DESIGN ANALYSIS OF WATER SUPPLY SYSTEM THROUGHOUT WATERGEMS

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ABSTRACT

WaterGEMS software developed by Bentley Systems enables engineers and planners for network designing and operating the water distribution network of area, and operate water distribution systems. This software uses hydraulic modeling techniques to simulate water flow and pressure in the system, which allows engineers to optimize its performance and efficiency. In this research paper we focused on design of water distribution network in system through WaterGEMS, various steps are followed, including data collection, model creation, calibration, scenario analysis, design, and implementation. WaterGEMS is tool used for improving the performance of water systems, resulting in improved water quality, reduced energy consumption, and cost savings.

Keyword: *WaterGEMS, water supply system, design, analysis, pipelines, pumps, tanks, valves, pipe diameter, etc.*

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1. INTRODUCATION

To design and analyze of a water supply system is a critical task that requires careful consideration of a wide range of factors, including population size, water demand, terrain, soil type, and climate. The use of advanced software tools, such as WaterGEMS, can help streamline the design and analysis process by providing a detailed and accurate model of the water supply system. This model can be used to evaluate the performance of the system under different scenarios, identify areas where improvements can be made, and optimize the overall design for maximum efficiency and reliability. In this context, this project aims to provide an overview of the methodology used to design and analyze a water distribution supply system through WaterGEMS software, as well as the results and conclusions that can be drawn from this process. The ultimate goal of this project is to promote public health and ensure sustainable access to clean water by designing and analyzing efficient and reliable water supply systems.

Water makes up 71% of the earth's surface, approximately 3% of which is fresh water, making it essential for all life forms. Rivers, lakes, and other water bodies make up only 5% of fresh water supplies. It has becoming more challenging to obtain a consistent supply of fresh water due to the rising population. On earth, there are almost billion of people drink water without access to clean it . It's critical to maximize supply and minimize waste given the severe water issue that the ever-expanding world faces. Urban water distribution systems' delivery function is crucial. Industries use a variety of software, including Winder, WaterGEMS, Synergy, SWMM, and others.

Water distribution systems (WDSs) distribute water to users as their primary duty. This objective still takes precedence over the company's other goals, but modern water operators work to meet it as effectively as possible. Operators must do a number of tasks, sometimes simultaneously, to ensure optimal operation. As a result, multi-criteria optimization techniques are frequently used to help decision-making processes. Its Connecting minor layout of water supply networks into group systems will significantly improve the conditions under which WDSs operate. Among the various potential solutions. It supports maintenance and management of WDSs, those tools which can automatically determine the best solution through the implementation of strategies which use for guiding search process methods, such as the deserve special attention.

1.1 History of WaterGems

WaterGEMS is a software tool developed by Bentley Systems that is used for the analysis and design of water distribution networks.

WaterGEMS is a software tool developed by Bentley Systems that is used for the analysis and design of water distribution networks. The first version of the software was released in 2004, but its origins date back to the 1980s.

In the early 1980s, a team of researchers at the University of Kentucky began developing a software tool called KYPIPE to model water distribution network.

In 1997, Haestad Methods, a software company focused on water resources engineering, acquired KYPIPE and began to further develop and improve the software In 2002, Haestad Methods was acquired by Bentley Systems, a global software company specializing in infrastructure design and engineering.

2. Literature Review

1.Tewelde Berhane and Tamru Tesseme. Optimization of water distribution system through waterGEMS
In Wukro town Ethiopia. The method they adopt is Description of study area. Wukro water supply system. Non-revenue water. Model calibration optimize pipes pump. The results they got are Evaluation in water distribution system. Optimize diameter.

2.Darshan Mehta and Sanchita Yadav. Design of optimal water distribution system using waterGEMS.

In case study of surat city. The method they adopted was Using Bentlys waterGEMS software. Encoding of input data. Network configuration. Hydraulic network simulation. The results are in surat (Punagam) area pressure flow and the velocity have been calculate.

3.Ms.P.S. Salunke, Ms.M.M. Dumane, Ms. S.P. kamble and Mr. O.S. Nalvade. Water distribution network by using waterGEMS software using Bentlys software.

The adopted method was Analyzing and existing water distribution system of Surat area using Bently waterGEMS software of (Bakhoripahat) The final results are to design water distribution network of Bakori area.

4.A.G. Chaudhari, Anushi Joshi, Nilima Bhosale and Nishigandha Dalavi.

Experiment investigation by waterGEMS software for redesign of water distribution system by Bhavani Mata ESR. Adopted method was Software algorithm used solution on the gradient method gives using software creating network using model building transfer existing data network. and the results are The design which have been made using software give result of minimum head loss and economical diameter.

5.Dessalegn Geleta Ebsa and Fekadu Fufa.

Hydraulic performance analysis of water supply distribution network using waterGEMS v8i. The method they adopted was Hydraulic Model are used to validate the design of water distribution network. The results are Among different techniques of population projection method the study analyzed the minimum error and used arithmetic methods of population.

6.Nikita Adhav, Aishwarya and Sasane Arpan Deshmukh distribution network using waterGEMS software.Analysis and redesign of 24/7 water Adopted Method was System layout, data entry used GIS and surveying fields with help of engineers and water supply system staff. The results of the paper is Analysis using GEO information technology and waterGEMS was carried out with the basic objective water in Nighoj Village.

3.Methodology

Steps for simulation Exercise

Selection of Drawing Model Units:

Here in this project water distribution network for Wadhamna Nagpur has been modeled using waterGems software. From the model all required parameters were determined.

3.1 Lay – out the network:

Using background file to layout a pipe network. First open the background and start layout the pipes according to the background.

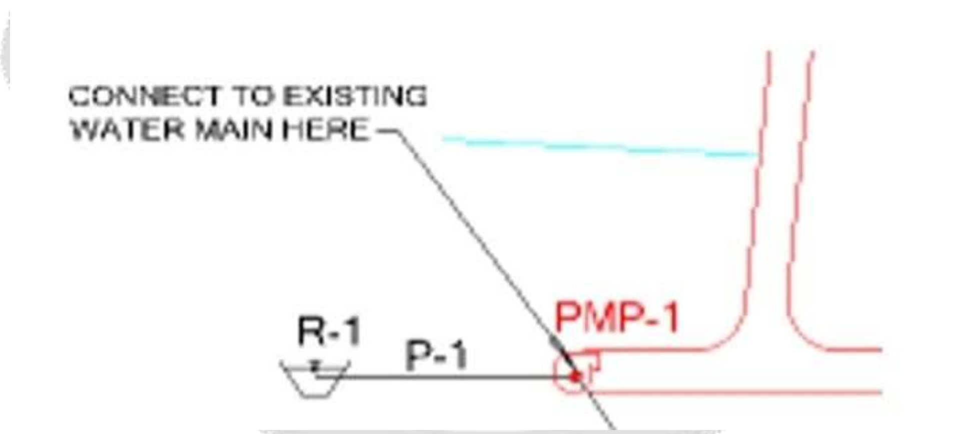

Fig 3.1

3.2 Entry and Modify data for different elements:

To access an element's property editor in WaterGEMS using following data

- Property Editor
- Flex Tables
- User Data Extensions
- Alternative Editors

3.3 Run a steady state analysis:

It is use for calculation options managers. Calculation Options under steady state/EPS solver heading for opening the proper editor. And its make sure that the time analysis of steady state.

Selecting the area which is to be analyzed. The below figure shows the area wadhamna which have been selected for hydraulic design.

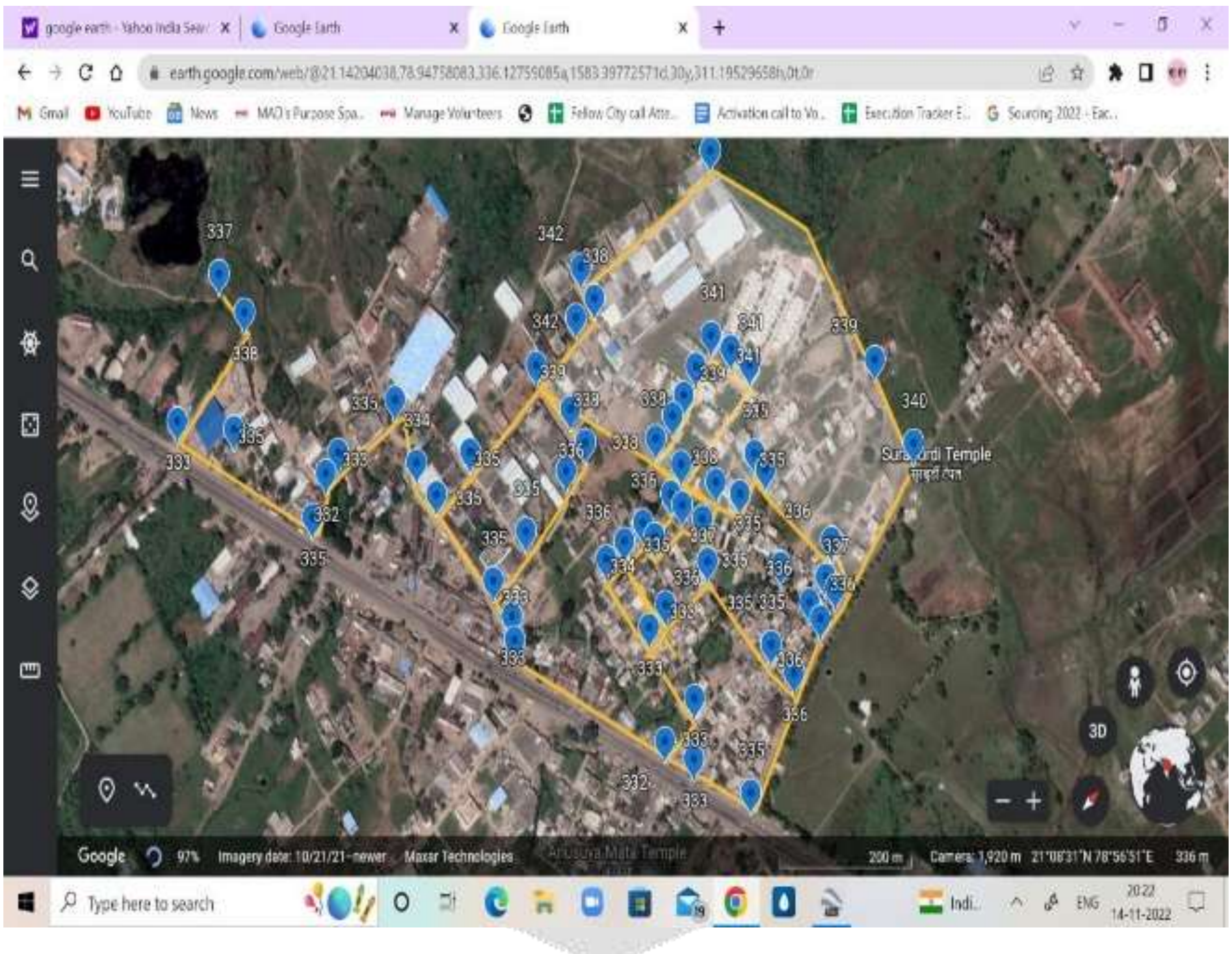

Fig 3.2

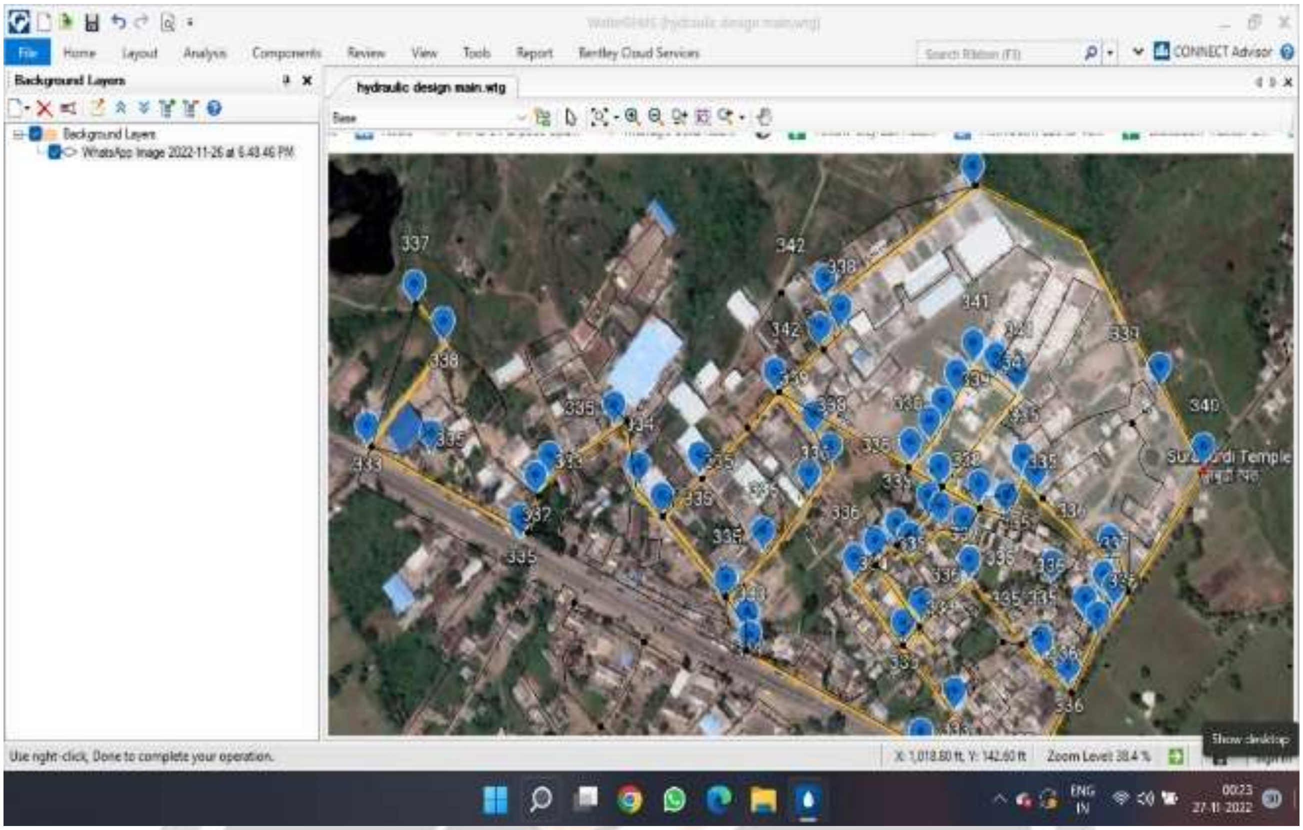

Fig 3.3

The methodology for designing and analyzing a water supply system through WaterGEMS software involves data collection and analysis, system design, calibration, system analysis, system optimization, and ongoing monitoring and maintenance. This process is repeated until the system is operating at peak efficiency and providing safe, reliable access to clean water.

Steps:

Step 3.1.1: Reservoir

Reservoir is consider as a main point from where the pipes and nodes will be drawn in Water GEMS software. Where elevation and flow direction were taken automatically from the input parameters by software.

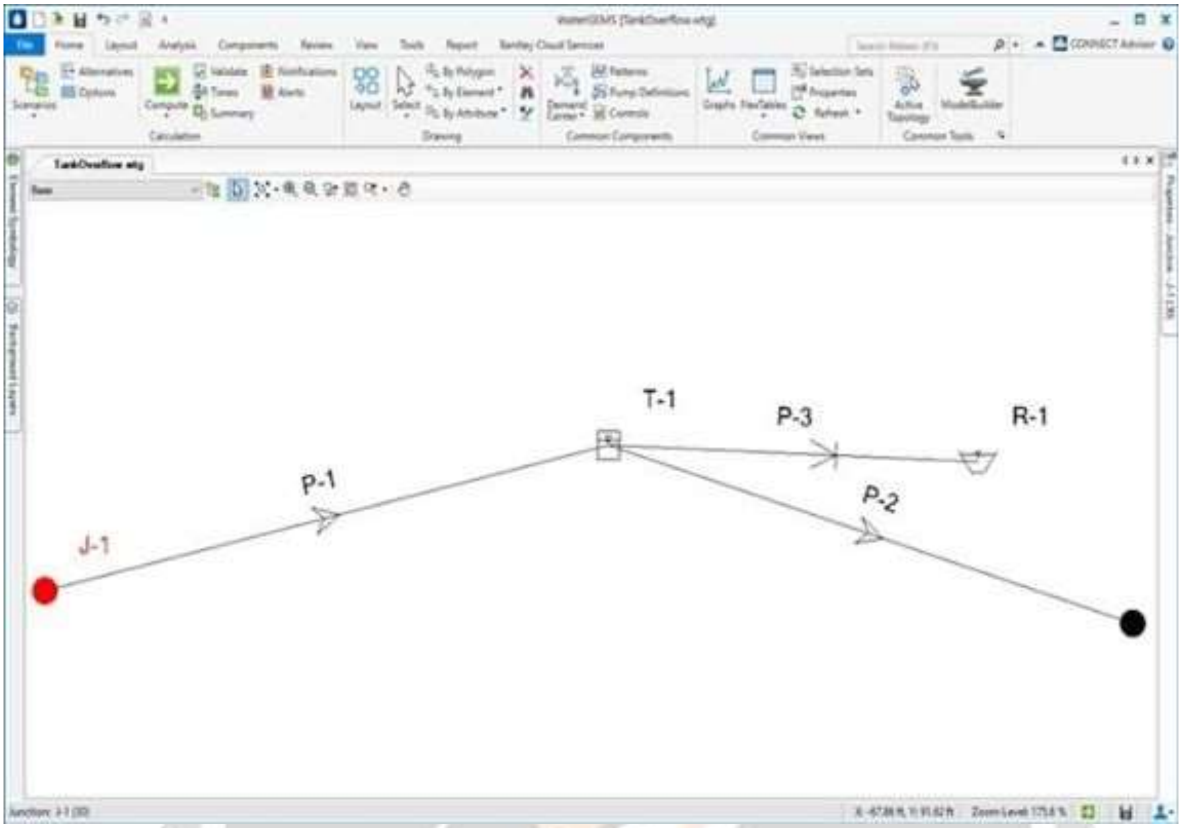

Fig 3.1.1

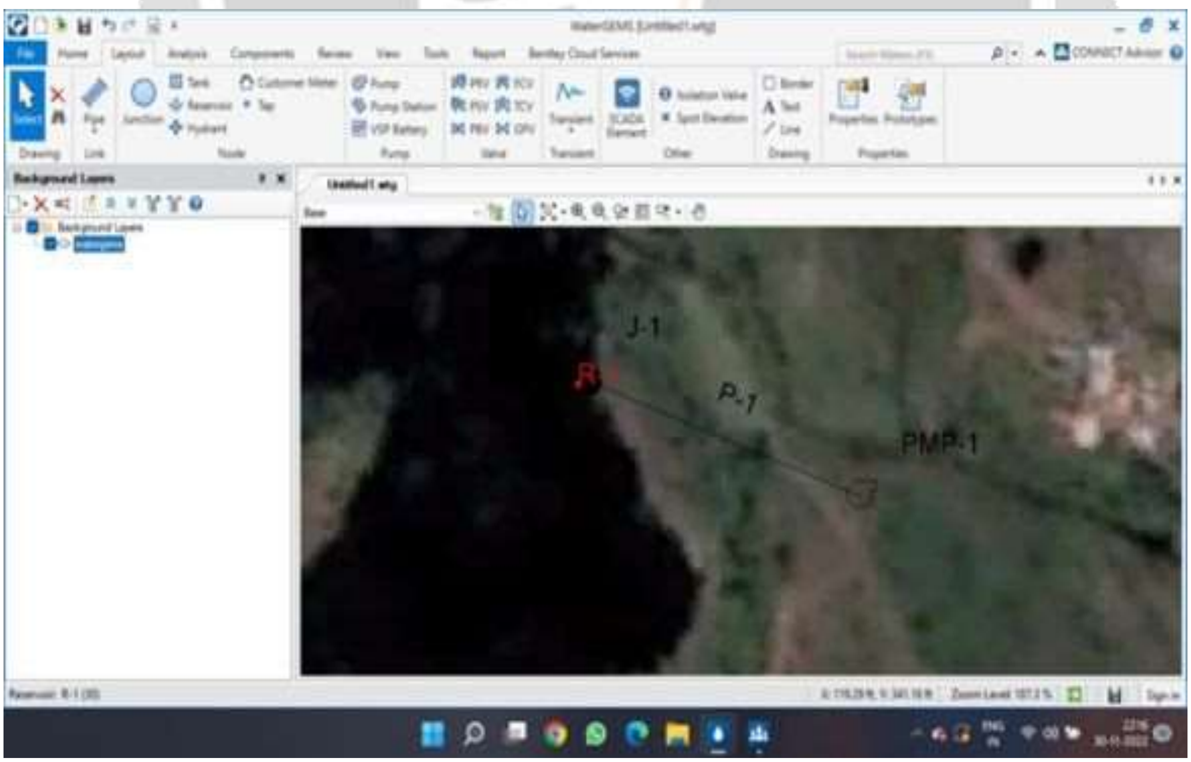

Fig 3.1.2

Reservoir location in Software

Figure shows the reservoir location in software it is a source of water have been used for further water supply in pipe line designing of model.

Step 3.2.1 Pump

Reservoir is connected to pump. A water distribution network are generally helps to increase the water pressure and flow rate, which allows the water to travel through the network and reach its intended destination. It supply continuous water in majority of the area through gravity.

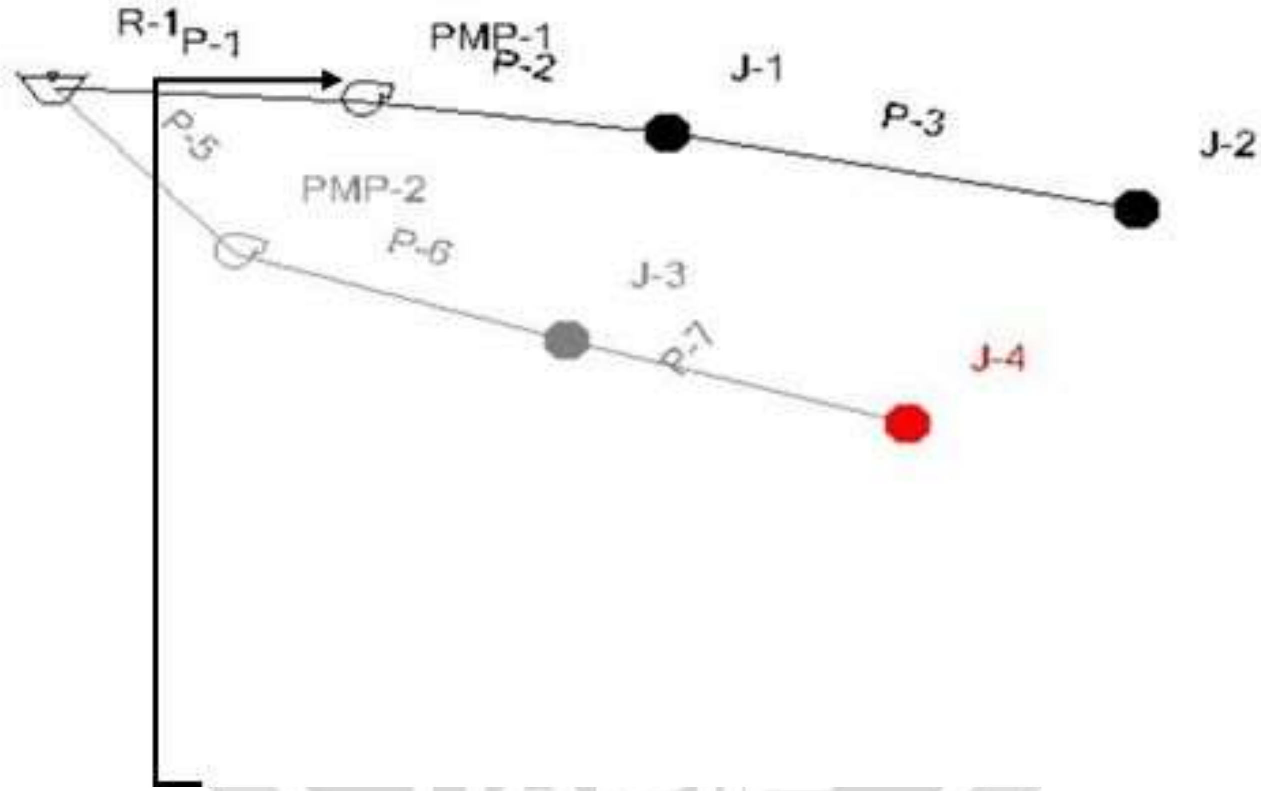

Fig 3.2.1

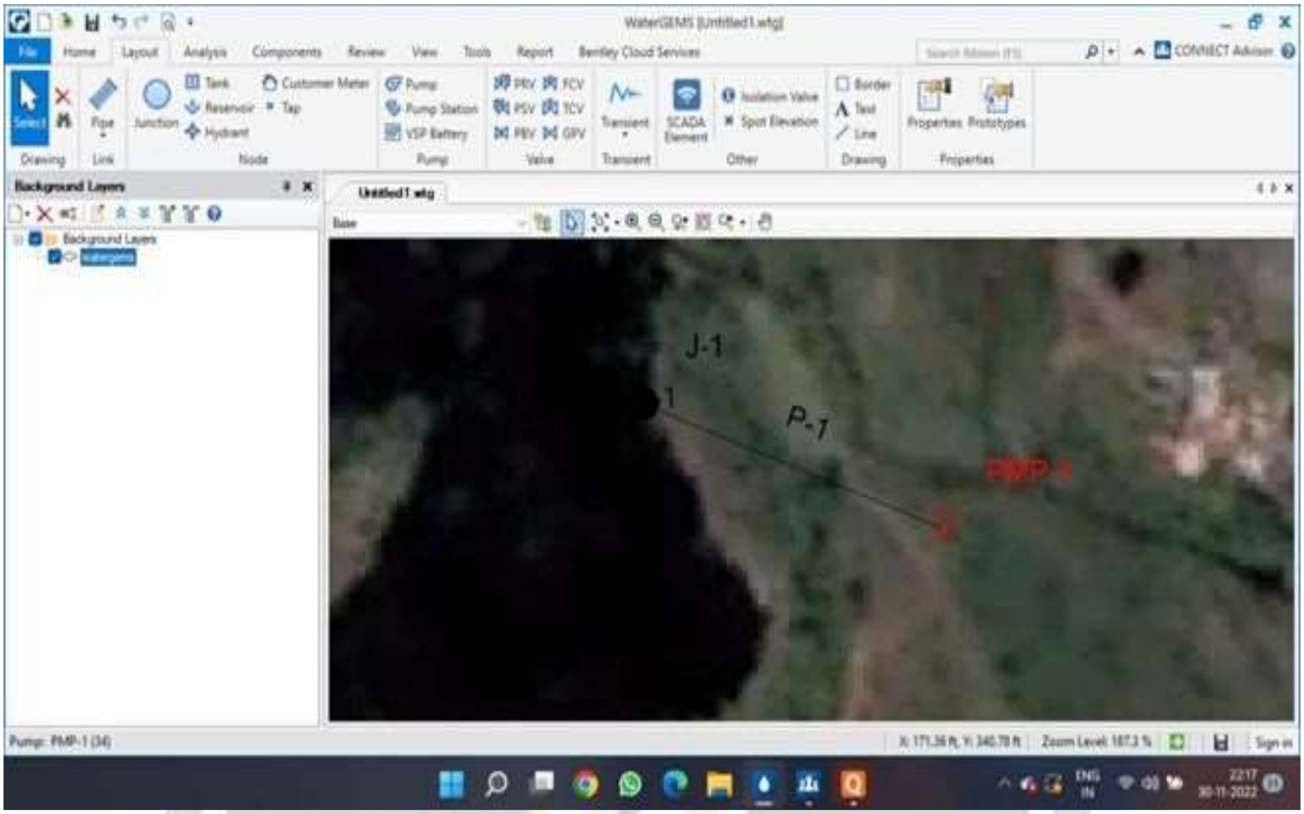

Fig 3.2.2

Pump Location in software.

A centrifugal pump has been provided to take water from reservoir and to provide water to tank.

Figure shows the location of the pump in software which have been used to supply water from reservoir to the tank Pressure Safety Valve have been given to avoid over pressurization and potential process safety incidents.

Step 3.3.1 PSV Pressure Safety Valve

The pressure safety valve works by automatically opening when the pressure in the network exceeds a certain setpoint, releasing excess pressure and preventing it from causing damage or safety hazards.

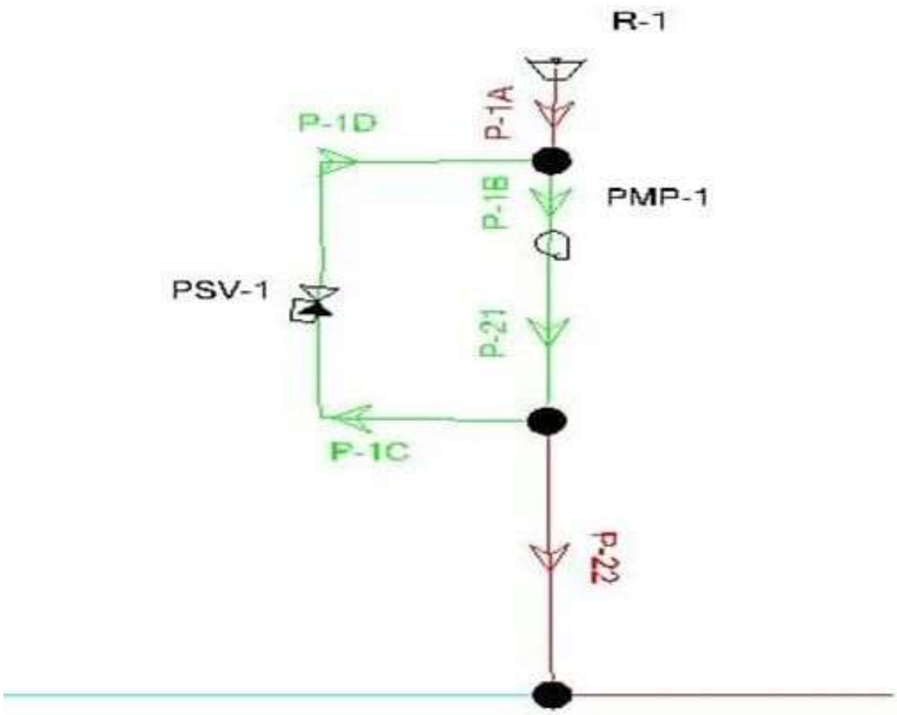

Fig 3.3.1

Pressure Safety Valve (PSV)

Step 3.4.1 Tank

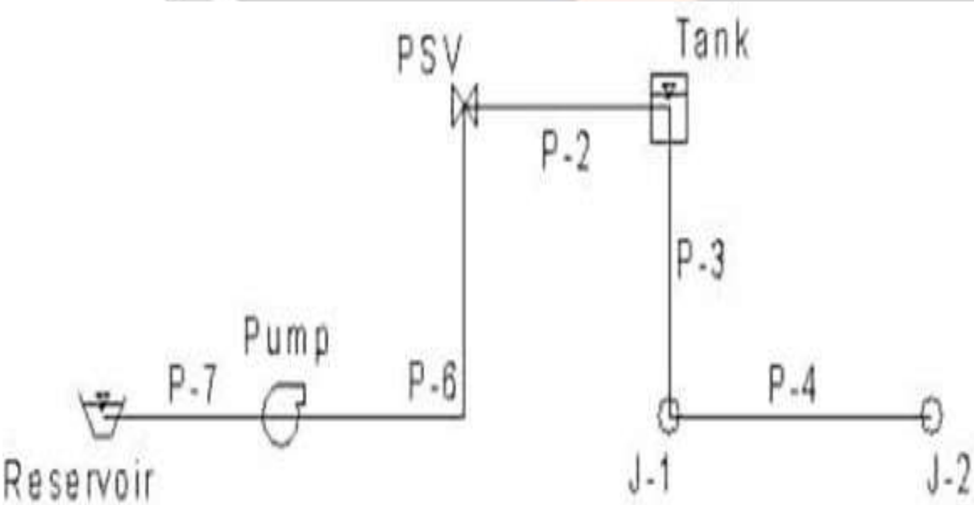

Fig 3.4.1

An overhead tank is filled with water from reservoir using centrifugal pump. The water is then distributed to consumers through pipelines that are connected to the tank's outlet valve. A tank with capacity of 2 lakh 50,000L has been provided.

Step 3.5.1 Pipe line Designing

Below Figure Contain a pipeline is a system that consists of pipes, fittings (valves and joints), pumps.

Each implemented task is represented by a stage of the pipeline. The design and oversee the construction of pipelines for transporting water.

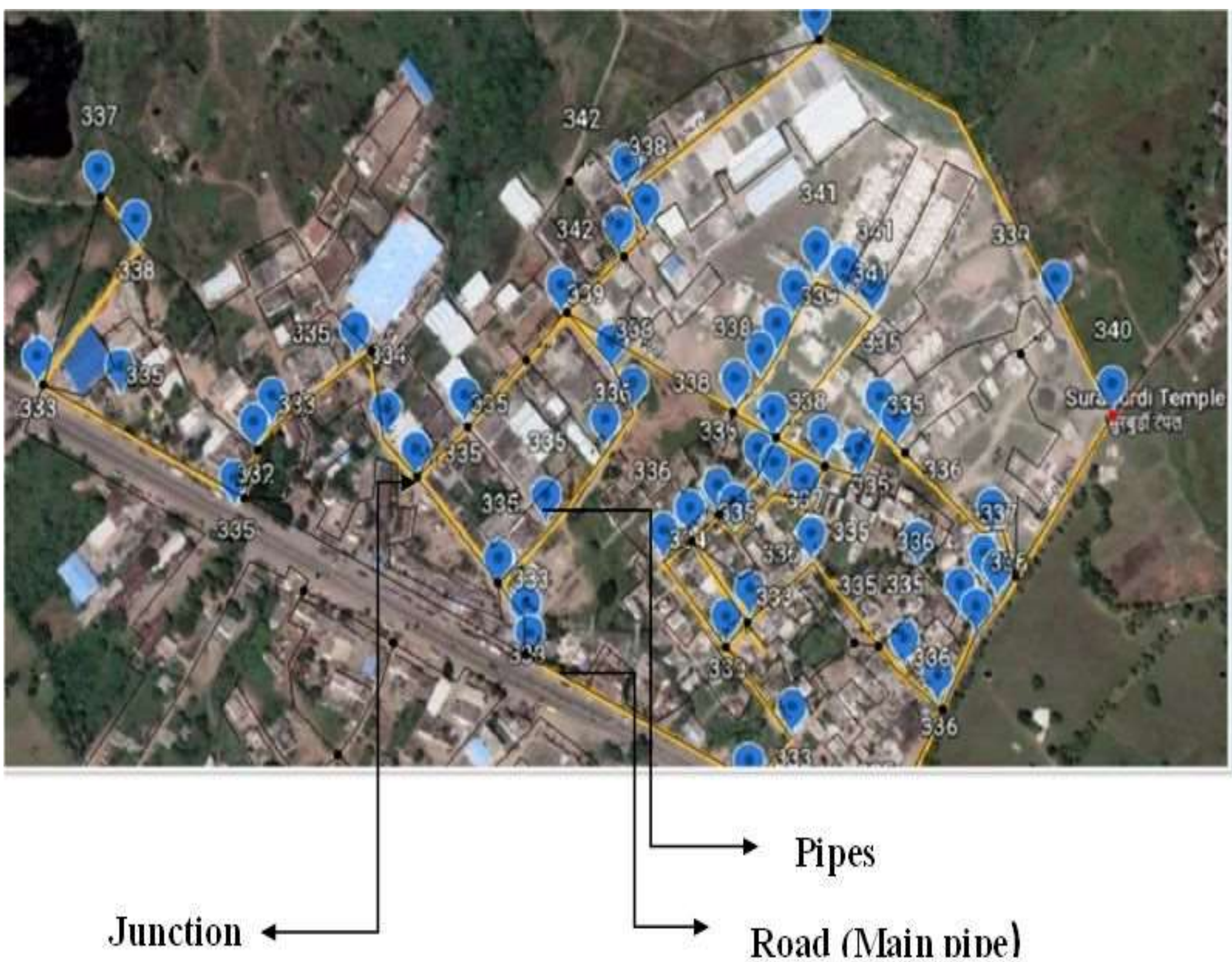

Fig 3.5.1

Pipe Line Network

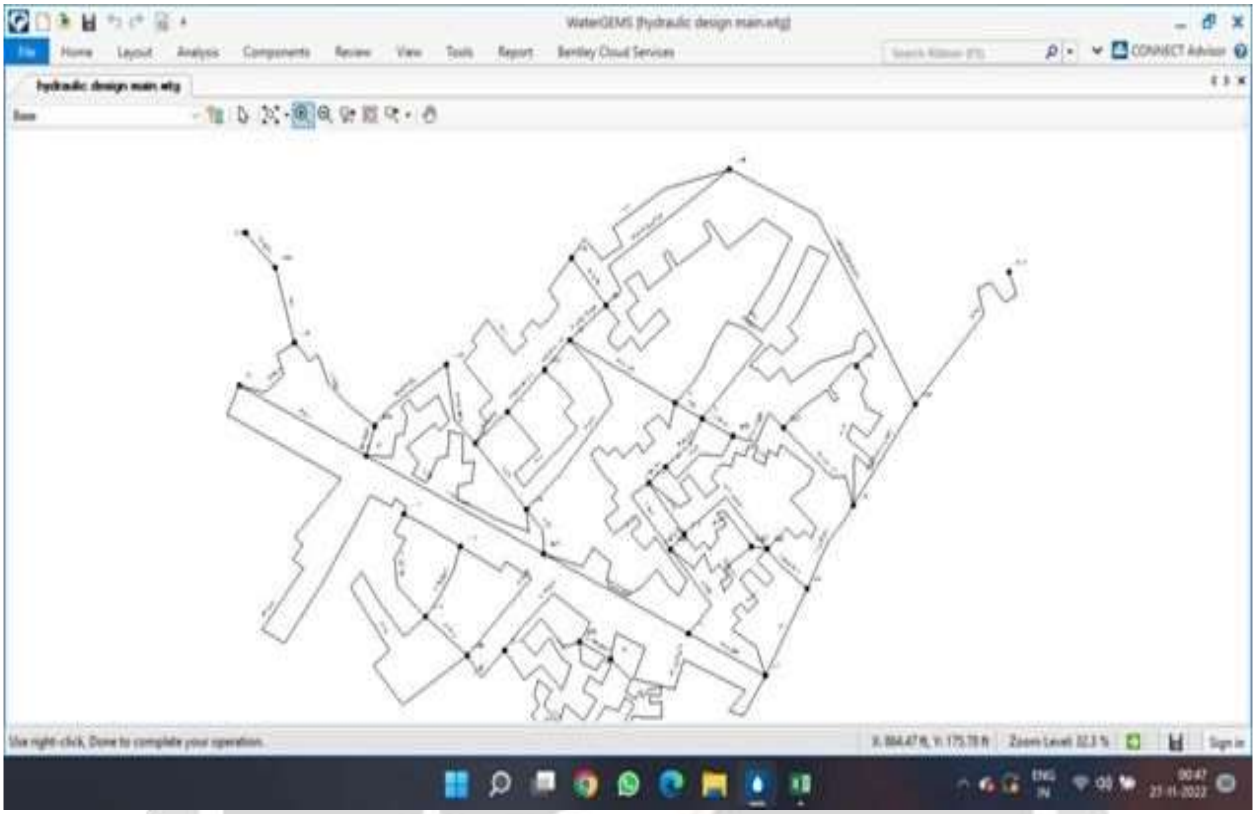

Fig 3.5.2

Fig Shows the pipe line design without background of area for which waterGems software have been use. It determines the optimal layout and size of the pipelines that transport water from the source to the consumers. The design process involves a thorough analysis of factors such as water demand, pressure requirements, topography, and environmental consideration.

4. Result

Hydraulic Model Inventory: hydraulic design main.wtg

Scenario Summary

ID	1
Label	Base
Notes	
Active Topology	Base Active Topology
Physical	Base Physical
Demand	Base Demand
Initial Settings	Base Initial Settings
Operational	Base Operational
Age	Base Age
Constituent	Base Constituent
Trace	Base Trace
Fire Flow	Base Fire Flow
Energy Cost	Base Energy Cost
Transient	Base Transient
Pressure Dependent Demand	Base Pressure Dependent Demand
Failure History	Base Failure History
SCADA	Base SCADA
User Data Extensions	Base User Data Extensions
Steady State/EPS Solver Calculation Options	Base Calculation Options
Transient Solver Calculation Options	Base Calculation Options

Hydraulic Summary

Time Analysis Type	Steady State	Use simple controls during steady state?	True
Friction Method	Hazen-Williams	Is EPS Snapshot?	False
Accuracy	0.001	Start Time	00:00:00
Trials	40	Calculation Type	Hydraulics Only

Fig 4.1.1

Hydraulic Model Inventory: hydraulic design main.wtg

Title	
Engineer	
Company	
Date	26-11-2022
Notes	

Scenario Summary

ID	1
Label	Base
Notes	
Active Topology	Base Active Topology
Physical	Base Physical
Demand	Base Demand
Initial Settings	Base Initial Settings
Operational	Base Operational
Age	Base Age
Constituent	Base Constituent
Trace	Base Trace
Fire Flow	Base Fire Flow
Energy Cost	Base Energy Cost
Transient	Base Transient
Pressure Dependent Demand	Base Pressure Dependent Demand
Failure History	Base Failure History
SCADA	Base SCADA
User Data Extensions	Base User Data Extensions
Steady State/EPS Solver Calculation Options	Base Calculation Options
Transient Solver Calculation Options	Base Calculation Options

Network Inventory

Pipes	66	Pump Stations	1
Laterals	0	Variable Speed Pump Batteries	0
Junctions	49	PRV's	0
Hydrants	0	PSV's	1
Tanks	1	PBV's	0
Reservoirs	1	FCV's	0
Customer Meters	0	TCV's	0
Taps	0	GPV's	0
SCADA Elements	0	Isolation Valves	0
Pumps	1	Spot Elevations	0

Transient Network Inventory

Turbines	0	Rupture Disks	0
Periodic Head-Flows	0	Discharges to Atmosphere	0
Air Valves	0	Orifices Between Pipes	0
Hydropneumatic Tanks	0	Valves With Linear Area Change	0
Surge Valves	0	Surge Tanks	0
Check Valves	0		

Fig 4.1.2

Flex Table

Sr no.	Id	Label	Length	Start Node	Stop Node	Diameter	Min velocity	Max velocity	Gradient
1	32	P-1	382	R-1	J-2	110	0.33	0.33	0.05
2	36	P-3	98	J-3	J-4	110	0.23	0.23	0.05
3	38	P-2(1)	230	J-2	J-5	90	0.034	0.034	0.05
4	43	P-2(2)(2)	235	J-6	J-3	90	0.21	0.21	0.05
5	53	P-4(1)(1)(1)	98	J-4	J-9	75	0.035	0.035	0.05
6	60	P-7(2)(1)	247	J-10	J-11	90	0.36	0.36	0.05
7	61	P-7(2)(2)	134	J-11	J-8	90	0.04	0.04	0.05
8	62	P-8	35	J-10	J-11	75	0.056	0.056	0.05
9	65	P-5(2)	110	J-12	J-6	90	0.074	0.074	0.05
10	69	P-5(1)(2)	21	J-13	J-12	90	0.25	0.25	0.05
11	72	P-9(2)	93	J-14	J-12	75	0.068	0.068	0.05
12	73	P-10	64	J-13	J-14	6	0.12	0.12	0.05
13	75	P-9(1)(1)	70	J-10	J-15	75	0.046	0.046	0.05
14	76	P-9(1)(2)	25	J-15	J-14	75	0.23	0.23	0.05
15	79	P-7(1)(2)	39	J-16	J-10	90	0.15	0.15	0.05
16	80	P-11	102	J-15	J-16	90	0.072	0.072	0.05
17	84	P-12(1)	125	J-2	J-18	75	0.23	0.23	0.05
18	87	P-12(2)(1)	81	J-18	J-19	75	0.33	0.33	0.05

40	122	P-22	132	J-21	J-27	110	0.09	0.09	0.05
41	124	P-23	250	J-28	J-9	75	0.045	0.045	0.05
42	126	P-24	83	J-5	J-29	75	0.015	0.015	0.05
43	127	P-25	256	J-29	J-24	90	0.21	0.21	0.05
44	130	P-4(2)(2)	31	J-30	J-5	75	0.25	0.25	0.05
45	131	P-26	238	J-2	J-30	75	0.31	0.31	0.05
46	133	P-4(2)(1)(1)	89	J-7	J-31	90	0.12	0.12	0.05
47	134	P-4(2)(1)(2)	102	J-31	J-30	75	0.056	0.056	0.05
48	135	P-27	209	R-1	J-31	75	0.079	0.079	0.05
49	138	P-28(1)	150	J-13	J-32	75	0.09	0.09	0.05
50	139	P-28(2)	187	J-32	J-12	90	0.23	0.23	0.05
51	140	P-29	17	J-26	J-32	75	0.16	0.16	0.05
52	142	P-16(1)	359	J-7	J-33	75	0.089	0.089	0.05
53	143	P-16(2)	61	J-33	J-21	110	0.05	0.05	0.05
54	146	P-4(1)(1)(2)	217	J-34	J-21	90	0.18	0.18	0.05
55	147	P-13	248	J-33	J-34	90	0.065	0.065	0.05
56	149	P-15(1)	64	J-20	J-35	75	0.32	0.32	0.05
57	152	P-15(2)(1)	152	J-35	J-36	75	0.06	0.06	0.05
58	154	P-31	290	J-35	J-36	75	0.045	0.045	0.05
59	156	P-15(2)(2)	40	J-36	J-37	90	0.12	0.12	0.05
60	157	P-32	343	J-37	J-3	90	0.31	0.31	0.05
61	158	P-4(1)(1)(2)	126	J-36	J-37	90	0.23	0.23	0.05

a result of a water supply system design and analysis through WaterGEMS software typically involves an optimized system design that meets the water demands of the area and provides reliable access to clean water. The system's performance is analyzed under different scenarios, and recommendations are made to improve its efficiency and reliability. The final result is water supply system that is optimized to meet the specific needs of the area and is capable of providing reliable access to clean water.

4. CONCLUSIONS

In water distribution network of waddhamna region. Designing and analyzing a water supply system through WaterGEMS software involves a systematic and data-driven process that considers the specific needs and conditions of the area. The process includes data collection and analysis, system design, calibration, system analysis, system optimization, and ongoing monitoring and maintenance. By following this process, it is possible to optimize the water supply system design to meet the needs of the area and provide reliable access to clean water. Ongoing monitoring and maintenance are necessary to ensure the system continues to operate at peak efficiencyand provide safe, reliable access to clean water. Ultimately, the design and analysis of a water supply system through WaterGEMS software can play a crucial role in promoting public health and ensuring sustainable access to clean water.

Tank capacity is of 2 lakh 50 thousand, Tank height 12 m above from ground

Pump- Centrifugal pump

Pipe-HDPE pipe

Total area pipe line - 3.75 km (12,230 ft)

Diameter 110,75,90, Junction -49

5. REFERENCES

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