111:1986, CPHEEO Manual codes and IRC 50, the sewer line and Stormwater drain is designed.

8. The proper drainage for Stromwater runoff is designed for the college campus.

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