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Design of Water Distribution System for Irrigation in Adarshnagar Village Using Storm water Harvesting Technique in WaterGEMS Software.

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Abstract- This project tackles the challenge of water scarcity in Adarshnagar Village by proposing a sustainable and efficient irrigation system built around storm water harvesting techniques. We'll begin by assessing the village's current water situation, analyzing existing irrigation practices, traditional water sources and their limitations, and the village's specific water needs.

The heart of the project lies in designing a system to capture rainwater runoff, a valuable resource that often goes to waste. We'll consider the average annual rainfall in the region, Adarshnagar's topography, and the most effective methods for rainwater collection and storage. To ensure efficient water distribution, we'll leverage the power of Watergems software. This tool allows us to create a detailed model of the entire irrigation system. We can virtually map the network of pipes and channels that will distribute the harvested rainwater throughout the village, optimizing the flow and ensuring each field receives its fair share. The model will also be instrumental in identifying potential bottlenecks or pressure imbalances before construction begins, allowing for proactive adjustments.

The successful implementation of this project will transform Adarshnagar Village. Farmers will have access to a reliable and sustainable source of irrigation water, reducing dependence on dwindling resources and promoting water conservation practices. By utilizing rainwater, a readily available yet often overlooked resource, the project fosters environmental sustainability.

Keywords - Water scarcity, Adarshnagar Village, Storm water harvesting, Watergems software,
Water distribution system, Network modelling

INTRODUCTION

Water scarcity is a growing problem in many communities around the world, including Adarshnagar Village. Traditional irrigation methods, which rely on depleting groundwater reserves or straining existing water sources, are becoming increasingly unsustainable. This project proposes a sustainable solution: a meticulously designed irrigation system that utilizes storm water harvesting techniques. This collected water can then be used for irrigation, reducing reliance on freshwater sources. WaterGEMS software is a hydraulic modelling tool that can be used to design, optimize, and analyse water distribution systems. In the context of this project, WaterGEMS software would be used to model the proposed storm water harvesting system and ensure that it meets the irrigation needs of the village. The software would take into account factors such as the amount of rainfall, the size of the collection area, the water demands of the crops, and the topography of the village. By using WaterGEMS software, the designers of the irrigation system can ensure that it is efficient and effective

AIM

To study and analysis of Watergems software to providing water for the irrigation of crops in Adarshnagar village

OBJECTIVE

1. To study the geography of the Adarshnagar
2. To study the watergems software
3. To study the irrigation systems
4. To study the storm water harvesting systems
5. To study the water distribution system
6. To design water distribution network in watergems software

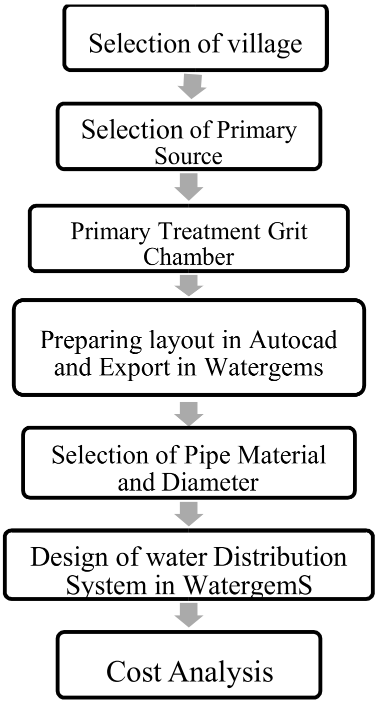
PROBLEM STATEMENT

1. Providing Sufficient Water for Deficient Agricultural Fields:

This statement highlights a common issue faced in adarshnagar village, where certain fields suffer from water deficiency, which can severely impact crop yield and quality

2. Creating an Efficient Water Distribution System using Watergems Software: Water distribution systems are crucial for managing water resources effectively, especially in agriculture where water is a critical input.

METHODOLOGY



Water Distribution System Design Methodology for Adarshnagar Village

1. Data Collection and Analysis:

- Village Information: Gather details about Adarshnagar, including population size, water consumption patterns (residential, commercial, industrial), and existing infrastructure (wells, storage tanks, if any).
- Bharangi Nadi Details: Collect data Bharangi Nadi's flow rate, water quality parameters (turbidity, presence of debris), and any seasonal variations.on

2. Software :

- AutoCAD: Procure or use a licensed version of AutoCAD software for creating the water distribution network layout.
- WaterGEMS: Obtain a licensed copy of WaterGEMS hydraulic modelling software for simulating water flow and pressure within the designed network.

3. Primary Treatment Design:

- Grit Chamber Sizing: Based on Bharangi Nadi's flow rate and expected sediment load, determine the appropriate dimensions for the grit chamber using standard design guidelines or consulting a water treatment engineer.

4. Water Distribution Network Layout in AutoCAD:

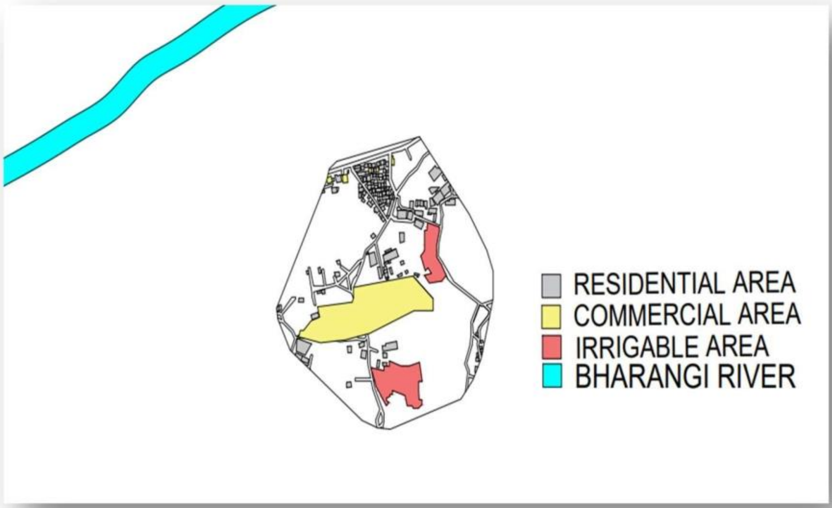
- Base Map Creation: Using Google Maps or high-resolution satellite imagery, create a base map of Adarshnagar village in AutoCAD. Ensure the map is scaled accurately and includes all relevant landmarks (roads, buildings).
- Network Design: Plan the layout of the water distribution network on the base map. Consider factors like population density, consumer locations, and future expansion needs. A looped network design is generally preferred for better redundancy and pressure management.
- Pipe Diameters: While 150mm HDPE pipes are specified, you might need to optimize the pipe diameters in different parts of the network based on water demand variations using the following approach:Divide the village into zones based on water consumption patterns (high, medium, low).Estimate water demand for each zone based on population and consumption data.

Use the Hazen-Williams equation or similar methods to calculate the required pipe diameter for each zone to ensure adequate flow and pressure.

- Valves and Hydrants: Include strategically placed valves to isolate sections for maintenance and pressure control. Incorporate fire hydrants at regular intervals to meet firefighting requirements.
- Storage Tanks: Consider incorporating elevated storage tanks if needed to maintain pressure during peak demand periods or provide backup water supply.

Map view of adarshnagar asangao

Map view in auto cad



5. Exporting Layout to WaterGEMS:

 Once finalized in AutoCAD, export the water distribution network layout in a format compatible with WaterGEMS (e.g., DXF).

6. Water Distribution Network Modelling in WaterGEMS:

- Import the AutoCAD-generated layout into WaterGEMS.
- Input data on

Pipe material (HDPE) and roughness coefficients.

Pipe diameters for each section of the network.

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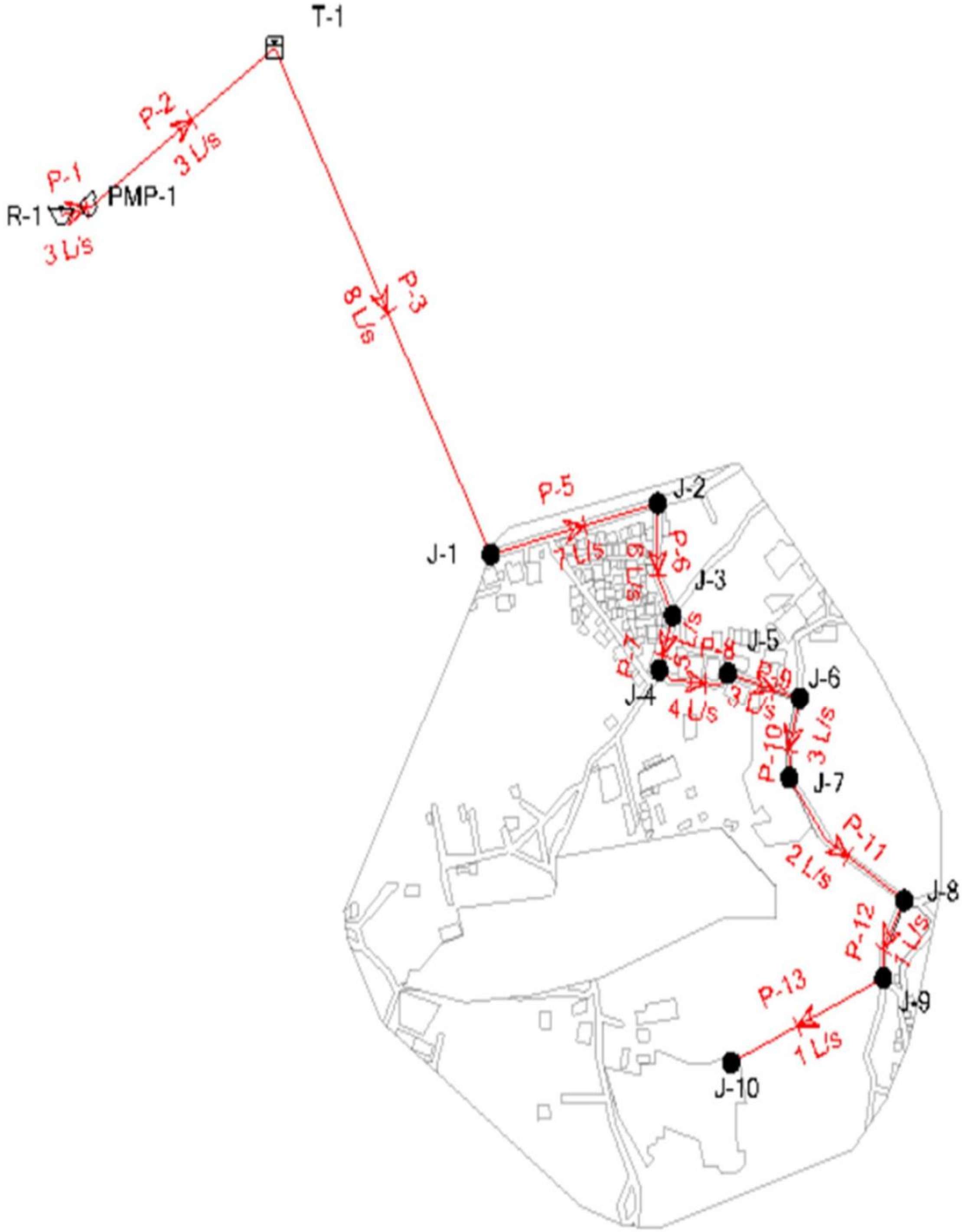
Node locations (junction points of pipes).
Water source (Bharangi Nadi) with its flow rate and elevation data.
Water demand profiles for different zones within the village.
Set boundary conditions (e.g., reservoir level for Bharangi Nadi) Run simulations to analyse hydraulic performance:
Assess pressure variations across the network at different demand scenarios (peak, average).
Identify potential bottlenecks or areas with insufficient pressure. Evaluate fire hydrant flow capacity.



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7. Design Optimization

Based on the WaterGEMS simulations, refine the network design if necessary. This might involve:

- Adjusting pipe diameters in specific sections.
- Introducing pressure-boosting pumps if low pressure persists in certain areas.
- Optimizing placements for better flow control.
- Re-run simulations in WaterGEMS to verify the effectiveness of the adjustments.

8. Cost Analysis:

Estimate the project cost by considering:
Material costs (pipes, valves, hydrants, storage tanks (if applicable), grit chamber).
Labor costs for construction and installation.
Equipment costs for excavation and pipe laying.

Item	Quantity	Unit Cost (₹)	Total Cost (₹)
HDPE Pipe (150mm dia, 1942m)	1942 m	229	4,44,718
Valves	3	2000	6000
Labour for Valves	1	1000	1,000
Hydrants	1	2000	2000
Labour for Hydrants	1	1500	2,000
Pump	1	30,000	30,000
Water Tank (10000L)	1	15,000	15,000
Grit Chamber	1	5,000	5,000
Labour, Machinery, Excavation etc.			1,60,415
Total Cost			6,56,133

Labour machinery and excavation

Item	Description	Total Cost (₹)
Estimated Labour, Machinery, Excavation etc.	30% of Sub-Total Material Cost	₹1,60,415

9. Implementation and Monitoring:

- Once the design is finalized and approved, implement the water distribution network construction phase.
- After construction, establish a monitoring program to track system performance over time. Monitor pressure levels at critical points and water consumption

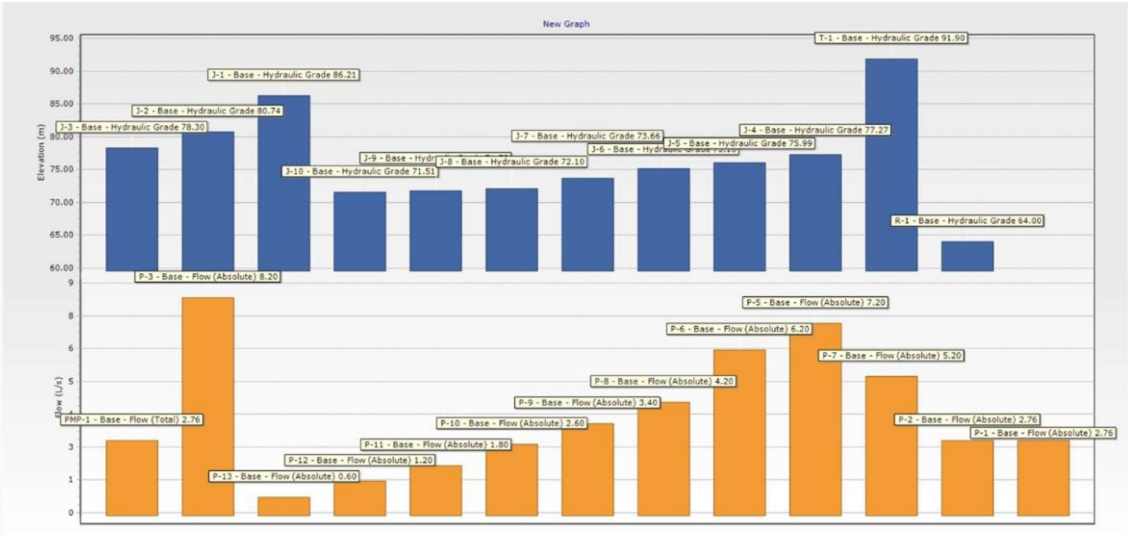
patterns. This will help identify any issues and ensure the system's long-term sustainability.

RESULTS FROM WATERGEMS

1. Junctions data

	ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (N/m²)
34: J-1	34	J-1	69.80	<None>	<Collection:	1	86.21	1,60,566
35: J-2	35	J-2	69.60	<None>	<Collection:	1	80.74	1,09,005
36: J-3	36	J-3	69.40	<None>	<Collection:	1	78.30	87,095
37: J-4	37	J-4	69.20	<None>	<Collection:	1	77.27	79,001
38: J-5	38	J-5	69.00	<None>	<Collection:	1	75.99	68,381
39: J-6	39	J-6	68.80	<None>	<Collection:	1	75.10	61,654
40: J-7	40	J-7	68.60	<None>	<Collection:	1	73.66	49,560
41: J-8	41	J-8	68.40	<None>	<Collection:	1	72.10	36,232
42: J-9	42	J-9	68.20	<None>	<Collection:	1	71.73	34,525
43: J-10	43	J-10	68.00	<None>	<Collection:	1	71.51	34,324

2. Graph of junctions and pipes



3. Elevation data

	ID	Label	Zone	Elevation (Base) (m)	Elevation (Minimum) (m)	Elevation (Initial) (m)	Elevation (Maximum) (m)	Volume (Inactive) (MG)	Diameter (m)	Flow (Out net) (L/s)	Hydraulic Grade (m)
32: T-1	32	T-1	<None>	90.00	91.50	91.90	92.00	0.00	1.40	6	91.90

4. Flow and velocity

	ID	Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Has Check Valve?	Minor Loss Coefficient (Local)	Flow (L/s)	Velocity (cm/s)	Headloss Gradient (ft/ft)	Has User Defined Length?	Length (User Defined) (m)
44: P-1	44	P-1	37	R-1	PMP-1	150.0	HDPE	140.0	☑	0.000	3	15.61	0.000	☑	22
45: P-2	45	P-2	280	PMP-1	T-1	150.0	HDPE	140.0	☑	0.000	3	15.61	0.000	☑	268
48: P-5	48	P-5	213	J-1	J-2	80.0	HDPE	140.0	☑	0.000	7	143.24	0.027	☑	204
49: P-6	49	P-6	119	J-2	J-3	80.0	HDPE	140.0	☑	0.000	6	123.35	0.020	☑	120
51: P-8	51	P-8	93	J-4	J-5	75.0	HDPE	140.0	☑	0.000	4	95.07	0.014	☑	95
52: P-9	52	P-9	93	J-5	J-6	75.0	HDPE	140.0	☑	0.000	3	76.96	0.009	☑	97
53: P-10	53	P-10	83	J-6	J-7	60.0	HDPE	140.0	☑	0.000	3	91.96	0.017	☑	87
54: P-11	54	P-11	193	J-7	J-8	60.0	HDPE	140.0	☑	0.000	2	63.66	0.008	☑	187
55: P-12	55	P-12	86	J-8	J-9	60.0	HDPE	140.0	☑	0.000	1	42.44	0.004	☑	95
56: P-13	56	P-13	208	J-9	J-10	60.0	HDPE	140.0	☑	0.000	1	21.22	0.001	☑	202
60: P-15	60	P-15	583	T-1	J-1	100.0	HDPE	140.0	☑	0.000	8	104.41	0.012	☑	495
112: P-16	112	P-16	58	J-3	J-4	80.0	HDPE	140.0	☑	0.000	5	103.45	0.015	☑	70

5. DEMAND CONTROLE

	ID	Label	Demand (Base) (L/s)	Pattern (Demand)	Zone
1	35	J-2	1.00	Fixed	<None>
2	36	J-3	1.00	Fixed	<None>
3	37	J-4	1.00	Fixed	<None>
4	38	J-5	0.80	Fixed	<None>
5	39	J-6	0.80	Fixed	<None>
6	40	J-7	0.80	Fixed	<None>
7	41	J-8	0.60	Fixed	<None>
8	42	J-9	0.60	Fixed	<None>
9	43	J-10	0.60	Fixed	<None>
10	34	J-1	1.00	Fixed	<None>

DISCUSSION

1. Water Scarcity and Sustainability.
2. WaterGEMS Software and System Design.
3. Stormwater Harvesting Integration.
4. System Benefits and Challenges.
5. Discuss the possibility of replicating this model in other water-scarce regions.
6. Explore potential future advancements in stormwater harvesting techniques and their integration with irrigation systems.

CONCLUSION

Crop	Water Requirement (mm/day)	Note
Gram	3	Relatively low water user.
Rice	4	High water user. Actual requirement may vary depending on variety and management practices.
Wheat	3	Moderate water user. Adjust based on specific growing conditions.
Ladyfinger	5	Moderate to high water user. Needs may vary depending on variety and climate.

FUTURE SCOPE

1. Advanced Water Management Strategies:

Demand Management: Integrate water demand management strategies like crop selection and scheduling into the model. This can help reduce overall water consumption while maintaining crop yields.

2. Integration with Smart Irrigation Systems:

Sensor Network Integration: Incorporate real-time data from soil moisture sensors into WaterGEMS. This allows for dynamic adjustment of irrigation schedules based on actual field conditions, optimizing water usage and minimizing waste.

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