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Design of Sewer System for Holkarwadi Village by using Sewer GEMS Software

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Abstract: ***Globally there has been a massive increase in the population Numbers, especially in India the rate of Increase is on a higher side. To inculcate The rising population, cities expand giving Rise to urbanization. This calls for Provision of various basic public service Amenities such as water pipeline, drainage Pipeline, roads, street lights, etc. The Waste water collection/drainage system is One if the basic public service entities Needed to maintain proper hygiene in a Locality since sanitation is a primary Aspect of public health in a society. This Project aims at modelling a Geographical Information System (GIS) based waste Water drainage system using QGIS and Bentley SewerGEMS software. The Village situated in the southern eastern Region of the city of Pune, Holkarwadi was Selected as it has been recently included in City limits and therefore has a need of a Well-designed waste-water drainage System.***

Keywords: Drainage, GIS, SewerGEMS, Sewer

I. INTRODUCTION

There has been a drastic increase in the population and the rate of increase in the population in recent decades. Due to which there is an increase in urbanization and industrialization. The recent trends also show expansion of cities. When cities are expanded, there is a need to provide basic public service entities such as drinking water pipeline, sewer system, street lights, roads, etc. by the Municipality. One such public service entity is sewer systems which is an important entity in terms of public health and sanitation. It is also called as waste water collection system or drainage system. An efficient, sustainable and economical sewer system is what an engineer desires while planning, designing and constructing a sewer system. A sewer system is an underground infrastructure consisting of manholes and conduits primarily constructed for discharging the waste water or storm water from its point of occurrence to a point of safe disposal. In order to design such sewer system, modelling studies are needed to be undertaken. Modelling can be of two types physical and numerical. There are many software's in market which can help design a sewer system for example InfoWorks, MIKE Urban, EPANET, SWMM, etc. This project aims at constructing a GIS based numerical model of a sewer system and performing simulations using QGIS and Bentley SewerGEMS software. QGIS (until 2013 known as Quantum GIS) is a free and open-source cross-stage work area geographic data framework (GIS) application that backs review, altering, and examination of geospatial information. QGIS capacities as geographical information system (GIS) programming, permitting clients to dissect and alter spatial data, as well as forming and trading graphical guides. SewerGEMS is a completely powerful, multi-stage, sterile and consolidated sewer demonstrating arrangement. Designers can dissect sterile or joined movement sewer frameworks utilizing worked in water driven and hydrology instruments and an assortment of wet-climate adjustment techniques. From metropolitan sewer wanting to flood remediation investigation, to advanced best administration rehearses plans, SewerGEMS gives a simple to-utilize climate for specialists to dissect, plan, and work sterile and consolidated sewer frameworks. SewerGEMS furnishes utilities and wastewater experts with cutting edge designing devices to design, plan, keep up, and work clean and consolidated sewer frameworks.

II. LITREATURE REVIEW

There has been extensive amount of work hydraulic modelling software's for design and analysis of piped networks. Authors S .Prof. R.I Patel, Hinal Sopariya, Prof. Y.P Pathak have utilized GIS, CAD and SewerGEMS software for designing an economical sewer system. Naveen Kumar Rai in his paper has used AutoCAD and SewerGEMS to assess the existing sewer network system and accordingly suggest remedial measure for the network. Authors Shraddha Tiwari, Mangesh Bhorkar in their paper have also design a sewer system using SewerGEMS. Their paper talks about how modelling software are user friendly and less time consuming as compared to manual designing. Authors Nishant Sourabh, P. V. Timbadiya in their paper have performed the assessment of the hydraulic condition of SVNIT campus. They identify nodes and junctions of overflowing and have suggested necessary measures to be undertaken accordingly. Vimla Singh, L. K. Sinha and Ampa Ganga Bhavani in their have used Remote Sensing and Geographical Information System for analysis of a drainage network. The paper explains how RS and GIS techniques help design an efficient and a sustainable drainage network. The literature study indicates how a GIS based modelling of a sewer system can benefit the designer to make better decisions and policy forming prior to actual construction while making the process economical.

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III. AIM & OBJECTIVES

1) *Aim*: To design a sanitary waste water Drainage system using SewerGEMS.
2) *Objective*:
a) Population forecasting for next 30 Years.
b) Digitization of nodes.
c) Extract elevation values for nodes Using GIS.
d) Network creation (Nodes and links).
e) Boundary Conditions and Run Simulation.

IV. STUDY AREA

The village of Holkarwadi situated in the Southern-eastern region of Pune (18°26'23.32"N), (73°56'20.63"E) was Considered for this project. The reason of Selection of this village is as this village is Newly included in the Pune Municipal Corporation City limits. Therefore, there is A need to design a sewer system for the Village.



Fig.1 Study Area

V. METHODOLOGY

A. Population Forecast

The sewer system components are designed for a set number of years which is called its design period. The conduits have a design period for 15 years, the treatment plants for 30 years etc. Therefore, they are designed keeping in mind the population for the next 30 years. In this project, Census reports of 1991, 2001 and 2011 were referred for population data. The population forecasting was done accordingly using Arithmetic Method, Geometric Method and Incremental Increase Method.

B. Geometry Creation

The geometry consists of nodes (manholes), links (conduits/pipes) and outlet points. The background image was downloaded from Google Earth Pro. The image file was imported in Bentley SewerGEMS and scaled too real time. The nodes were digitized on this image file manually as per Central Public Health and Environment Engineering Organization (CPHEEO) Manual. The node shapefile created was exported as a raster file for working in GIS.

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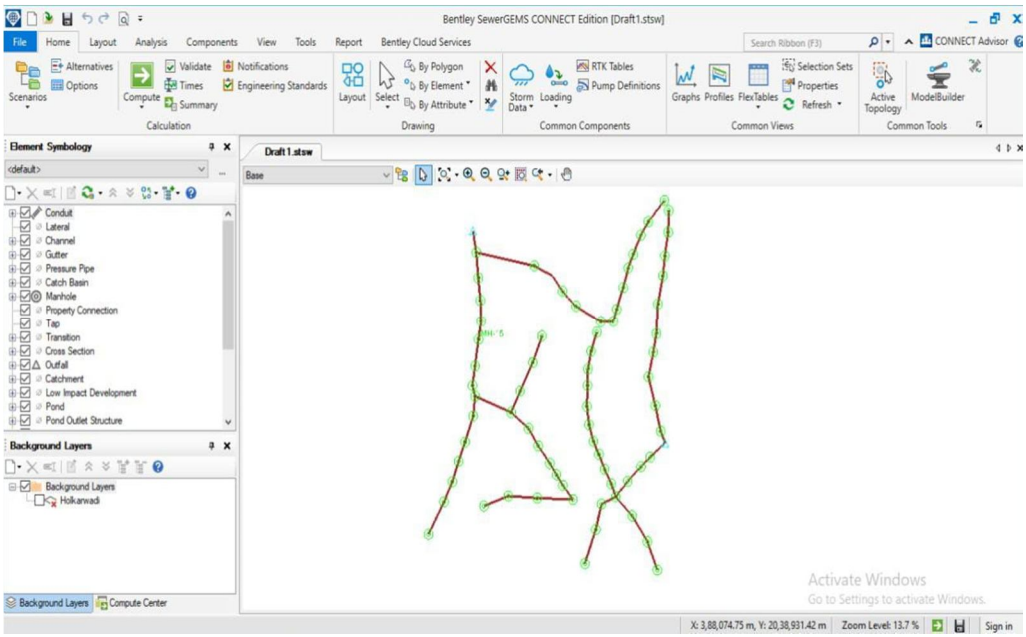


Fig.2 Network Creation

C. Elevation Values

The node shapefile was imported in QGIS. Cartoset-1 Digital Elevation Model for the Study area was downloaded from the Bhuvan.nrsc.gov.in website and was Imported in SewerGEMS. 'Sample Raster Value' tool of QGIS was used to extract Elevation values from the DEM. The tool Superimposes both shapefiles imported and Assigns the elevation values of the points on DEM where nodes are plotted.

D. Sanitary Loading

In the next 30 years the water demand can Increase from 135 liters per capita per day To 180-200 lpcd. The waste water is Assumed to be 80% of the water demand. Therefore, the sewer was designed for Approximately, 150 lpcd of waste water. A Hydraulic pattern for hourly usage Compensating for the fluctuations in usage Was also made. Further, simulation was run for a time Period of 24 hours.

VI. RESULT

A. Population Forecast Result

Table: Population Forecasting

Year	Population	Arithmetic
1991	1831	2021
2001	2355	2031
2011	2913	2041
Year	Geometric	Incremental
1991	3596	3488
2001	4437	4097
2011	5476	4740

Since, the region falls in DMIC (Delhi Mumbai Industrial Corridor) impact zones, Geometric increase method was adopted for population forecasting. Hence, 5476 people will be contributing to the system in the next 30 years.

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B. Simulation Summary:

After entering all the required data, simulation was run for a period of 24 hours. SewerGEMS will not successfully run the simulation until all the created network and input data is valid and appropriate.

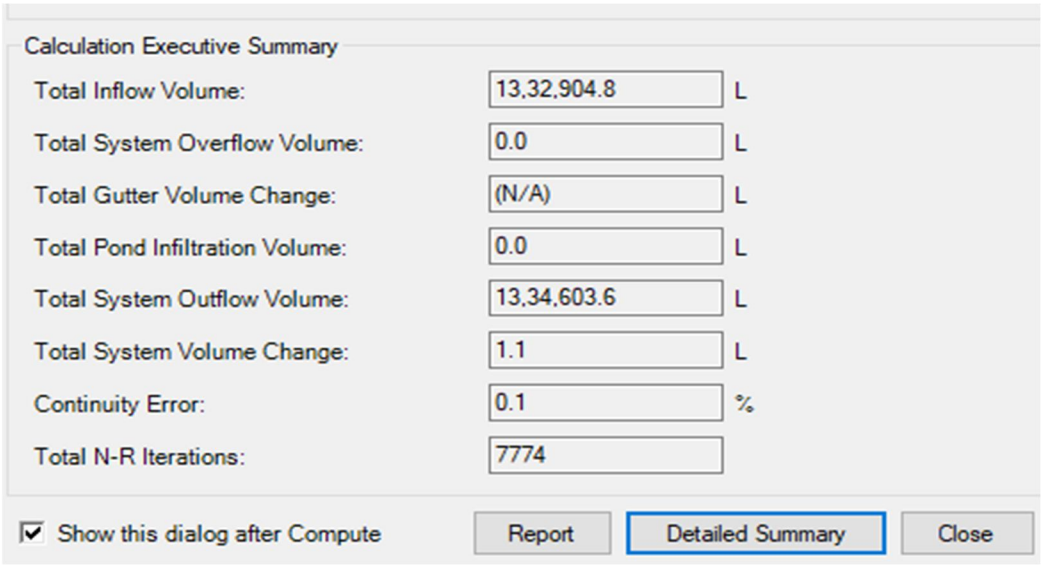


Fig.3 Calculation Summary

VII. DISCUSSION

The study area was demarcated using Google Earth Pro. It was exported as jpeg file and Imported in SewerGEMS and scaled Accordingly. The nodes were delineated as Per the CPHEEO Manual in SewerGEMS. The nodal shapefile was exported and Imported in QGIS. The elevation values for All the nodes was extracted from the DEM. The connection of links was done with Respect to the elevation values from higher Potential to lower potential as the flow in a Drainage system is always Freudian i.e., from A higher potential to a lower potential. The Sanitary loading was done with respect to Population data. Approximately 150 lpcd of Water will be contributed to the system and The simulation was run for this condition. After successful simulation, the flow Velocities were found to within permissible Limits i.e., minimum flow velocity 0.45 m/s At least once in a day to maximum flow Velocity of 3m/s to avoid scouring.

VIII. CONCLUSION

The study concludes by designing a waste water drainage system for the village of Holkarwadi using SewerGEMS. The design was done using the CPHEEO manual and keeping in mind it's guidelines as well. SewerGEMS manual was used for software training and help. Since, visit to the actual site and physical survey was not feasible, we have tried designing a drainage system as close as possible to the real time. SewerGEMS proved to be a user friendly and hassle free software for designing and running simulations. Since the design is GIS based open source QGIS and open source DEM's were used. These Remote Sensing tools and GIS techniques give us a better understanding of the study area without actually physically visiting. The hydraulic modelling software show us a real time behaviour of flow for the modelled infrastructure. This helps engineers in decision making and policy forming which directly make the project economical, sustainable and efficient by saving the resources.

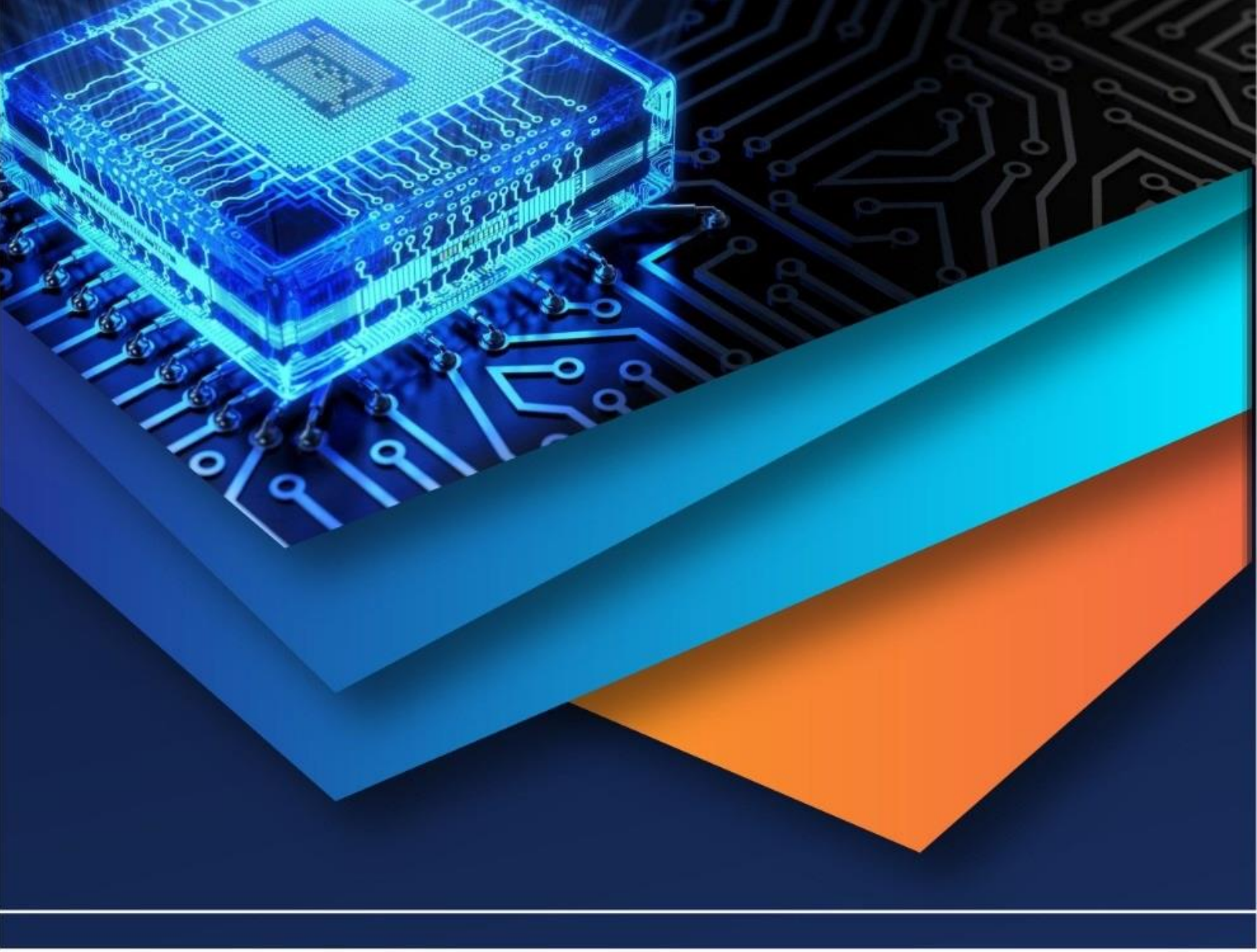
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