INTERNSHIP REPORT

"Design of Tubewell and Design of Pipe Network – A Study at Ratua-I Block"

Submitted in partial fulfilment of the requirements for the award of

The Bachelor of Technology in Civil Engineering

Aliah University, Newtown Campus, Kolkata, Govt. of WB- 700156

Under the supervision of

Public Health Engineering Department, Kolkata, Govt. of West Bengal

Internship Duration: 30th June – 31st July, 2025

Submitted by:

MD SAYEED HASAN

(Roll No. CEN233015)

Bachelor of Technology, Civil Engineering Department
Aliah University, Newtown Campus, Kolkata Govt. of WB- 700156

ACKNOWLEDGEMENT

I would like to express my sincere and heartfelt gratitude to the **Public Health Engineering Department, Government of West Bengal**, for granting me the opportunity to undertake this internship program. It has been a highly enriching and insightful experience that allowed me to gain practical exposure to various aspects of **water supply engineering**, **field-level project execution**, and **infrastructure planning**.

As part of the internship, I had the opportunity to visit three key locations. At the **CIT Annex Building, PHED**, I was involved in survey-related work, including planning and layout preparation using modern software tools such as **ARCH-GIS**, **QGIS**, and **AutoCAD**. At the **Assistant Engineer Office, Serampore Division, Hooghly**, I visited two **Overhead Reservoir (OHR)** construction sites and also participated in **laboratory testing** of various **water quality parameters**. Additionally, at the **Water Treatment Plant in Newtown**, I gained practical insights by observing and understanding the entire **treatment process** and plant operations. These experiences together significantly enhanced my technical knowledge, practical skills, and field-level understanding of public water infrastructure.

I am especially thankful to the engineers, field supervisors, and technical staff at all these locations for their constant support, valuable guidance, and for generously sharing their time and experience during the site visits. Their professionalism, domain knowledge, and willingness to mentor an intern like me have left a lasting impression and further deepened my interest in the field of **civil engineering and public infrastructure development**.

I extend my sincere thanks to my department at **Aliah University, Newtown Campus**. I am deeply grateful to our **Head of Department, Dr. Indranil Mukherjee**, and all the respected faculty members of the **Civil Engineering Department** for their continuous encouragement, academic support, and motivation throughout this internship journey. Their guidance has been instrumental in bridging the gap between theoretical learning and real-world practice.

This internship has been a stepping stone in my academic and professional growth, enabling me to relate classroom knowledge with actual field conditions, especially in the domain of water supply systems and rural infrastructure planning. The experience has strengthened my technical foundation, improved my observational and analytical skills, and instilled confidence to take on future engineering responsibilities.

Lastly, I would like to thank my **family and friends** for their unwavering moral support and encouragement during the course of this internship.

Md Sayeed Hasan
B.Tech (Civil Engineering)
Aliah University, Newtown Campus

DECLARATION

I, **MD SAYEED HASAN** (Roll No. **CEN233015**), hereby declare that the Internship Report entitled "Design of Tubewell and Design of Pipe Network – A Study at Ratua-I Block", submitted in partial fulfilment of the requirements for the award of the Bachelor of Technology (B.Tech) in Civil Engineering at Aliah University, Newtown Campus, Kolkata, is an original work carried out by me during my internship under the Public Health Engineering Department, Government of West Bengal.

I further declare that this report has not been submitted to any other institution or university for the award of any degree, diploma, or certificate. All information and data presented in this report are true to the best of my knowledge and belief, and any material borrowed from other sources has been duly acknowledged.

Date: …………………

Place: ………………

(Signature)

Md Sayeed Hasan

Roll No.: CEN233015

B.Tech in Civil Engineering

Aliah University, Newtown Campus, Kolkata

INTERNSHIP CERTIFICATE

ALIAH UNIVERSITY

(A UGC approved autonomous institution under the Department of Minority Affairs and Madrasah Education, Govt. of West Bengal)

IIA/27, New Town, Kolkata – 700156, West Bengal, India

Phone: 033-27062271 / 2269 | Website: WWW.ALIAH.AC.IN

BONAFIDE CERTIFICATE

(Issued by the Department)

This is to certify that **Mr. MD SAYEED HASAN**, Roll No. **CEN233015**, a bonafide student of B.Tech in Civil Engineering at Aliah University, Newtown Campus, has successfully completed his **Summer Internship** from **30th June 2025 to 31st July 2025** under the guidance and supervision of the **Public Health Engineering Department, Government of West Bengal**.

This internship was carried out as a part of the **academic requirements** of the B.Tech curriculum, and the accompanying report submitted by him is a **genuine record of the work and training undertaken** during this period.

We appreciate his sincere efforts and commitment during the course of the internship and wish him success in all his future endeavors.

Date: ____________

Dr. Indranil Mukherjee

HoD, Department of Civil Engineering
Aliah University, Newtown Campus

1. Introduction

The internship undertaken at the **Public Health Engineering (PHE) Department**, Government of West Bengal, provided a unique opportunity to gain insights into the planning and design aspects of essential public infrastructure—particularly in the domain of **rural water supply systems**. This internship bridged the gap between academic learning and practical exposure by allowing me to understand how large-scale government projects are conceptualized, designed, and prepared for execution at the departmental level.

The design focus during this internship was on the **Piped Water Supply Scheme (PWSS)** proposed for **Ratua-I Block of Malda district**. Although no direct fieldwork was conducted at the Ratua site, I was involved in understanding and contributing to the **office-level design, planning, and documentation** of the scheme. The primary objective of the project is to ensure a safe, sustainable, and adequate drinking water supply to rural households, thereby improving community health and living standards.

During the internship period, I worked on several components of the **planning process**, including **population forecasting** using census data and projected growth trends, **water demand estimation** for domestic and institutional purposes, and **design considerations** for deep tube wells as the main water source. In addition, I became familiar with **technical drawings**, **layout planning**, **tender documentation**, and the **administrative procedures** that support the implementation of such schemes.

This experience also highlighted various challenges in rural infrastructure projects, such as groundwater limitations, cost constraints, and the importance of community participation and environmental sustainability. While the work was primarily office-based, it provided substantial learning in terms of technical knowledge, planning logic, and procedural workflows that go into public health engineering projects.

Overall, the internship proved to be an invaluable learning experience that deepened my understanding of civil engineering applications in public infrastructure planning and strengthened my skills in project coordination, data interpretation, and technical decision-making.

2. About the Public Health Engineering (PHE) Department

The **Public Health Engineering (PHE) Department**, Government of West Bengal, is the apex agency responsible for the **planning, design, execution, operation, and maintenance** of drinking water supply and sanitation infrastructure across both **rural and urban areas** of the state. The department plays a crucial role in promoting public health and improving the quality of life, especially in underdeveloped and underserved regions.

Guided by the vision of **universal, equitable, and sustainable access** to safe drinking water and improved sanitation, the PHE Department integrates its efforts with national flagship programs such as the **Jal Jeevan Mission (JJM)**, **Swachh Bharat Mission (SBM)**, and the **Atal Mission for Rejuvenation and Urban Transformation (AMRUT)**. With a strong emphasis on **long-term water security and health safety**, it functions as a backbone of the state's public health infrastructure.

Major Functions and Responsibilities:

- Conducting technical surveys to assess the availability and quality of water resources, including both **surface water** and **groundwater**.
- Designing and implementing comprehensive **water supply schemes**, involving overhead reservoirs (OHRs), treatment plants (WTPs), and distribution pipelines.
- Deploying **groundwater-based solutions** such as bore wells, deep tube wells, and submersible pump systems in areas lacking access to surface water.
- Ensuring **water quality monitoring** through a robust network of state- and district-level laboratories, as per **BIS drinking water standards (IS 10500)**.
- Providing **operation and maintenance (O&M)** support to sustain the efficiency and continuity of water supply infrastructure.
- Encouraging **community participation** via **Village Water and Sanitation Committees (VWSCs)** for better ownership and long-term sustainability of projects.
- Collaborating with **NGOs**, **Panchayati Raj Institutions (PRIs)**, and other government bodies to ensure transparency and efficiency.
- Utilizing **GIS-based mapping** and **Management Information Systems (MIS)** to track project progress and performance metrics.

The department is structured through a multi-tiered administrative hierarchy comprising **Chief Engineers, Superintending Engineers, Executive Engineers**, and **Assistant Engineers**, supported by technical and clerical staff across divisions, sub-divisions, and field offices statewide.

As part of this internship, exposure was primarily at the **design and planning level** for a proposed **Piped Water Supply Scheme (PWSS)** for **Ratua-I Block in Malda district**. Though no field-level deployment was undertaken, the internship provided a valuable opportunity to understand the PHE Department's role in transforming community health through sustainable water infrastructure development across West Bengal.

3. Objectives of the Internship

- To understand the design and planning process of a rural water supply scheme.
- To learn the application of population forecasting methods in infrastructure planning.
- To perform calculations for daily water demand and design distribution systems.
- To assist in tube well design considering hydrogeological and engineering factors.
- To observe practical construction, survey techniques, and project execution during site visits.

4. Site Visit Summary

My internship was primarily based at the Public Health Engineering Department (PHED), Bikash Bhawan, under the supervision of the Junior Engineers/Assistant Engineer. From this central office, we were assigned to visit various locations to gain field exposure to different stages of water supply system planning, design, construction, and operation.

- **PHE Department, Bikash Bhawan Office**

  Worked under the guidance of the JE/AE, gaining an overview of project planning, coordination, and monitoring processes. Understood how technical teams allocate tasks, manage resources, and schedule field visits for survey and inspection purposes.

- **CIT Annex Building, PHED**

  Participated in survey planning, mapping, and layout preparation using AutoCAD, QGIS, and ArcGIS. Learned how population statistics, terrain data, and GIS inputs are integrated to create technical designs for rural water supply projects. Observed pipeline alignment planning and the transformation of raw survey data into detailed engineering drawings.

- **Assistant Engineer's Office, Serampore Division, Hooghly**

  Visited active Overhead Reservoir (OHR) construction sites. Observed foundational works, staging erection, concrete curing, and site safety measures. Also participated in water quality testing in the PHED laboratory, learning standard testing procedures for basic water parameters.

- **Water Treatment Plant, Newtown**

  Gained first-hand exposure to the complete water purification cycle, including aeration, coagulation, filtration, chlorination, and distribution. Observed pumping operations, automated control systems, and safety regulations implemented at large-scale treatment facilities.

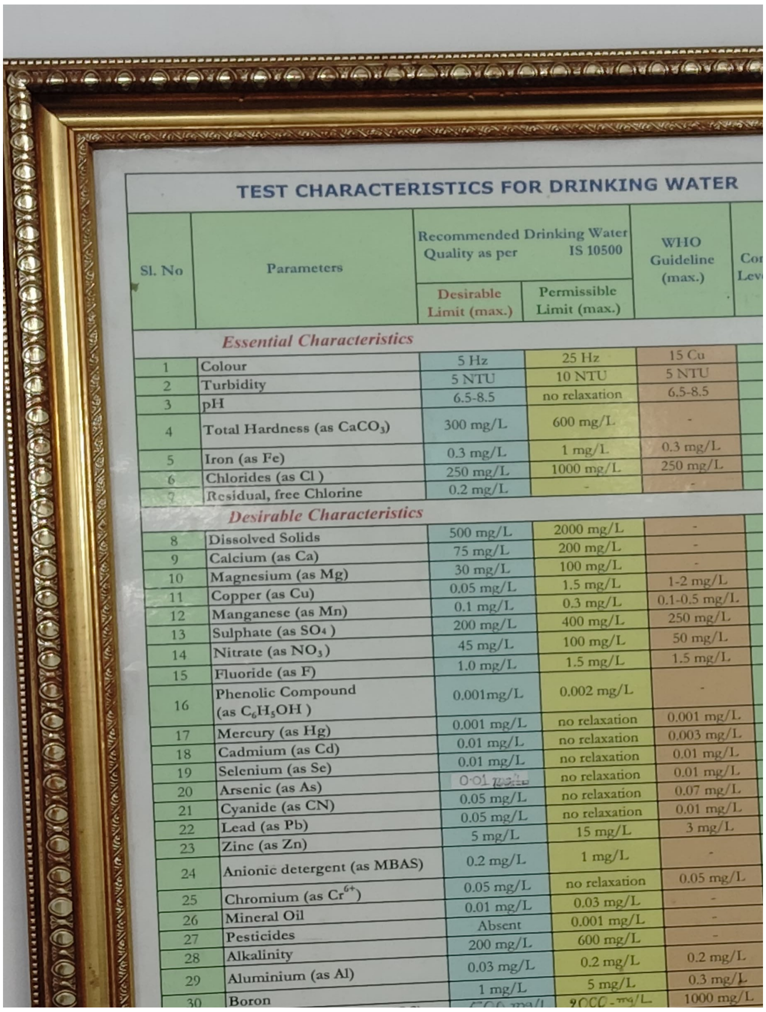
5. Photographic Documentation

PHE OFFICE BIKASH BHAWAN

Visited construction sites of Overhead Reservoirs

Serampore Division,Hooghly

Sites Visited Serampore Division Hoogly

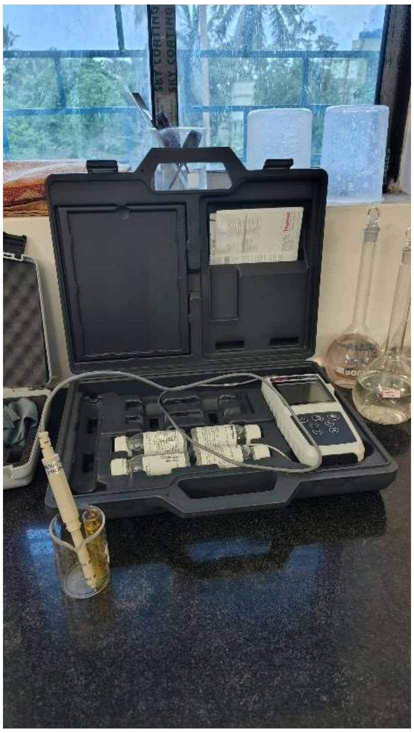


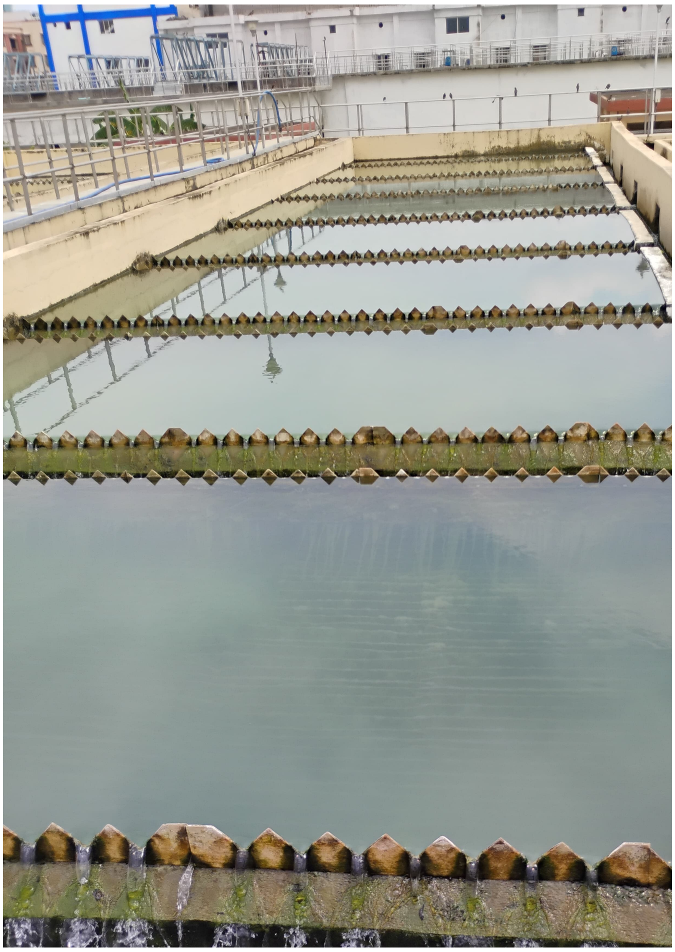
TEST CHARACTERISTICS FOR DRINKING WATER

Sl. No	Parameters	Recommended Drinking Water Quality as per IS 10500		WHO Guideline (max.)	Co Lev
		Desirable Limit (max.)	Permissible Limit (max.)		
	Essential Characteristics				
1	Colour	5 Hz	25 Hz	15 Cu	
2	Turbidity	5 NTU	10 NTU	5 NTU	
3	pH	6.5-8.5	no relaxation	6.5-8.5	
4	Total Hardness (as $CaCO_3$)	300 mg/L	600 mg/L	-	
5	Iron (as Fe)	0.3 mg/L	1 mg/L	0.3 mg/L	
6	Chlorides (as Cl)	250 mg/L	1000 mg/L	250 mg/L	
7	Residual, free Chlorine	0.2 mg/L	-	-	
	Desirable Characteristics				
8	Dissolved Solids	500 mg/L	2000 mg/L	-	
9	Calcium (as Ca)	75 mg/L	200 mg/L	-	
10	Magnesium (as Mg)	30 mg/L	100 mg/L	-	
11	Copper (as Cu)	0.05 mg/L	1.5 mg/L	1-2 mg/L	
12	Manganese (as Mn)	0.1 mg/L	0.3 mg/L	0.1-0.5 mg/L	
13	Sulphate (as SO_4)	200 mg/L	400 mg/L	250 mg/L	
14	Nitrate (as NO_3)	45 mg/L	100 mg/L	50 mg/L	
15	Fluoride (as F)	1.0 mg/L	1.5 mg/L	1.5 mg/L	
16	Phenolic Compound (as C_6H_5OH)	0.001mg/L	0.002 mg/L	-	
17	Mercury (as Hg)	0.001 mg/L	no relaxation	0.001 mg/L	
18	Cadmium (as Cd)	0.01 mg/L	no relaxation	0.003 mg/L	
19	Selenium (as Se)	0.01 mg/L	no relaxation	0.01 mg/L	
20	Arsenic (as As)	0.01 mg/L	no relaxation	0.01 mg/L	
21	Cyanide (as CN)	0.05 mg/L	no relaxation	0.07 mg/L	
22	Lead (as Pb)	0.05 mg/L	no relaxation	0.01 mg/L	
23	Zinc (as Zn)	5 mg/L	15 mg/L	3 mg/L	
24	Anionic detergent (as MBAS)	0.2 mg/L	1 mg/L	-	
25	Chromium (as Cr^{6+})	0.05 mg/L	no relaxation	0.05 mg/L	
26	Mineral Oil	0.01 mg/L	0.03 mg/L	-	
27	Pesticides	Absent	0.001 mg/L	-	
28	Alkalinity	200 mg/L	600 mg/L	-	
29	Aluminium (as Al)	0.03 mg/L	0.2 mg/L	0.2 mg/L	
30	Boron	1 mg/L	5 mg/L	0.3 mg/L	

Water Quality Test Laboratory, Serampore Division , Hoogly

S.N.	Parameters	Unit	Te
1	pH	-	pH met
2	Dissolved oxygen	mg/L	Winkle
3	Biochemical oxygen demand	mg/L	Incubat titratio
4	Conductivity	ms/cm	Conduc
5	Alkalinity	mg/L	Titratic
6	Total dissolved solids	mg/L	Digital meter
7	Chloride	mg/L	Argent titratio
8	Total hardness as $CaCO_3$	mg/L	Compl titratio
9	Ca	mg/L	Compl titratio





Site Visited: 20 MGD Water Treatment Plant Phase-II Newtown

6. Water Treatment Process

Water Treatment Plants (WTPs) are designed to purify raw water (from river, reservoir, or groundwater) and make it suitable for human consumption. During my internship, I visited the **Water Treatment Plant at New Town, Kolkata**, which is part of the WB HIDCO Project executed by the Public Health Engineering Department (PHED), Government of West Bengal. This visit gave me an understanding of the entire treatment cycle, from intake to distribution.

Stages of Water Treatment Process

I. **Intake & Screening:**
   - Raw water is drawn from the source (river or canal) and passed through **bar screens** to remove large floating objects such as leaves, sticks, and plastics.
   - Pumps lift the water to the treatment units.

II. **Aeration (Optional Stage):**
   - Sometimes raw water is aerated to remove dissolved gases (like CO_2, H_2S) and oxidize dissolved iron and manganese.

III. **Coagulation & Flocculation:**
   - **Alum (Aluminium Sulphate)** or other coagulants are added to destabilize suspended particles.
   - Gentle mixing allows particles to collide and form larger flocs.
   - This stage helps in removing turbidity and color.

IV. **Sedimentation:**
   - Water is allowed to settle in large **sedimentation tanks**.
   - Heavy flocs and suspended solids settle at the bottom as sludge.
   - Clear water flows to the next stage.

V. **Filtration:**
   - The partially clarified water passes through **Rapid Sand Filters** (layers of sand, gravel, and pebbles).
   - This process removes fine suspended impurities, turbidity, and microorganisms.
   - Backwashing is done periodically to clean the filters.

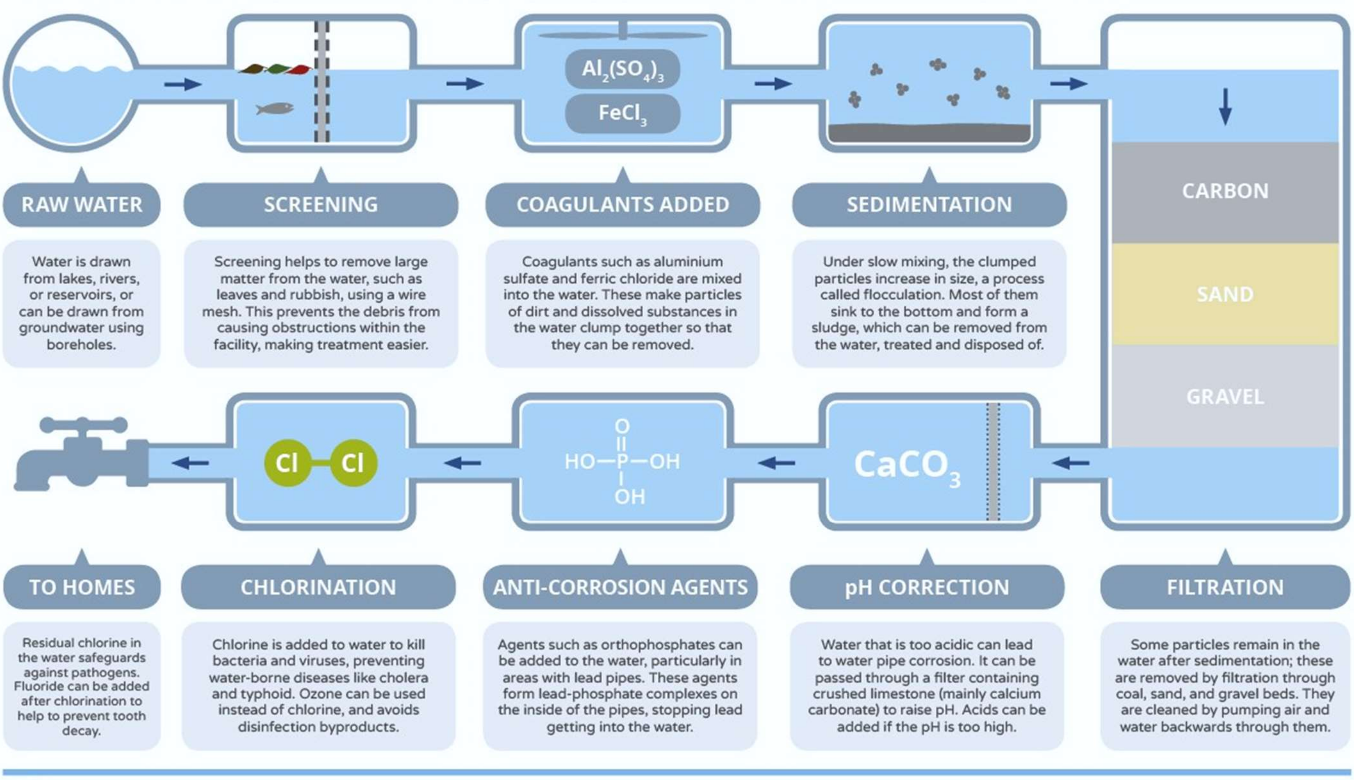
VI. **Disinfection:**
   - **Chlorination** is carried out to kill harmful bacteria, viruses, and pathogens.
   - Sometimes advanced methods like UV disinfection or ozonation are also used, but chlorination remains the most common and economical.

VII. **pH Adjustment (if required):**
   - Lime or other chemicals are added to maintain a neutral pH (6.5–8.5) suitable for drinking.

VIII. **Storage & Distribution:**
   - Treated water is collected in **Clear Water Reservoirs (CWRs)**.
   - From there, it is pumped or sent by gravity to **Over Head Reservoirs (OHRs)** and finally distributed through pipelines to consumers.

Water Treatment – From Reservoir to Home

We take the water coming from our taps for granted – but what happens to it before it gets there? Here's how chemistry helps!



Observations at New Town WTP (Site Visit Notes)

- The plant followed a **conventional water treatment process** (Coagulation → Sedimentation → Filtration → Disinfection).
- I observed **sedimentation tanks** where settled sludge was periodically removed.
- **Rapid sand filters** were in operation, with arrangements for backwashing.
- A dedicated **chlorination unit** ensured proper dosing of chlorine.
- Separate **control rooms and laboratories** were maintained for water quality monitoring.
- Treated water was stored in large clear water reservoirs before being pumped to OHRs and pipelines.

Technical Learnings

- Importance of each stage (screening to disinfection) in making water potable.
- Role of chemicals like alum and chlorine in water treatment.
- Operational aspects such as flow control, backwashing of filters, and sludge management.
- Significance of laboratory testing in ensuring compliance with **IS:10500 (Drinking Water Standards)**.

7. Over Head Reservoir

An Over Head Reservoir (OHR) is an elevated water storage structure used in water supply schemes to store treated water at a certain height and distribute it to consumers through gravity pressure. This arrangement ensures a continuous and reliable water supply even during peak demand hours and maintains adequate distribution pressure without continuous pumping.

Main Components of an OHR

1. Foundation

- Constructed in **Reinforced Cement Concrete (RCC)** to safely transfer the structural load to the ground.
- Designed considering the **Safe Bearing Capacity (SBC)** of the soil obtained from geotechnical investigation.
- Generally circular or octagonal in shape for load uniformity.

2. Staging / Columns & Bracings

- RCC columns are provided to support the container/tank at the desired height.
- **Horizontal Bracing** and **Diagonal Bracing** are used between columns to enhance stability and resist lateral loads (wind, seismic).
- The height of staging is selected to provide the required *gravity head* for distribution.

3. Container / Tank Components
The water-holding portion of an OHR consists of the following RCC elements:

- **Container Floor Slab** – The base slab of the tank that transfers water load to the staging.
- **Ring Beam** – Circular RCC beam at the base and top of the tank wall to distribute loads evenly.
- **Tank Wall** – Vertical RCC wall forming the side surface of the container.
- **Dome (Top Slab)** – A domed RCC roof to cover and protect water from contamination.
- **Dome (Bottom/Underneath)** – In some designs, a domed base is used instead of a flat slab for structural efficiency.
- **Heel Beam** – RCC beam at the junction of wall and base slab for structural integrity.

4. Pipe Connections

- **Inlet Pipe** – To fill treated water into the tank.
- **Outlet Pipe** – To distribute water into the supply network.
- **Overflow Pipe** – To discharge excess water safely.
- **Washout Pipe** – To drain water for cleaning and maintenance.

5. Access Facilities

- Staircase with landing platforms for inspection.
- Walkway or gallery with railing around the dome for maintenance.

Types of Pipes Commonly Used in OHR Works

- **Mild Steel (MS) Pipes** – For inlet and outlet connections, capable of high-pressure handling.
- **Cast Iron (CI) Pipes** – Traditionally used for distribution mains.
- **Ductile Iron (DI) Pipes** – High strength, corrosion-resistant, widely preferred.
- **PVC / HDPE Pipes** – Lightweight, economical, used for small-diameter or rural distribution lines.
- **Galvanized Iron (GI) Pipes** – Often used for overflow and washout lines.

Site Visit – Serampore, Hooghly (PHE Sub-Division)

As part of my internship, I visited an OHR construction site at Serampore, Hooghly. The visit provided hands-on exposure to various construction stages:

- **Foundation Stage (Reinforcement & Shuttering)** – Circular RCC foundation was under preparation, with reinforcement cages for columns placed inside shuttering. Concrete was being poured for the base slab, ensuring adequate strength to bear the full tank load.
- **Staging & Column Construction** – RCC columns with horizontal bracings were being erected using bamboo scaffolding. Proper alignment and curing were ensured for structural stability.
- **Completed OHR Observation** – A fully constructed OHR was inspected, featuring staircase access, RCC dome top cover, safety railing, and clearly installed inlet/outlet/overflow/washout pipes. Stacks of HDPE and DI pipes were stored on-site for connecting the distribution network.

Technical Learnings from the Visit

- Identification of all RCC structural components of an OHR – foundation, staging, columns, bracings, heel beam, ring beam, floor slab, dome.
- Understanding practical pipe arrangements and their purposes.
- Material usage: RCC, reinforcement, DI/HDPE pipes.
- Importance of proper shuttering, scaffolding, curing, and column alignment.
- Hydraulic principle of elevated storage for gravity-based distribution.

8. Design And Analysis of Over Head Reservoir

350000 Liters Capacity

Volume = (350000/1000) = 350 m^3

π * r2 * h = 350 m^3

r^2 * h = 350/3.14

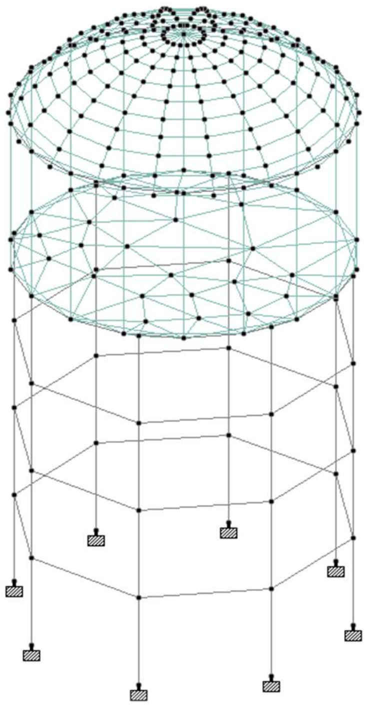
= 111.46m^3

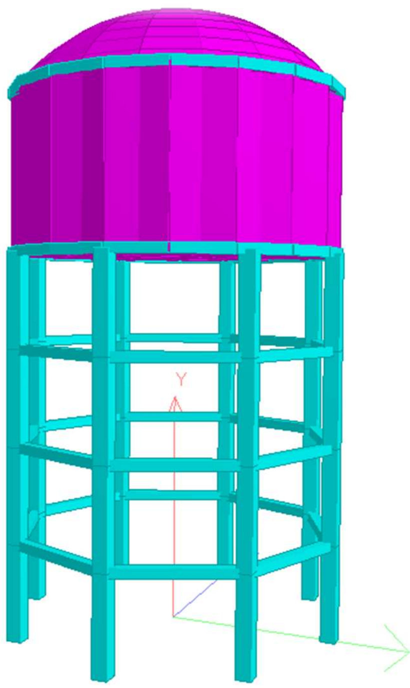
Approximately = 125 m^3

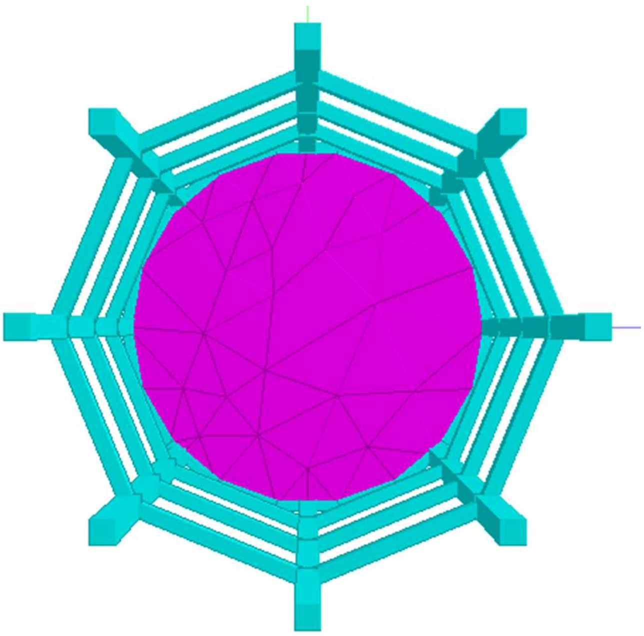
Assuming, r = 5 m and h = 5m

The volume of Tank = 5 ^ 3 * X * 3.14 = 392.5 m^3

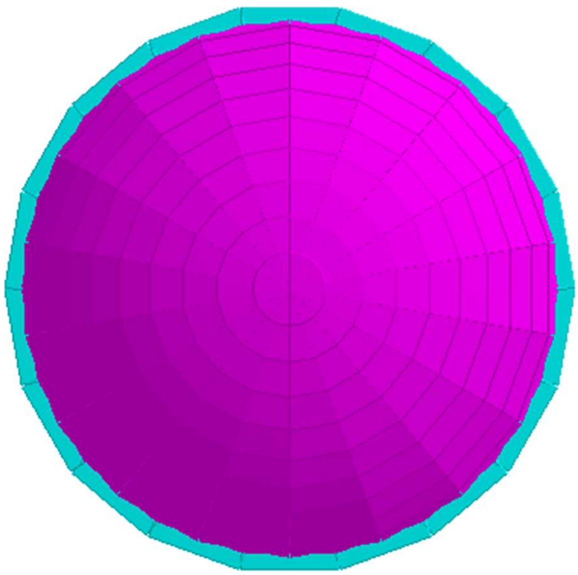
3D RENDERING VIEW OF OHR:





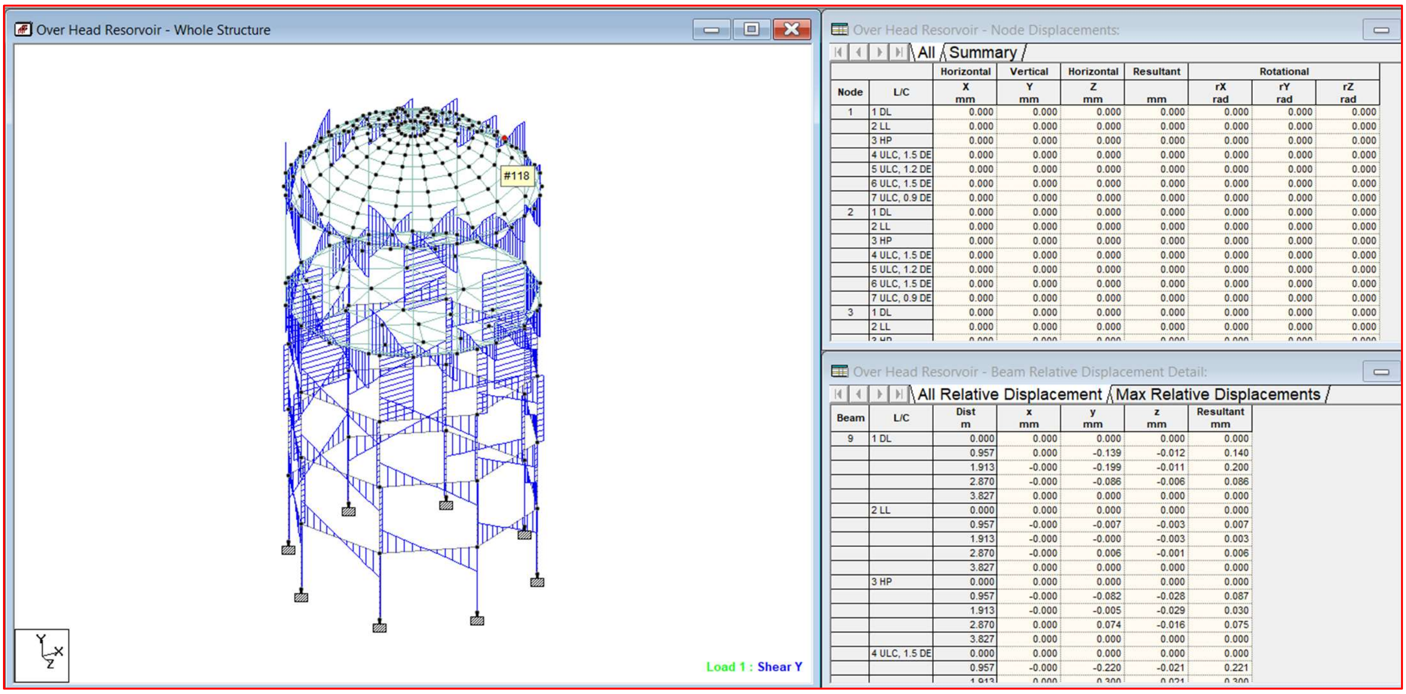


BOTTOM VIEW

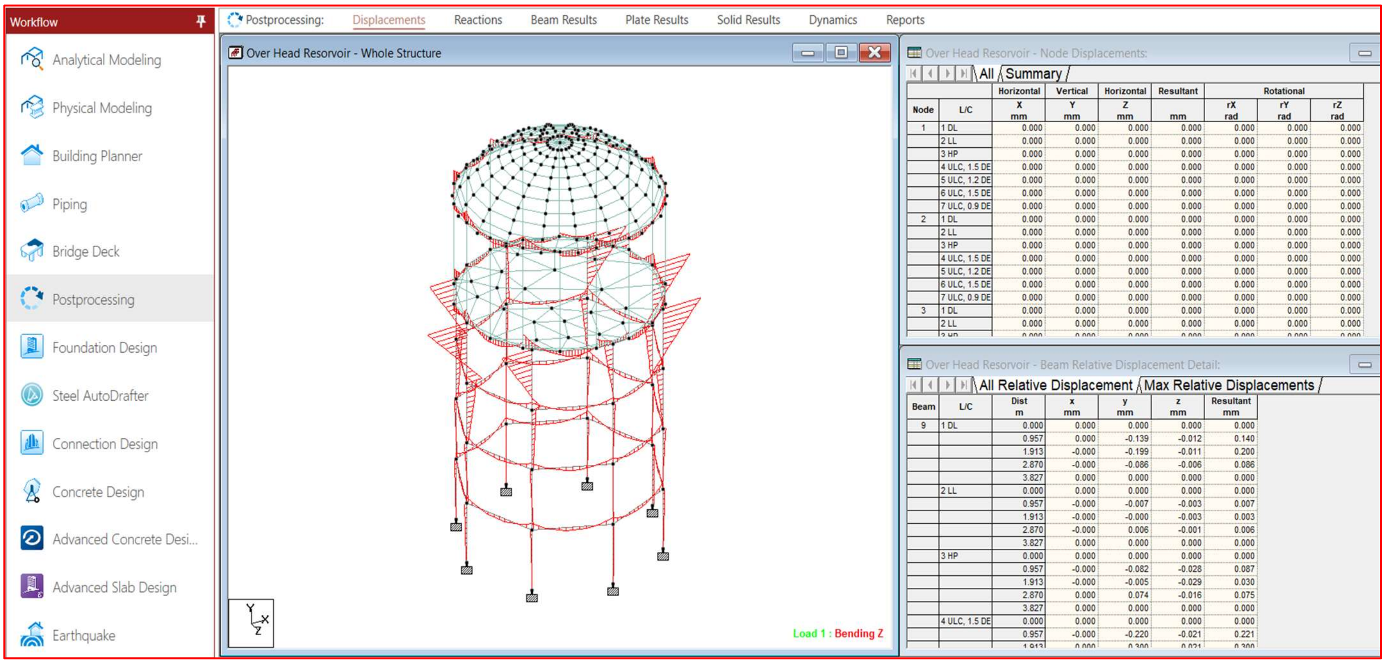


TOP VIEW

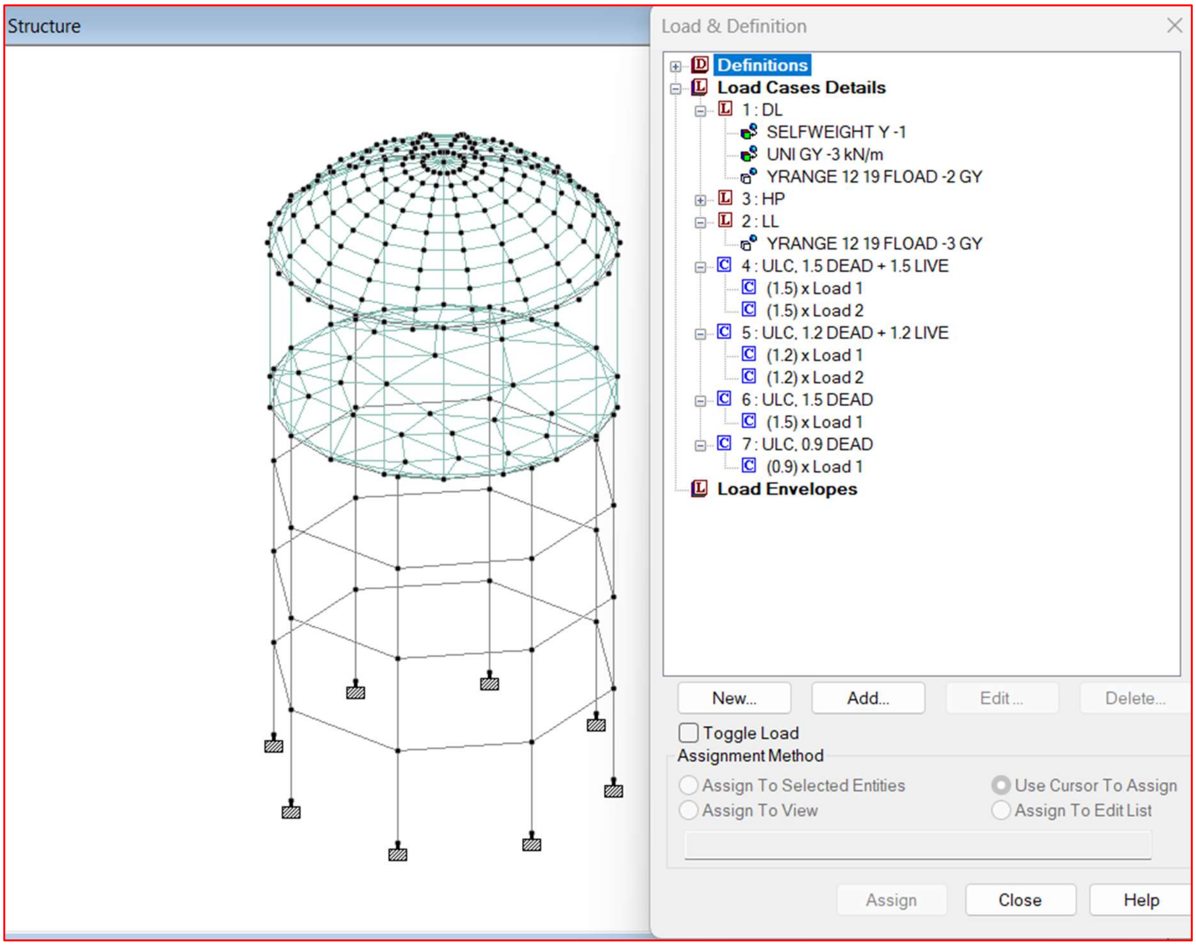
SHEAR FORCE DIAGRAM :



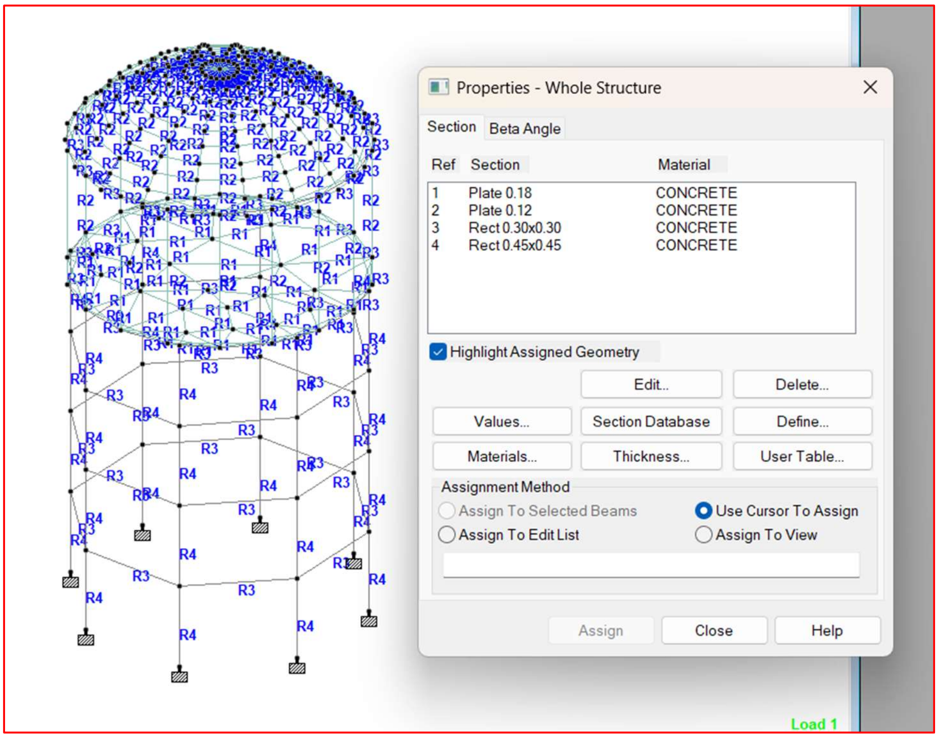
BENDING MOMENT DIAGRAM:



LOAD CASES DETAILS:



PROPERTIES OF OHR STRUCTURE:



9. Pipe Line Layout / Distribution System

A **pipeline distribution system** is the network of pipes through which treated water is conveyed from the **Over Head Reservoir (OHR)** to consumers in residential, commercial, and industrial areas. The purpose of this system is to ensure **uniform, adequate, and continuous supply of safe drinking water** under required pressure.

Components of a Distribution System

1. **Main (Primary) Pipes:**
   - Large diameter pipes carrying water from the source/OHR to the distribution area.
   - Generally made of **Ductile Iron (DI)** or **Mild Steel (MS)**.
2. **Secondary Mains:**
   - Branches from the primary mains, supplying water to sub-zones or smaller areas.
3. **Service Pipes:**
   - Small diameter pipes connecting individual houses, institutions, or industries to the secondary mains.
   - Usually made of **HDPE or PVC**.
4. **Valves and Appurtenances:**
   - **Sluice Valves / Gate Valves** – for controlling water flow.
   - **Air Valves** – to release trapped air.
   - **Scour Valves** – for flushing and cleaning pipelines.
   - **Non-return Valves** – to prevent backflow.
5. **Hydrants:**
   - Provided at suitable locations for firefighting and emergency water withdrawal.

Types of Pipe Materials Used

- **Ductile Iron (DI) Pipes** – strong, durable, commonly used for mains.
- **Mild Steel (MS) Pipes** – for large diameter trunk mains.
- **Cast Iron (CI) Pipes** – traditional use, now being replaced by DI.
- **High-Density Polyethylene (HDPE) Pipes** – flexible, lightweight, economical, used for service connections.
- **PVC Pipes** – commonly used in small diameter distribution.

Types of Distribution System Layouts:

1. **Dead-End or Tree System:**
    - Branching type network.
    - Easy to design and low cost but water stagnation may occur at dead ends.

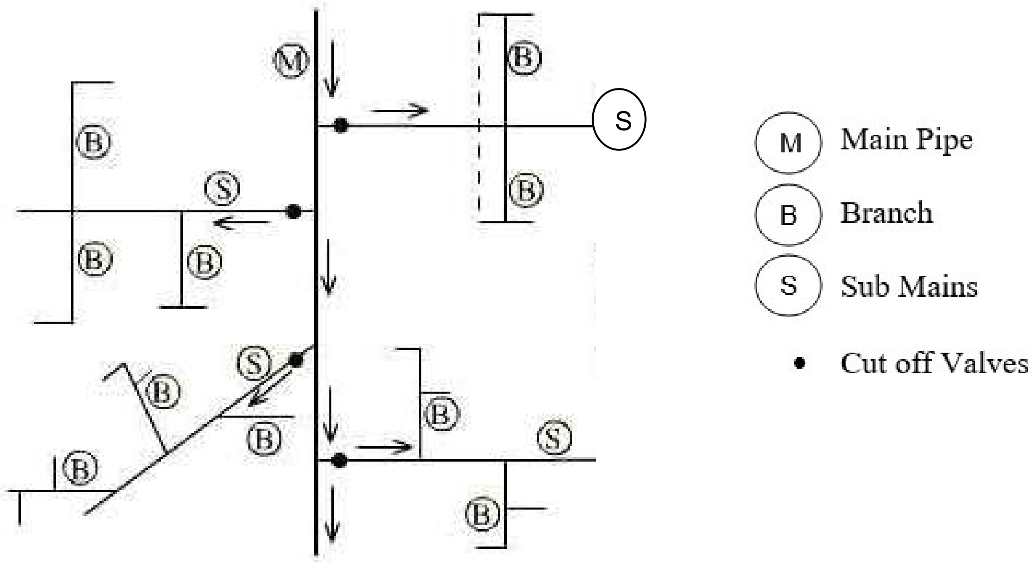


Fig.- Dead – End or Tree System

2. **Grid Iron System:**
    - All mains and branches are interconnected.
    - Ensures uniform pressure and continuous flow.

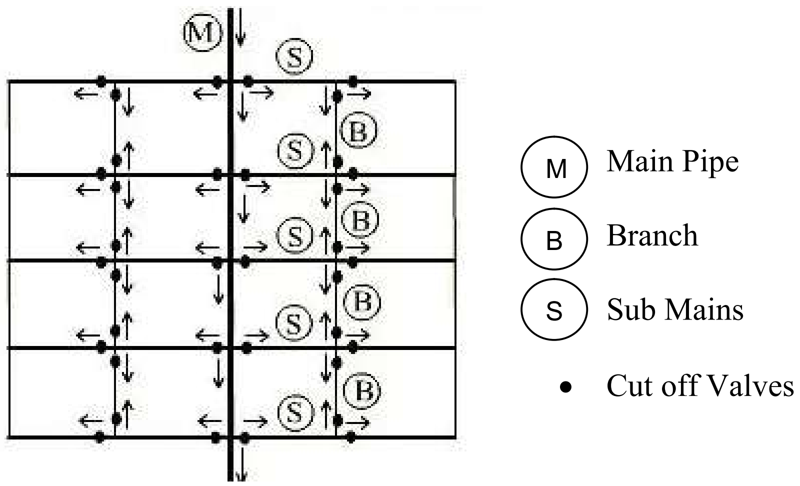


Fig.- Grid Iron System

3. **Ring System:**
   - Mains form a loop or ring around the distribution area.
   - Provides high reliability; water can flow from both directions.

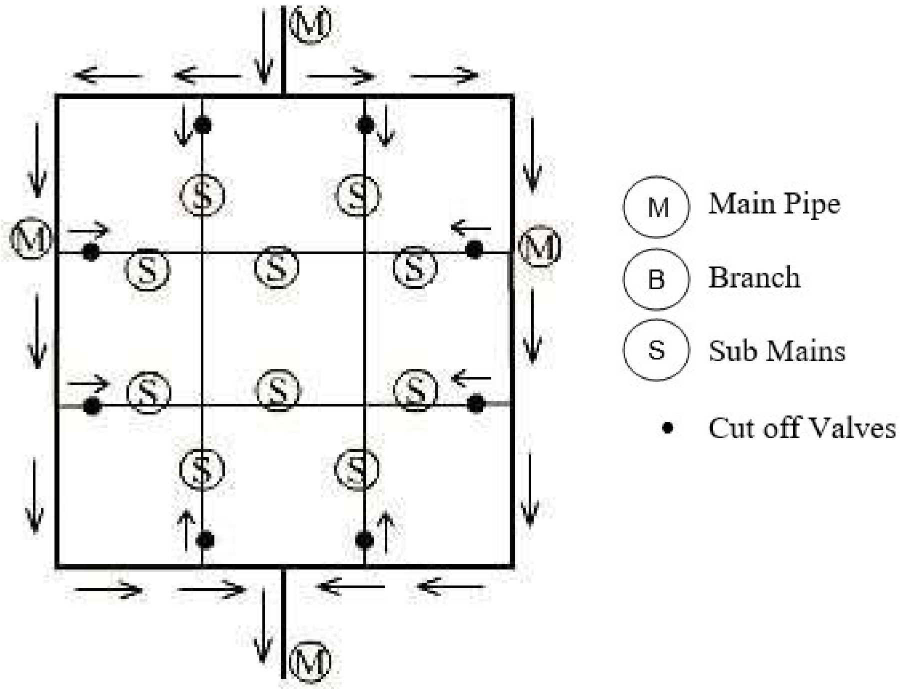
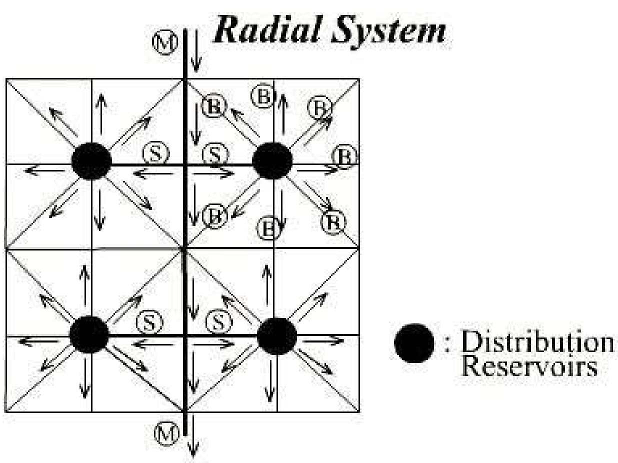


Fig.- Ring System

4. **Radial System:**
   - Water is supplied radially from a central point.
   - Easy to operate and efficient for planned towns.



10. Methodologies and Procedures

The internship was structured into three technical units: -

Unit 1: Population Forecasting

Unit 2: Water Demand Calculation

Unit 3: Tube Well Design

Each unit began with literature review and understanding of IS codes followed by data analysis, problem solving, and field observations. Calculations were cross-checked with standard forms used by the department. Discussions with senior engineers helped refine understanding.

Field visits were supported by data collection, image documentation, observation of live construction, and participation in briefings and reviews.

11. Population Forecasting – Theory and Application

- Population Forecasting: It is the process of estimating future population numbers of a particular area over a specific period, based on current data and trends.
  It is used by government departments and planning authorities for effective decision-making in areas such as infrastructure development, public health, education, housing and resource allocation.

- Population Data: The present population of a town or a city can be best determined by conducting an official enumeration, called census. The government of every country generally carries these official surveys at intervals of say about 10 years called decennial census.

- Population forecasting methods:

  The various methods which are generally adopted for estimating future populations by engineers are described below. Some of these methods are used when the design period is small and some are used when the design period is large. The particular method to adopted for a particular method to be adopted for a particular case.

  i. **Arithmetic Increase Method:**
  This method is based upon the assumption that the population increases at a constant rete, i.e. rate of change of population with time is constant.
  PHE Department generally use this method for population forecasting.

  $$P_n = (P_o + n.\overline{x})$$

  Where;
  P_n= Prospective or forecasted population after n decades from the present i.e. last known census.
  P_o= Population at present i.e. last known census.
  n =No. of decades between now and future
  $\overline{x}$= Arithmetic mean of population increases in known decades

  ii. **Geometric Increase Method:**
  In this method, the per decade percentage increase or percentage growth rate (r) is assumed to be constant and the increase is compounded over the existing population every decade. This method is, therefore, also known as uniform increase method.
  The basic difference between arithmetic and geometric progression methods of forecasting future populations is that: whereas, in arithmetic method, no compounding is done; in geometric method, compounding is done every decade. The computations in two methods are, thus, comparable to simple and compound interest computations, respectively.

$$\boldsymbol{P_n = P_O \left(1 + \frac{r}{100}\right)^n}$$

Where;

$\boldsymbol{P_n}$= Future population after n decades

$\boldsymbol{P_o}$= Initial population; i.e. the population at the end of last known census

$\boldsymbol{r}$ = Assumed growth rate (%)

This assumed growth rate (r) can be computed in several ways from the past known population data:

a) $r = \sqrt[t]{\frac{P_2}{P_1}} - 1$

Where

P_1= Initial known population

P_2= Final known population

t= No. of decades (periods) between P_1 and P_2

b) The other method to determine r, is to compute to average of the percentage growth rates of the several known decades of the past. The growth rates; i.e. $\frac{increase\ in\ population}{original\ popultion}\ x\ 100$ values, are computed for each known decade and their average may be taken as the assumed constant per decade increase (r). The average may again be either the arithmetic average i.e.

$$\frac{\mathrm{r_1}\ + \mathrm{r_2} + \mathrm{r_3} + \cdots \mathrm{r_t}}{t}$$

Or the geometric average i.e.

$$\sqrt[t]{\mathrm{r_1} \,.\, \mathrm{r_2} . \mathrm{r_3} \dots \mathrm{r_t}}$$

The design engineers in the field generally consider the arithmetic mean here, because it is slightly higher than the geometric mean.

iii. Incremental Increase Method:

In this method, the per decade growth rate is not assumed to be constant as in the arithmetic or geometric progression methods ; but is progressively increasing or decreasing , depending upon whether the average of the incremental increases in the past data is positive or negative.

The population for a future decade is worked out by adding the mean arithmetic increase (say $\overline{x}$) to the last know population as in arithmetic increase method , and to this is added the average to the incremental increase y, one for the first decade , twice for the second decade, thrice for the third decade, and so on.

The method, thus, assumes that the growth rate in the first decade is $(\overline{x} + \overline{y})$ in the second decade@ $(\overline{x} + 2\overline{y})$, and the nth decade @ $(\overline{x} + n\overline{y})$.

Thus, the growth rate is assumed to be varying.

We can mathematically write as

$$P_n = P_O + n\overline{x} + \frac{n(n+1)}{2} . \overline{y}$$

Where

P_n = Population after n decade form present (i.e., last known decades)

$\overline{x}$ = Average increase of populations of known decades.

$\overline{y}$ = Average of incremental increases of the known decades.

This method will give end results, somewhere between the results given by arithmetic increase method and geometric increase method and is considered to be giving quite satisfactory results.

iv. Logistic Curve Method:

- Ideal Population Growth curve:

  There are various factors which is affecting population growth. There are three main factors i) births, ii) deaths and iii) migrations. Besides these three main factors, some others factors like wars, natural havocs and disasters may also bring about sharp reductions in the populations.

  When all these varying influences do not produce extraordinary changes, the population would probably follow the growth curve characteristics of living things within limited space or with limited economic opportunity. The curve is S-shaped is known as logistic curve.

State/District/Sub Division/Police Station												
WB/Malda/Sadar /Ratua-I												
PROJECTED POPULATION OF RATUA-I												
		POPULATION AS PER CENSUS						PROJECTED POPULATION				ARITHMETIC MEAN
J.L NO.	VILLAGE NAME	1961	1971	1981	1991	2001	2011	2021	2031	2041	2051	X
49	Arazi Balarampur	0	0	0	0	0	0	0	0	0	0	0
29	Arazi Haragobindapur	884	1164	1345	1576	2001	3147	3600	4052	4505	4957	453
32	Asutola	1196	1609	2207	2713	3698	4880	5617	6354	7090	7827	737
45	Bahirkap	1590	1981	2415	2828	3877	4549	5141	5733	6324	6916	592
12	Bajitpur	1075	1398	1618	1890	1916	2283	2525	2766	3008	3249	242
16	Balarampur	252	0	698	921	1465	2165	2548	2930	3313	3695	383
13	Balupur	3304	3694	5664	6844	8590	10808	12309	13810	15310	16811	1501
46	Bangshipur	0	0	0	0	0	31	37	43	50	56	6
47	Bhado	4957	5911	8151	9748	13863	17190	19637	22083	24530	26976	2447
39	Bhaluara	400	586	764	946	1640	2443	2852	3260	3669	4077	409
42	Bihari	768	1046	1164	1362	3027	4183	4866	5549	6232	6915	683
24	Bishnupur Lakshmipur	1357	1279	1289	1255	1587	1684	1749	1815	1880	1946	65
48	Chandipur	772	1113	1506	1873	2699	3259	3756	4254	4751	5249	497
19	Debipur	1807	2452	2688	3129	3773	4070	4523	4975	5428	5880	453
14	Durgapur	1277	1891	2291	2798	4260	5366	6184	7002	7819	8637	818
8	Dwitiya Balupur	750	264	0	0	0	0	0	0	0	0	0
1	Gadai Maharajpur	4297	6137	8253	10231	10744	15023	17168	19313	21459	23604	2145
37	Ghumania	0	0	0	0	0	64	77	90	102	115	13
30	Haragobindapur	139	170	207	241	926	479	547	615	683	751	68
44	Harinkol	698	777	1024	1187	1513	1961	2214	2466	2719	2971	253
28	Haripur Gopi	1404	1765	2131	2495	2705	3300	3679	4058	4438	4817	379
5	Ishwarpar	659	762	857	956	974	725	738	751	765	778	13
20	Jannagar	1289	1749	2242	2719	3094	4140	4710	5280	5851	6421	570
31	Kalutola	752	1020	1251	1501	1553	2015	2268	2520	2773	3025	253
3	Kamalpur	3902	5415	6068	7151	5025	6802	7382	7962	8542	9122	580
50	Kankot	1468	1971	2824	3502	4748	6491	7496	8500	9505	10509	1005
40	Karbana	1212	1432	2076	2508	3324	4046	4613	5180	5746	6313	567
15	Kasichak	646	87	255	60	433	612	612	612	612	612	0
10	Kotoali	457	841	227	112	322	489	495	502	508	515	6
17	Kshidirganj	0	0	1184	1776	464	574	689	804	918	1033	115
36	Mahadebpur	4	32	0	0	625	847	1016	1184	1353	1521	169
4	Maniknagar	3844	5282	5431	6225	7943	8877	9884	10890	11897	12903	1007
27	Mohanpur	439	568	840	1041	1290	892	983	1073	1164	1254	91
22	Nandanpur Gopalpur	370	364	440	475	906	797	882	968	1053	1139	85
26	Narottampur	117	501	973	1401	2047	3554	4241	4929	5616	6304	687
38	Nijgaon Faridpur	270	317	460	555	1333	2093	2458	2822	3187	3551	365
2	Paschim Ratanpur	237	182	264	278	651	988	1138	1288	1439	1589	150
18	Radha Nagar	1043	1194	965	926	1866	2694	3024	3354	3685	4015	330
33	Raghunathpur Kalekhan	130	151	368	487	589	765	892	1019	1146	1273	127
9	Ramnagar	249	359	0	0	0	0	0	0	0	0	-50
41	Rampur	543	680	1308	1691	1554	1953	2235	2517	2799	3081	282
34	Ratua	2165	2675	3256	3802	4685	5498	6165	6831	7498	8164	667
35	Rukundipur	2889	3473	4297	5001	5804	7260	8134	9008	9883	10757	874
6	Saha Nagar	1119	1398	2573	3300	2907	3585	4078	4571	5065	5558	493
11	Sambalpur	862	1024	910	934	1076	1333	1427	1521	1616	1710	94
43	Seharakol	0	0	5	8	23	98	118	137	157	176	20
25	Shibpur	913	837	230	0	223	254	122	0	0	0	-132
23	Surjapur	458	541	669	775	899	1082	1207	1332	1456	1581	125
21	Terashia Debipur	576	712	950	1137	722	949	1024	1098	1173	1247	75
7	Udaypur	413	1289	1274	1705	1314	1474	1686	1898	2111	2323	212
Total Population		53953	68093	85612	102055	124678	157772	178742	199722	220825	241927	

Census	Total Population	Increase in Population	% population on increase per decade
1961	53953		
1971	68093	14140	26.208
1981	85612	17519	25.72805
1991	102055	16443	19.20642
2001	124678	22623	22.16746
2011	157772	33094	26.54358
2021	178742	20970	13.29133
2031	199722	20980	11.73759
2041	220825	21103	10.56619
2051	241927	21102	9.555983

12. Water Demand Estimation and Design Process

Whenever an engineer is given the duty to design a water supply scheme for a particular section of the community, it becomes imperative upon him, to first of all, evaluate the amount of water available and the amount water demanded by the public. In fact, the first study is to consider the demand and then the second requirement is to find sources to fulfil that demand.

Generally we considered per day consumption of water per person is 135 litre (135 lpcd)

But according to PHE Department we considered only 55 lpcd.

There are various types of water demands, but following water demand considered during PHE Supply scheme:

i. Domestic Water Demand :

$$\left(\frac{Populatin\ of\ the\ community\ or\ area\ x\ 55}{1000}\right)\ KLD$$

Unit- KLD (Kilo-litre per day)

ii. Institutional Demand :
5% of Domestic Demand

iii. Distribution Loss :
10% of (Institutional demand + Domestic demand)

iv. Treatment Loss :
5% of (Institutional demand + Domestic demand)

Therefore, the total water demand for a community or area is equal to the sum of all these demands. (Gross Water Demand= i+ii+iii+iv)

Block	Estimated Total Poppulation 2051	Domestic Demand (KLD)	Institutional Demand (KLD)	Distribution Loss (KLD)	Treatment Loss (KLD)	Gross Demand (KLD)
RATUA-1	241927	13305.985	665.29925	1397.1284	698.5642	16067

13. Tube Well Design – Theory, Standards, and Calculations

A **tube-well** is a type of well in which a long, narrow steel pipe is bored deep into the ground to extract groundwater. It is one of the most efficient and widely used methods for water supply in rural and semi-urban areas. Tube-wells are especially suitable for areas with deep water tables and permeable soil strata such as alluvial plains. The proper design and construction of tube-wells are essential to ensure sufficient yield, longevity, and sustainable groundwater withdrawal.

The primary objective of tube-well design is to ensure that the required quantity of groundwater can be extracted to meet the **average daily demand** of a specific area in a **safe, sustainable, and efficient** manner. The design process takes into consideration the local hydrogeological conditions, water demand, discharge capacity, velocity constraints, and mechanical details of the well structure.

Functions of Tube Well Components

1. **Housing Pipe**

- Protects the borehole from collapse.
- Supports the well assembly during and after construction.
- Prevents surface contaminants from entering the aquifer.

2. **Well Pipe**

- Acts as the main vertical conduit for lifting water from the aquifer to the surface.
- Houses the pump column or submersible pump.

3. **Reducer**

- Connects pipes of different diameters in the well assembly.
- Ensures smooth transition and minimizes head loss.

4. **Strainer**

- Filters out sand and silt from the pumped water.
- Allows only clean water to pass through.

5. **Pump**

- Lifts groundwater to the surface at the required discharge rate and head.

Design Considerations:

1. **Water Demand Estimation:**
   - The **average daily demand** of the area (e.g.,16067 KLD for Ratua-1 block) is calculated based on population, per capita consumption, and service hour requirements.
   - This is then converted into **hourly demand** by dividing by the number of pumping hours per day.
2. **Number of Tube-Wells:**
   - The total number of tube-wells required depends on **topographical conditions**, such as terrain undulation, elevation differences, village dispersion, and accessibility.
   - In this case, **7 tube-wells** are considered optimal for the 50 villages of Ratua-1 block.
3. **Discharge Calculation:**
   - The hourly and per-minute discharge per tube-well is calculated by dividing the total hourly demand by the number of tube-wells.
   - Discharge is expressed in multiple units – kilolitres per hour (KL/hr), litres per minute (LPM), and cubic meters per second (cumec), to suit design checks.
4. **Yield Consideration:**
   - The **expected yield** per standard tube-well is considered around **7 KL/hr**, whereas standard designs usually operate within **40–45 L/sec**.
   - This helps in deciding the number of replacement and new wells needed for sustainability.

Design Steps of Tube-Well:

- Average daily demand of Ratua-1 (50 villages) = 16067 KLD
- Hour of Pumping = 16 hrs.
- ∴ hourly demand = $\frac{16067}{16}$ = 1004.187 KL/hr.
- No. of tube-wells varies according to topographical conditions due to uneven terrain, scattered villages, elevation differences, accessibility issues etc.
- So, for the 50 villages of Ratua-1 Block, total number of Tube-Well required = 10
- Hourly discharge per Tube-Well = $\frac{1004.187}{7}$ = 143.455 KL/hr.
- Discharge in Litre per minute per Tube-Well = $\frac{143.455 \ x \ 1000}{60}$ = 2390.916 L/min/TW
- Discharge in Cu m per sec. per Tube-Well = $\frac{2390.916}{60 \ x \ 1000}$ = 0.0398 Cum/sec.

Expected yield of each Tube-Well = 7 KL/hr.

Discharge through standard Tube-Well is generally about 40 to 45 litres/sec.= 154.8 KL/hr

Therefore considering 7 number new Tube-Well will be sufficient to meet present demand.

- Length of housing Pipe is calculated below:
  i. Static head = 8 m.
  ii. Yearly fluctuation = 10 m.
  iii. Permissible drawdown = 4 m.
  iv. Length of pump = 2 m.
  v. Additional length = 24 m.
  Total Length = 48 m.
- Length of housing pipe provided = 36 m.
- Provided diameter of housing pipe = 250 mm
- Diameter of well pipe = 210 mm
- Diameter of strainer = 210 m.
- Length of strainer = 45 m

Check Velocity:

i. **Entry Velocity :**

Effective opening are of the strainer with slot size 0.25 mm is 10% of gross strainer area.

Assuming 50% sand bridging around strainer, consider effective area of slot opening 50% of slot area.

Hence actual total effective area of slot opening per tubewell

= Grain slot area X effective area X (3.14 x dia. of strainer)

= 0.5 x 0.1 x 3.14 x 0.2 x 45

= 1.413 sq-m

Entry velocity of ground water through strainer per Tube-Well-

$$= \frac{Discharge\ per\ tubewell}{Effective\ area\ of\ slot\ opening\ per\ Tubewell}$$

$$= \frac{0.0398}{1.413}\ x\ 100$$

= 2.8167 cm/sec

As per IS 8110-2000;

The permissible entrance velocity is = 0.03 m/sec = 3 cm/sec

3 cm/sec > 2.8167 cm/sec hence okay.

ii. Velocity of Rise (at Well Pipe):

Area of Well pipe = $\frac{\pi}{4}\ .\ d^2$

$= \frac{\pi}{4}\ .\ 0.21^2$

= 0.0346 m^2

Velocity of Rise in the Well pipe = $\frac{Discharge\ of\ Tubewell}{Area\ of\ Well\ pipe}$

$$= \frac{Hourly\ discha\quad per\ tubewell}{Area\ of\ Well\ pipe}$$

$$= \frac{0.0398}{0.0346}$$

= 1.15 m/sec

1.2 < 1.15 > 0.85656

The ideal velocity for well pipe is typically considered between 0.6 to 1.2 m/s

demand	sup. Hr	sup./hr	no of tw	hr. dis./tw	dis. In litre / min per tw	disx. Per tubewell in cum/sec.
16067	16	1004.187	7	143.455	2390.916	0.0398

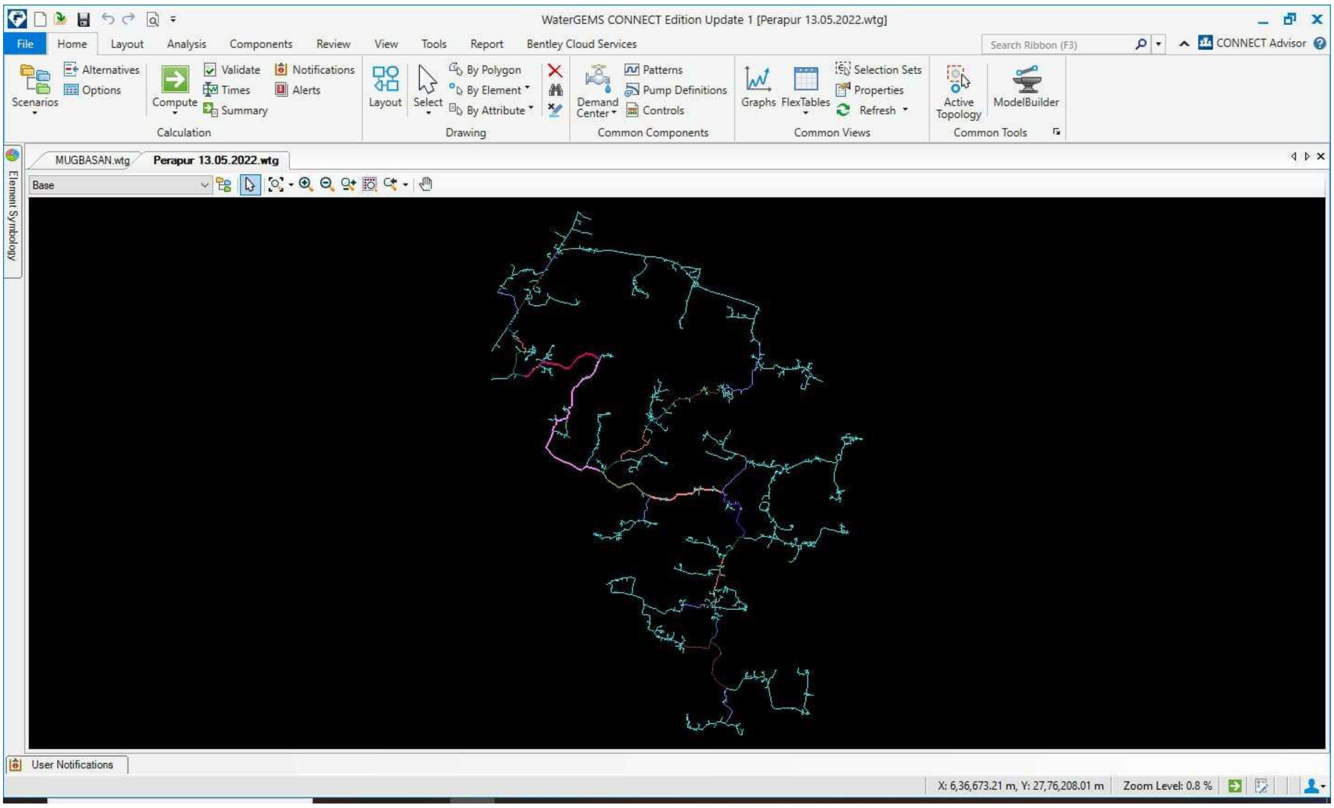
FlexTable: Pipe Table (Current Time: 0.000 hours) (Perapur 13.05.2022.wtg)

	Label	Start Node	Stop Node	Length (Scaled) (m)	Diameter (mm)	Material	Hazen-Williams C	Flow (L/s)	Velocity (m/s)	Headloss Gradient (m/km)
2543: P-634	P-634	J-897	J-921	13.54	83.8	uPVC	145.0	3.012	0.55	3.990
2186: P-485	P-485	J-921	J-925	10.88	83.8	uPVC	145.0	3.001	0.54	3.962
5558: P-2133	P-2133	J-463	J-379	174.90	83.8	uPVC	145.0	-2.985	0.54	3.924
5119: P-1932	P-1932	J-925	J-1008	66.14	83.8	uPVC	145.0	2.949	0.53	3.835
1952: P-396	P-396	J-1008	J-1036	8.66	83.8	uPVC	145.0	2.923	0.53	3.774
5560: P-2134	P-2134	J-572	J-466	130.28	83.8	uPVC	145.0	-2.917	0.53	3.759
4045: P-1336	P-1336	J-1036	J-1076	24.65	83.8	uPVC	145.0	2.902	0.53	3.724
3933: P-1279	P-1279	J-1076	J-1098	23.54	83.8	uPVC	145.0	2.885	0.52	3.685
4948: P-1837	P-1837	J-644	J-572	51.33	83.8	uPVC	145.0	-2.857	0.52	3.618
2865: P-772	P-772	J-648	J-644	15.22	83.8	uPVC	145.0	-2.830	0.51	3.555
4816: P-1760	P-1760	J-1098	J-1243	43.05	83.8	uPVC	145.0	2.829	0.51	3.552
3750: P-1188	P-1188	J-652	J-648	21.50	83.8	uPVC	145.0	-2.802	0.51	3.490
3741: P-1184	P-1184	J-1243	J-1313	21.45	83.8	uPVC	145.0	2.800	0.51	3.485
4577: P-1624	P-1624	J-1313	J-1393	34.73	83.8	uPVC	145.0	2.774	0.50	3.425
5026: P-1880	P-1880	J-666	J-652	56.46	83.8	uPVC	145.0	-2.769	0.50	3.413
4875: P-1793	P-1793	J-1393	J-1463	49.17	83.8	uPVC	145.0	2.743	0.50	3.355
1852: P-358	P-358	J-671	J-666	8.78	83.8	uPVC	145.0	-2.726	0.49	3.316
3509: P-1068	P-1068	J-675	J-671	19.54	83.8	uPVC	145.0	-2.704	0.49	3.267
5024: P-1878	P-1878	J-699	J-675	56.23	83.8	uPVC	145.0	-2.681	0.49	3.216
2262: P-516	P-516	J-703	J-699	11.55	83.8	uPVC	145.0	-2.639	0.48	3.124
3647: P-1137	P-1137	J-1463	J-1515	20.90	83.8	uPVC	145.0	2.627	0.48	3.097
4590: P-1633	P-1633	J-1515	J-1520	35.00	83.8	uPVC	145.0	2.605	0.47	3.048
5348: P-2071	P-2071	J-1520	J-1642	155.03	83.8	uPVC	145.0	2.547	0.46	2.924
5354: P-2075	P-2075	J-816	J-824	151.91	83.8	uPVC	145.0	2.521	0.46	2.870
4945: P-1834	P-1834	J-824	J-848	51.30	83.8	uPVC	145.0	2.473	0.45	2.769
4837: P-245	P-245	J-304	J-302	44.10	102.6	uPVC	145.0	-4.191	0.51	2.745
5455: P-2123	P-2123	J-907	J-703	758.34	83.8	uPVC	145.0	-2.452	0.44	2.726
5450: P-267	P-267	J-729	J-832	609.26	102.6	uPVC	145.0	4.143	0.50	2.686
5325: P-2058	P-2058	J-848	J-983	116.27	83.8	uPVC	145.0	2.431	0.44	2.682
5368: P-261	P-261	J-306	J-304	153.59	102.6	uPVC	145.0	-4.134	0.50	2.676
2506: P-617	P-617	J-983	J-989	13.34	83.8	uPVC	145.0	2.383	0.43	2.585
5257: P-2012	P-2012	J-989	J-1082	90.48	83.8	uPVC	145.0	2.350	0.43	2.519
5172: P-255	P-255	J-318	J-306	76.07	102.6	uPVC	145.0	-3.972	0.48	2.484
2348: P-552	P-552	J-1082	J-1090	12.28	83.8	uPVC	145.0	2.315	0.42	2.451
2209: P-496	P-496	J-1090	J-1100	11.13	83.8	uPVC	145.0	2.307	0.42	2.434
5197: P-256	P-256	J-369	J-318	79.27	102.6	uPVC	145.0	-3.917	0.47	2.421
4019: P-1321	P-1321	J-1100	J-1110	24.33	83.8	uPVC	145.0	2.289	0.42	2.400
4655: P-239	P-239	J-379	J-369	38.58	102.6	uPVC	145.0	-3.798	0.46	2.287
1731: P-215	P-215	J-789	J-785	4.38	102.6	uPVC	145.0	-3.798	0.46	2.286
3935: P-233	P-233	J-791	J-789	23.50	102.6	uPVC	145.0	-3.775	0.46	2.262
1955: P-397	P-397	J-1110	J-1115	8.66	83.8	uPVC	145.0	2.212	0.40	2.251

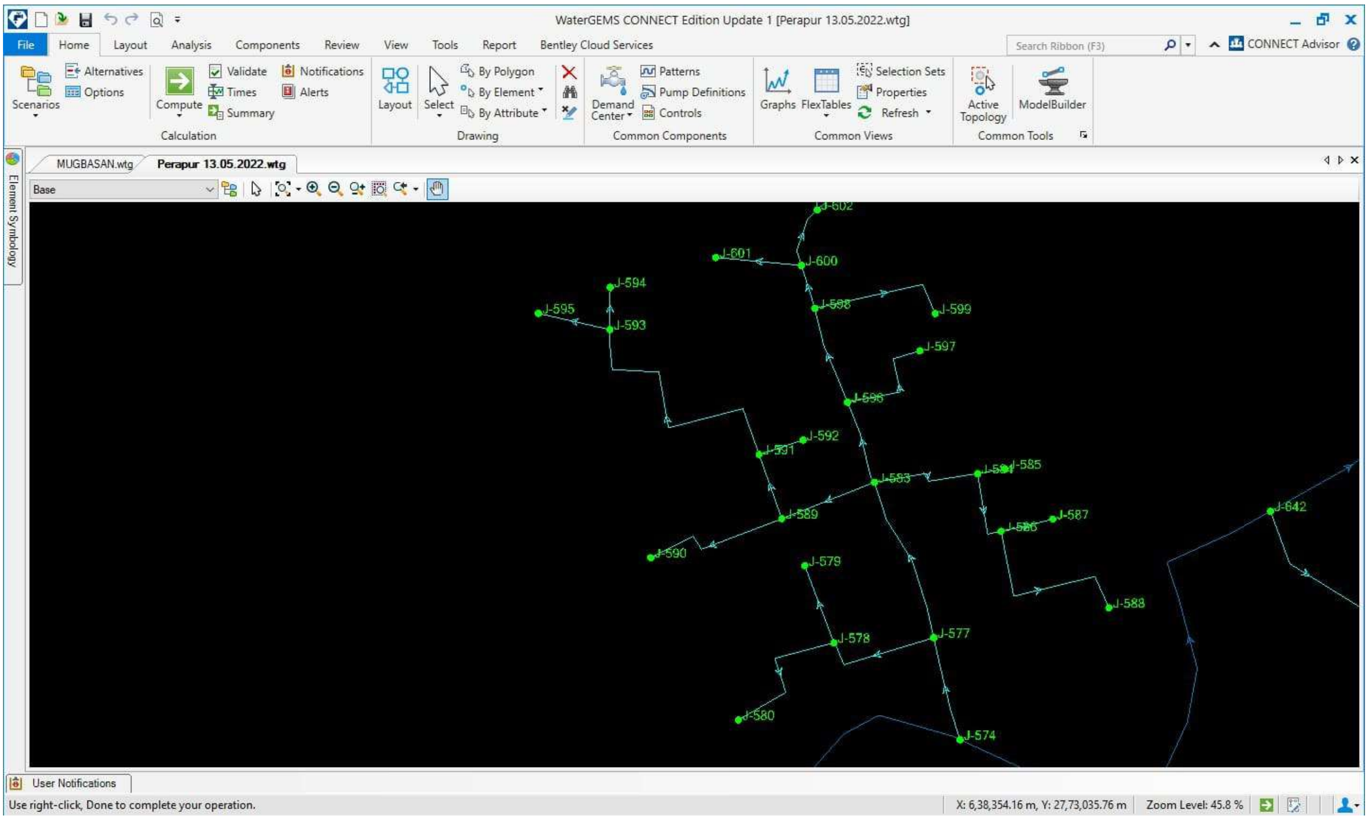
2145 of 2145 elements displayed

SORTED

- Figure : Pipe FlexTable Showing Hydraulic Parameters in WaterGEMS



- Figure : Water Distribution Network Layout in WaterGEMS



- Figure : Junctions and Pipe Connections in WaterGEMS Model

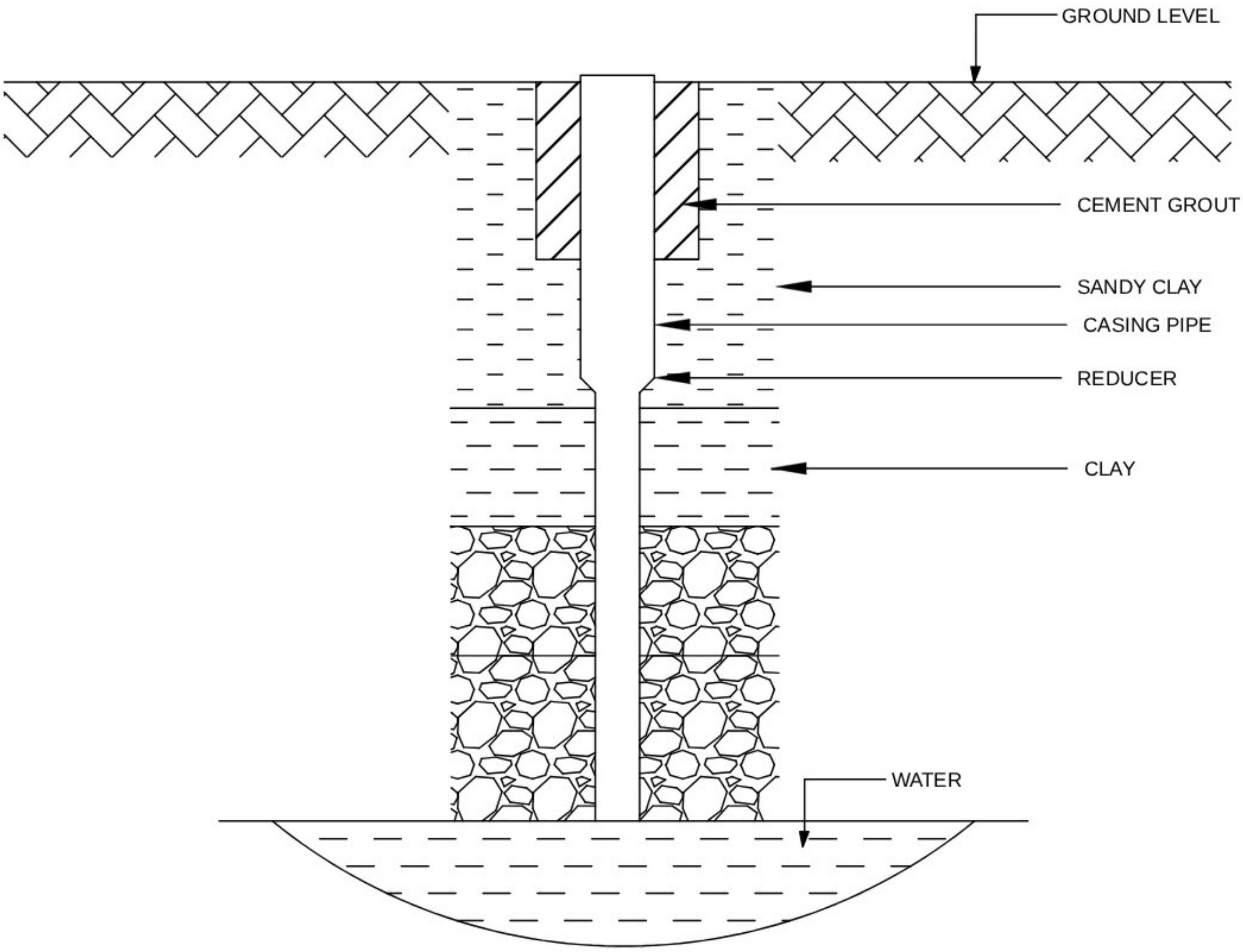
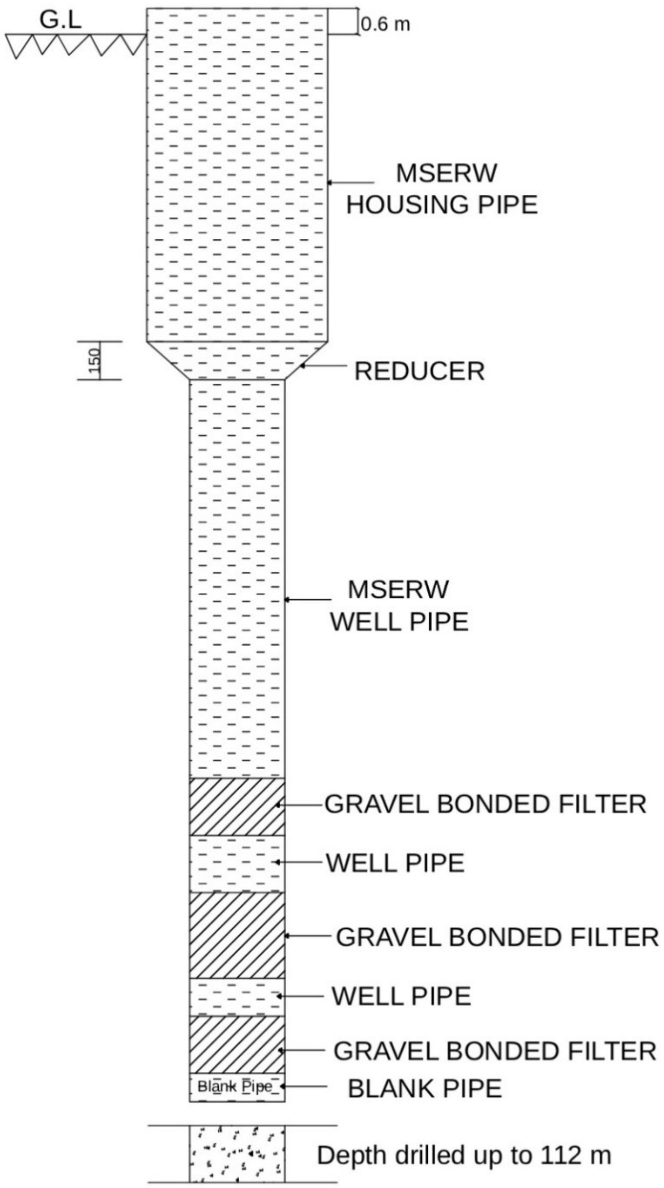


Fig.-TUBE WELL

TUBE WELL ASSEMBLY	
250 mm dia. MSERW Housing	36.60 mm
210 mm dia. MSERW Well Pipe	52.38 mm
210 mm dia. Pre packed resin Bonded gravel filter (shrouded screen on MS Slotted Pipe)	21.37 mm
210 mm dia. MSERW Blank Pipe	3.05 mm
250 mm dia. M.s top cap	1 nos.
250 mm dia. MS Housing Clamp	1 pair
250 mm X 210 mm dia. Reducing socket	1 nos.
210 mm dia M.S Centre Guide	6 sets
210 mm dia M.S Bottom cap	1 nos.
<u>M.S Ring;</u> 250 mm dia.: 210 mm dia.:	 5 nos. 16 nos.



Note: Drawing is not to accurate Scale

14. Tube-Well Estimation & Costing:

			TABLE: III
DETALED ESTIMATE FOR TUBE WELL			
MALDA (ZONE-I) PIPED WATER SUPPLY SCHEME			
BLOCK – RATUA-I, DISTRICT- MALDA			
Details of tubewell:			
A.	Nos of Tubewell:	10	250 mm x150 x 300 mtr Depth
B.	Yield:	7.0	KL/Hr. Per tube-well
		Diameter	**Length**
Housing Pipe		250	36 m
Well pipe		210	216
Strainer		210	45 m
Blank pipe		210	3
			300

Sl No.	Description of item	Unit	Quantity	Rate (Rs)	Amount (Rs)
1	Site Preparation, Temporary Latrine, Placement & levelling of Rig Machine, Mast hoisting and Casing drilling (Up to 6 mtr.) Placement of Casing with all allied works necessary to commence drilling woks and wind up of all machineries after completion of Drilling. **[Ref. PHED SOR Civil, Pg.-TW-1, It-1]**	L.S	1	64146	64146
2	Drilling by Direct Rotary method of drilling using 9 7/8" dia.bit for pilot bore followed by subsequently reaming using 12 1/4" dia. ,15"dia. and 17.5" dia. Rock Roller Bits/Drag Bits in consolidated, semi consolidated and soft formation up to required depth including casing boring and casing lowering as required including cost of fuels and lubricants etc. as required for drilling.				
	1) Rate only for pilot drilling				
	i) From 6 Mtr. to 60 Mtr.	Mtr	54	442.5	23895
	ii) From 60 Mtr. to 90 Mtr.	Mtr	30	487	14610

	iii) From 60 Mtr. to 90 Mtr.	Mtr	30	535.5	16065
	iv) From 120 Mtr. to 150 Mtr.	Mtr	30	589	17670
	v) From 150 Mtr. to 180 Mtr.	Mtr	30	648	19440
	vi) From 180 Mtr. to 210 Mtr.	Mtr	30	713	21390
	vii) From 210 Mtr. to 240 Mtr	Mtr	30	784.5	23535
	viii) From 240 Mtr. to 270 Mtr.	Mtr	30	863	25890
	ix) From 270 Mtr. to 300 Mtr.	Mtr	30	949.5	28485
	2) Rate for reaming by 12-1/4" dia. bit				
	i) From 6 Mtr. to 60 Mtr.	Mtr	54	123.9	6690.6|
	ii) From 60 Mtr. to 90 Mtr.	Mtr	30	136.36	4090.8|
	iii) From 60 Mtr. to 90 Mtr.	Mtr	30	149.94	4498.2
	iv) From 120 Mtr. to 150 Mtr.	Mtr	30	164.92	4947.6
	v) From 150 Mtr. to 180 Mtr.	Mtr	30	181.44	5443.2
	vi) From 180 Mtr. to 210 Mtr.	Mtr	30	199.64	5989.2
	vii) From 210 Mtr. to 240 Mtr	Mtr	30	219.66	6589.8
	viii) From 240 Mtr. to 270 Mtr.	Mtr	30	241.64	7249.2
	ix) From 270 Mtr. to 300 Mtr.	Mtr	30	265.86	7975.8
	3) Rate for reaming by 15 " dia. bit.				
	i) From 6 Mtr. to 60 Mtr.	Mtr	54	141.6	7646.4
	ii) From 60 Mtr. to 90 Mtr.	Mtr	30	155.84	4675.2
	iii) From 60 Mtr. to 90 Mtr.	Mtr	30	171.36	5140.8
	iv) From 120 Mtr. to 150 Mtr.	Mtr	30	188.48	5654.4
	v) From 150 Mtr. to 180 Mtr.	Mtr	30	207.36	6220.8
	vi) From 180 Mtr. to 210 Mtr.	Mtr	30	228.16	6844.8
	vii) From 210 Mtr. to 240 Mtr	Mtr	30	251.04	7531.2
	viii) From 240 Mtr. to 270 Mtr.	Mtr	30	276.16	8284.8
	ix) From 270 Mtr. to 300 Mtr.	Mtr	30	303.84	9115.2
	4) Rate for reaming by 17.5 " dia. bit				
	i) From 6 Mtr. to 60 Mtr.	Mtr	54	177	9558
	ii) From 60 Mtr. to 90 Mtr.	Mtr	30	194.8	5844
	iii) From 60 Mtr. to 90 Mtr.	Mtr	30	214.2	6426
	iv) From 120 Mtr. to 150 Mtr.	Mtr	30	235.6	7068
	v) From 150 Mtr. to 180 Mtr.	Mtr	30	259.2	7776
	vi) From 180 Mtr. to 210 Mtr.	Mtr	30	285.2	8556
	vii) From 210 Mtr. to 240 Mtr	Mtr	30	313.8	9414
	viii) From 240 Mtr. to 270 Mtr.	Mtr	30	345.2	10356
	ix) From 270 Mtr. to 300 Mtr.	Mtr	30	379.8	11394
	[Ref. PHED SOR Civil, Pg.-TW-1, It-2]				
3	Supply and delivery of UPVC pipe (CD) conforming to IS 12818:2010. (CIPET Certified)				
	b) 250 mm. dia.	Mtr	60	4158	249480
	c) 210 mm. dia.	Mtr	210	1551	325710
4	Supply and delivery of UPVC Deep Well Screen (RDS) Pipes with Ribs conforming to IS 12818:2010(CIPET Certified)				

	210 mm. dia.	Mtr	30	2367	71010
	[Ref. PHED SOR Civil, Pg.-TW-3, It-10]				
5	Supply and delivery of UPVC Reducer **(Ref. PHED SOR Corri on 28.2.22)**				
	200 mm X210 mm	Each	1	1213|	1213
	250mm X 200 mm	Each	1	1967	1967
6	Supply and delivery at site of UPVC End Cap				
	210 mm dia	Each	1	685	685
	250 mm dia	Each	1	1960	1960
	[Ref. PHED SOR Civil, Pg.-TW-3, It-14 (b)&(d)]				
7	Supply and delivery of M.S. Housing clamp 250 mm dia **[Ref. PHED SOR Civil, Pg.-TW-3, It-15]**	Set	1	3252|	3252
8	Supply and delivery of M.S. Centre guide (Special Type) **[Ref. PHED SOR Civil, Pg.-TW-3, It-16]**	Set	6	950	5700
9	Supply and delivery of Washed gravel size ranging from 1.80 mm to 4.74 mm. conforming to IS 4097: 1967 **[Ref. PHED SOR Civil, Pg.-TW-3, It-17]**	Cu. m	13	3810|	49530|
10	Electro-logging charge. **[Ref. PHED SOR Civil, Pg.-TW-3, It-19]**	L.S	1	15715	15715
11	Lowering the tube well assembly (UPVC Casing pipe, well pipe, strainer along with UPVC accessories) vertically in a position with proper lowering arrangement by applying necessary jointing compound including labour cost for subsequent gravel packing and machine operation cost etc. **[Ref. PHED SOR Civil, Pg.-TW-3, It-4]**	LS	1	26571	26571
12	Protective sealing for upper saline aquifer by packing annular space of the well pipe and bore cement and sluff and water proofing compound @30% by weight of cement W.P.C. labour charges for sealing including carriage of tools and plants and other equipment what so ever will be required.	Mtr	10	1336.5	13365
13	Development (Min. 8 Hr. continuous) of tube well by using suitable air compressor (Min. Capacity: 600CFM & operating Pressure 14 Bar) followed by yield testing with BHT pump (Head :45 to 50mtr., Discharge :1100 to 1000 LPM and 25 BHP engine) all complete including To & Fro Transportation cost and Cost of fuels, lubricants & Labour etc.	L.S	1	56908	56908

	[Ref. PHED SOR Civil, Pg.-TW-3, It-6]				
14	Packing annular space between the outside of the housing pipe and the bore with puddle clay balls of approved size as per direction of the E.I.C. with cost of all materials and labour complete.	cum	15	417	6255
15	Water sample collection and chemical test including Arsenic Test. **[Ref. PHED SOR Civil, Pg.-TW-2, It-7]**	L.S	1	2425	2425
16	Transportation cost of drilling equipment and accessories rig machine etc. including cost of fuel, Lubricant & loading unloading the materials from store/stack yard /supplier's godown and unloading /stacking the same at site. (Up to 60.0 km distance.) **[Ref. PHED SOR Civil, Pg.-TW-2, It-8]**	L.S	1	59786|	59786|
17	Supply and delivery of Bentonite Powder conforming to IS 6186 :1986 [Ref. PHED SOR Civil, Pg.-TW-3, It-18]	MT	1	13963	13963
18	Labour for making arrangement for showing verticality test including the cost for hire charges of tools and plants, scaffolding labour etc. all complete	L.S	1	916|	916
19	Solvent cement		8	130	1040
				Total=	₹13,53,557.0

Note: Above estimation and costing rate may vary from actual govt. rate / market rate

15. Technical Learnings during Internship

- Population data interpretation using census and local records
- Water demand calculation under real-world constraints
- Hydraulic design and discharge estimation for groundwater extraction
- Importance of IS Codes in structural and hydraulic design
- Role of loss considerations in realistic planning
- Groundwater safety, recharge strategies, and well yield estimation

16. Challenges Faced During Internship

- Limited Access to Advanced Simulation Software
  Due to software licensing restrictions and limited infrastructure at the field level, there was minimal use of advanced design or hydraulic simulation tools, which slightly affected the precision and speed of technical analysis.

- Language and Communication Gaps During Site Visits
  At some project sites, local dialects and regional language barriers created communication difficulties with field staff and workers, occasionally leading to delays in instructions and understanding site conditions.

- Real-Time Changes in Design Due to Field Topography
  Unexpected variations in ground levels and soil conditions required frequent on-the-spot adjustments in pipe alignment, foundation depth, or layout plans, which was challenging to accommodate within tight schedules.

- Delayed Data Inputs During Survey Phase
  Data from field surveys, such as population figures, bore depth, or GPS locations, were sometimes received late or in inconsistent formats, causing delays in preparing accurate design calculations and proposals.

17. Recommendations for Future Work

- Introduce SCADA-based monitoring of flow and chlorination
- Incorporate solar-powered pumps to reduce operating cost
- Provide training for local maintenance teams
- Add GIS layers to planning documents

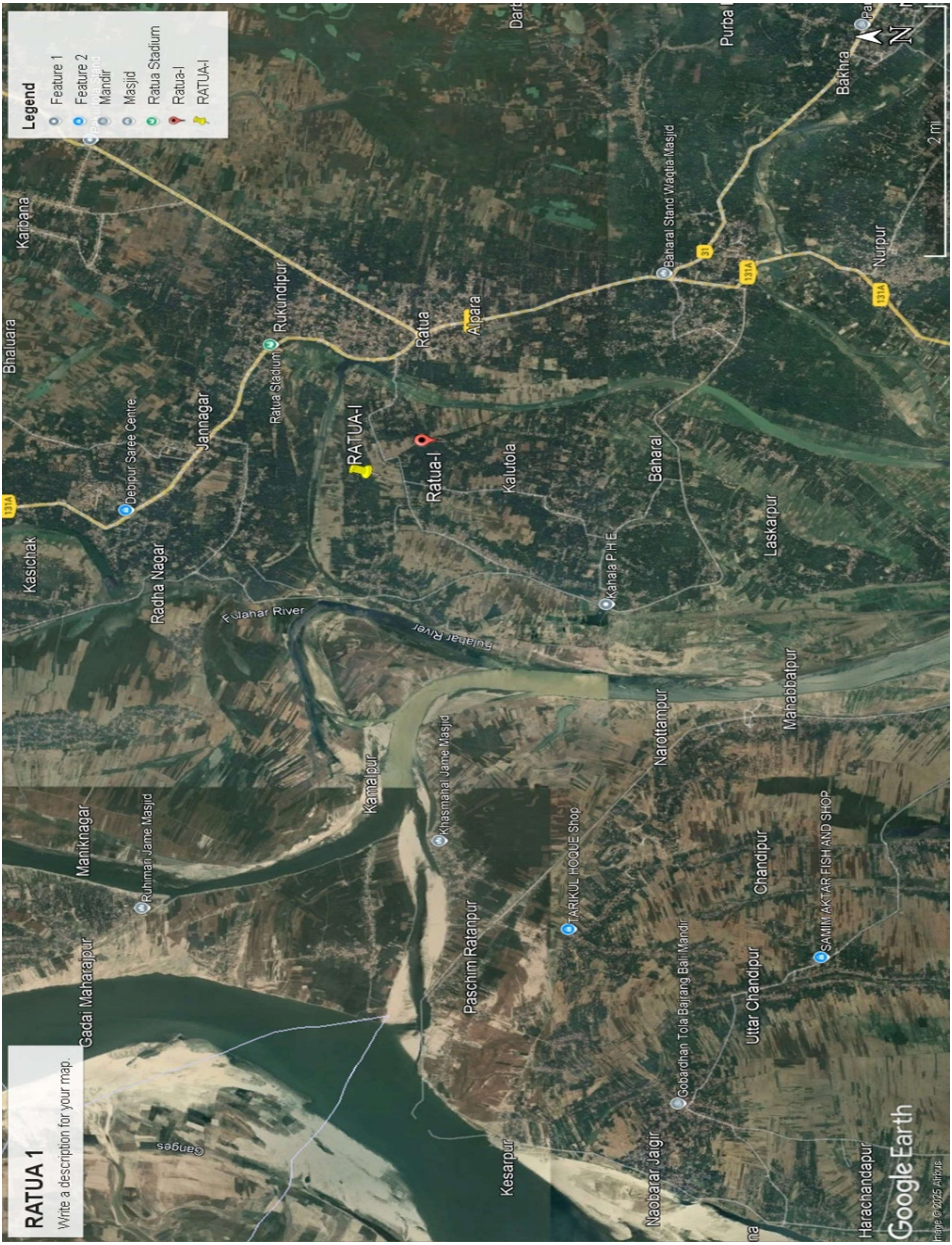
18. References

- IS 1172:1993 – Code of Basic Requirements for Water Supply, Drainage, and Sanitation
- IS 456:2000 – Code of Practice for Plain and Reinforced Concrete (Limit State Method)
  Essential for design of reservoirs, water tanks, foundations, etc.
- IS 1893 (Part 1):2016 – Criteria for Earthquake Resistant Design of Structures
  Originally IS 1893:1984, now updated in 2016
- IS 3370 (Part I to IV) – Code of Practice for Concrete Structures for the Storage of Liquids
- IS 2911 – Design and Construction of Pile Foundations
- IS 10500:2012 – Drinking Water Quality Standards
- IS 8110: Design Guidelines for Tube Wells
- IRC codes for pipeline alignment
- PHE Guidelines, Government of West Bengal
- Class Notes and Internship Materials

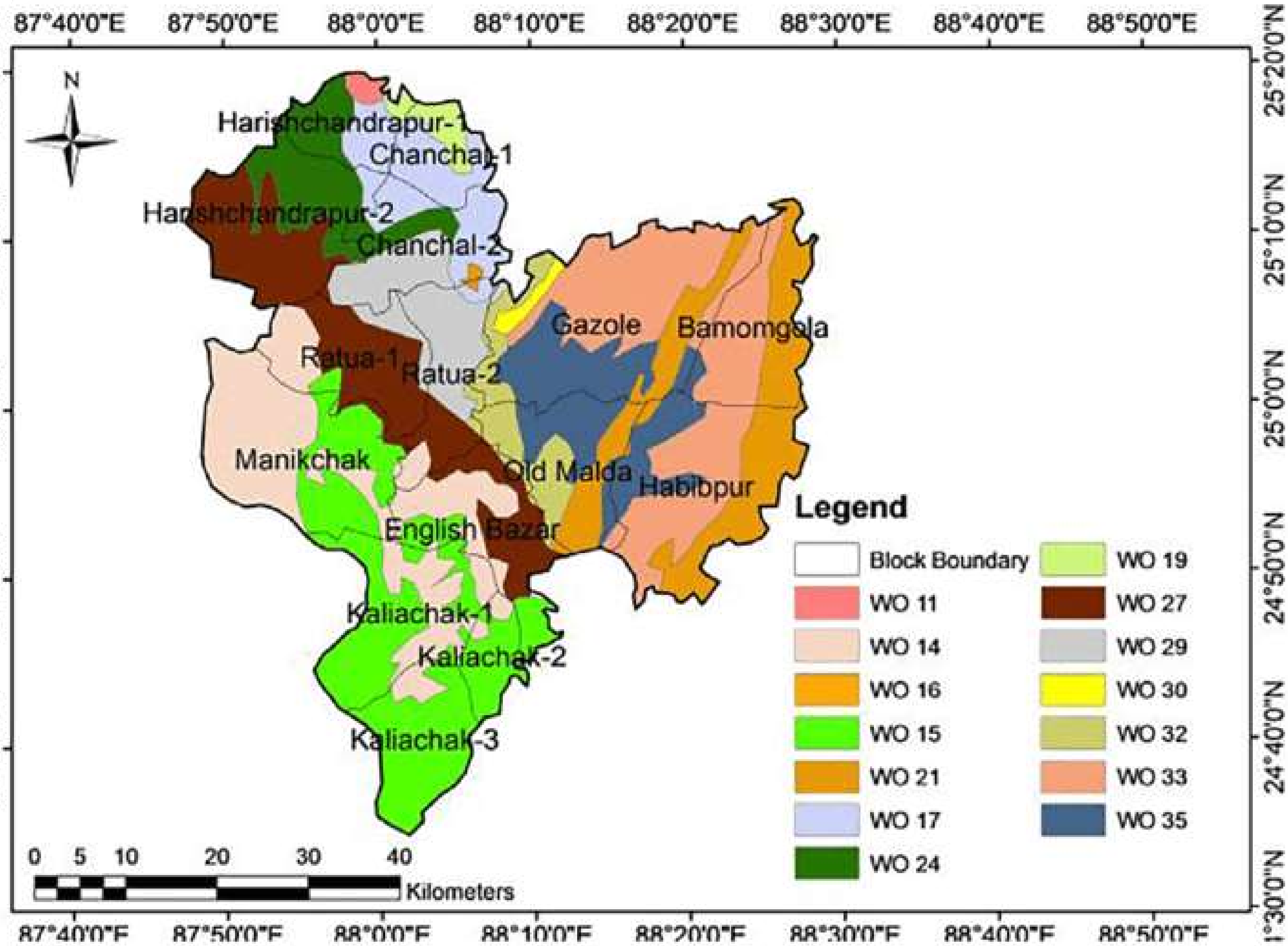
19. Conclusion

This internship provided hands-on exposure to water supply system design, especially in the context of rural Bengal. Learning to apply civil engineering principles in real field conditions has been a rewarding experience. The technical, observational, and analytical insights gained here will undoubtedly shape my professional journey.

Looking ahead, future scope lies in the integration of **digital modeling tools**, **automation in water treatment and distribution**, and **sustainable practices such as renewable energy-driven pumping and advanced water quality monitoring**. These innovations will make rural water supply systems more efficient, reliable, and environmentally sustainable.

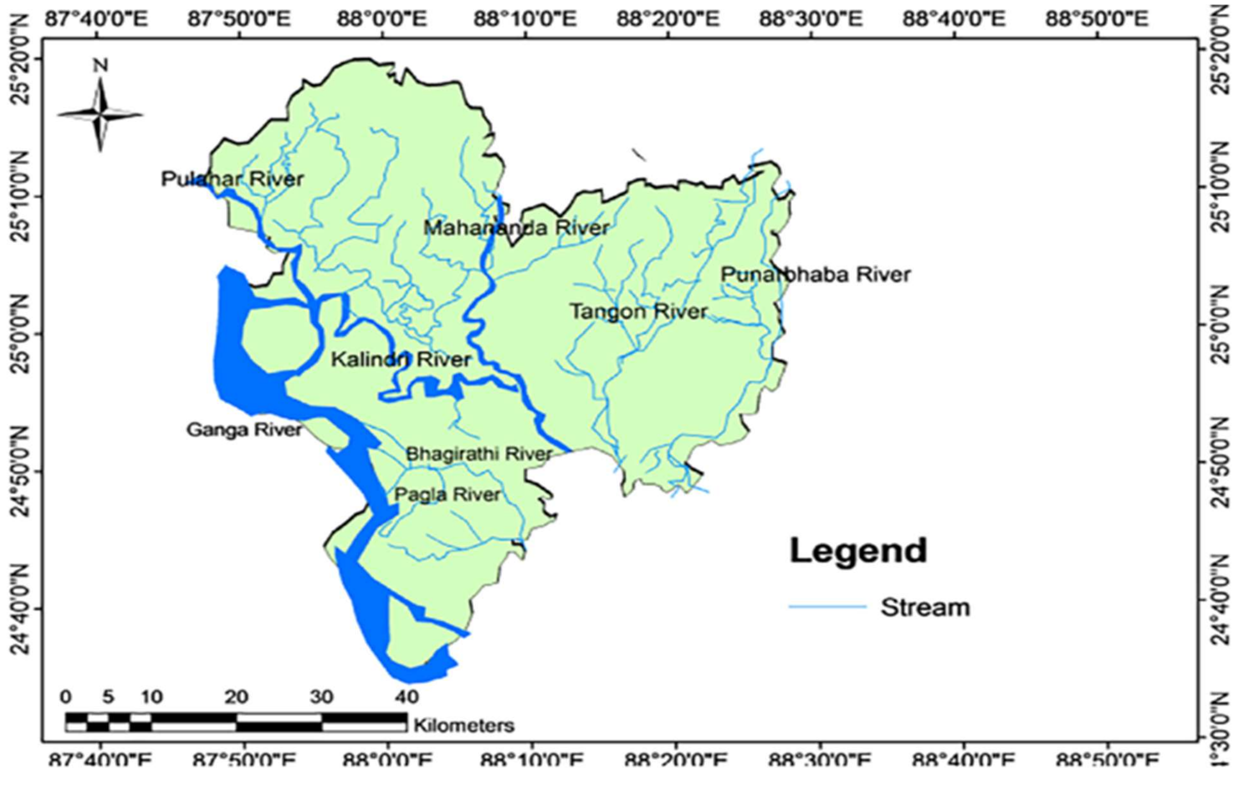


RATUA-I : GOOGLE EARTH PRO MAP FOR GEOGRAPHICAL INFORMATION



Soil-map-of-Malda-district

Drainage-map-of-Malda-district



Website:

HTTPS://SITES.GOOGLE.COM/VIEW/ERSAYEEDCIVIL/HOME

E-Mail:

MSHASAN.BR@GMAIL.COM

Linkedin:

HTTPS://WWW.LINKEDIN.COM/IN/MD-SAYEED-HASAN-6B2711329

-: *End of Extended Report* **:-**

Thank you