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A Study on Drinking Water Supply Distribution System of Guwahati City in Kamrup (M) District, Assam

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Abstract : This paper presents a study on the drinking water supply distribution system in Guwahati city, located in the Kamrup (M) district of Assam, India. The city's drinking water is primarily sourced from surface water, groundwater, and precipitation, with the river Brahmaputra and local groundwater aquifers being the main sources. The supply of drinking water is managed by three major authorities: Guwahati Municipal Corporation (GMC), Public Health and Engineering Department (PHED), and Urban Water Supply and Sewerage Board (UWSSB).

The study provides an overview of the water availability status in the city and highlights the population growth in recent years. The study takes into account the population of Guwahati city, which is projected to reach 16.42 lakhs by the year 2031. Based on this population estimate, the water requirement for the year 2031 is calculated to be 2,216.7 lakh liters per day at a rate of 135 liters per capita per day (lpcd).

The paper discusses the various departments and organizations involved in the drinking water supply system, including the Guwahati Municipal Corporation, Public Health Engineering Department, Central Ground Water Board, Guwahati Metropolitan Development Authority, Northeast Frontier Railway, and Guwahati Refinery. It provides insights into the roles and responsibilities of these entities in ensuring the provision of clean drinking water to the residents.

Furthermore, the paper examines the present water supply position in the city, detailing the surface water and groundwater sources utilized by different water supply agencies. It emphasizes the disparities in water distribution, with some areas experiencing water stress and unequal access to piped water.

The study also discusses the water availability from treatment plants operated by the GMC, PHED, UWSSB, and other organizations. It provides an overview of the surface source plants and deep tube well schemes, along with their capacities and distribution networks. Additionally, the paper highlights the availability of underground potable water through hand pumps and treatment plants operated by PHED and UWSSB.

Based on the findings, the paper concludes that the city faces water stress due to the growing population and unequal distribution of water resources. It raises important questions about the incidence pattern of water stress, its causes, and its impact on vulnerable groups. The study suggests the need for improved water management and infrastructure to meet the increasing water demand and ensure equitable access to safe drinking water for all residents of Guwahati.

Keywords: Drinking water supply, Guwahati city, Water stress, Water distribution, Surface water, Groundwater

1. INTRODUCTION

Access to safe and reliable drinking water is essential to the health and well-being of city dwellers. For Guwahati, the largest city in the Kamrup (M) district of Assam, ensuring an efficient and effective drinking water supply and distribution system is paramount. Rapid urbanization, population growth and changing water demand patterns in cities are creating significant challenges in meeting the water supply needs of residents. This study aims to provide an overview of the existing literature on the drinking water supply distribution system of Guwahati city, synthesizing findings from multiple research papers, reports, and articles.

Guwahati, located on the banks of the Brahmaputra River, serves as a major commercial and administrative hub for the Northeast region of India. The city's population has been steadily increasing over the years, leading to an escalating demand for

clean drinking water. However, the existing drinking water supply distribution system in Guwahati faces various challenges, ranging from inadequate infrastructure to inefficient water management practices.

A study by Bhattacharya et al. (2016) examined the drinking water supply system in Guwahati and identified several challenges. The study highlighted issues related to infrastructure, such as leakages, inadequate storage facilities, and old distribution pipelines. Additionally, it emphasized the need for effective management and monitoring of water supply to minimize disruptions and ensure equitable distribution.

The quality of drinking water is also a significant concern. A study by Kakati et al. (1990), Borah et al (2020) investigated the microbiological quality of surface and groundwater of different areas of Guwahati. The findings indicated the presence of heavy metals, suggesting the possibility of waterborne diseases. The study underscored the importance of regular monitoring, water treatment, and ensuring the quality of water throughout the city.

Another study by Mondal et al. (2017) investigated the distribution network layout and infrastructure in Guwahati. They identified issues such as leakages, low pressure, and inadequate capacity of storage tanks, which led to water supply disruptions and inefficiencies in the distribution system. The study emphasized on the hydraulic analysis of the distribution network in Guwahati. The efficiency of the drinking water supply distribution system depends on various factors, including the design and layout of the network. It emphasized the need for hydraulic modeling and network optimization to improve the system's overall performance.

Furthermore,the issue of non-revenue water (NRW), which includes both physical losses (leakages) and commercial losses (unbilled or unaccounted water), is another crucial aspect of the drinking water supply distribution system. These factors included technical losses, meter inaccuracies, unauthorized connections, and inefficient billing systems. The study emphasized the importance of leak detection, metering, and proper revenue management to reduce NRW and improve financial sustainability.

The distribution of drinking water in an urban setting involves complex governance and institutional arrangements. Research by Mckenzie et al. (2015) examined the institutional framework governing the drinking water supply system in India. The study highlighted the roles and responsibilities of various stakeholders, including the municipal corporation, water supply board, and community-based organizations. It emphasized the need for effective coordination and collaboration among these entities to ensure the smooth operation of the distribution system.

While these studies provide valuable insights into the challenges and issues within the drinking water supply distribution system of Guwahati, several research gaps and areas for improvement remain. Future research should focus on comprehensive water resource management, including source protection, treatment technologies, and demand management strategies. Additionally, study by Singh et al. (2010) suggests the integration of advanced technologies such as remote sensing, GIS, and real-time monitoring systems can enhance the efficiency and effectiveness of the distribution system.

While several challenges exist, there have also been notable successes in the drinking water supply distribution system in Guwahati. For instance, the Guwahati Municipal Corporation (GMC) is focusing on the successful implementation of water metering and consumer engagement programs in the city and Guwahati Metropolitan Development Authority (GMDA) is working on successful completion of Asian Development Bank (ADB) and JICA funded water supply projects.

In Guwahati, the primary source of drinking water is groundwater obtained from dug wells, hand tube wells, and deep tube wells constructed by private individuals. Despite the presence of the Brahmaputra River, the Guwahati Municipal Corporation (GMC) and various government bodies lack the necessary infrastructure to provide piped water to a significant portion of the city's residents. The existing wells are insufficient to meet the current demand, exacerbated by the population growth and groundwater level evaporation during the winter season. The Central Public Health and Environmental Engineering Organization, under the Government of India, implements urban water supply plans to meet the standard requirement of 135 liters per capita per day. However, additional provisions are necessary in metropolitan areas where water is distributed through public standposts at a rate of 40 liters per person per day. The Municipal Corporation authorities are responsible for establishing and maintaining the municipal water supply system, ensuring its efficiency, affordability, and scalability.However, their performance is often hindered by internal challenges like poor management and a lack of resources, as well as external factors such as political influence and centralized decision-making.

To address these issues effectively, it is essential to conduct a comprehensive study of the primary surface and groundwater sources used by various organizations and individual households in Guwahati. This study will shed light on the existing water supply challenges and help identify potential solutions to ensure equitable access to clean drinking water for all residents.

Fig 1 Location of Study Area

Fig. 1.1 Satellite View of Guwahati

2. Objective of the Study

i. Assessment of Present Status of demand & supply of Guwahati city drinking water supply distribution system.
ii. Mapping of existing water supply distribution system using GIS techniques.

3. Methodology

The methodology of the study on the drinking water supply distribution system of Guwahati City in Kamrup (M) District, Assam involves the following steps. First, the water availability status of the city is assessed, considering surface water, groundwater, and precipitation as the primary sources of drinking water. The study acknowledges the three major authorities responsible for providing drinking water: Guwahati Municipal Corporation (GMC), Public Health and Engineering Department (PHED), and Urban Water Supply and Sewerage Board (UWSSB).

Next, the present population of the city is analyzed, indicating a population growth trend over the years. Based on this trend, the projected population for the year 2030 is estimated. The water requirement for 2030 is calculated using a per capita water demand of 135 liters per capita per day (lpcd).

The study involves visiting and gathering information from various departments, including Guwahati Municipal Corporation, Public Health Engineering Department, Central Ground Water Board, Guwahati Metropolitan Development Authority, Northeast Frontier Railway, and Guwahati Refinery. These departments play different roles in the water supply distribution system and contribute to the overall understanding of the current situation.

To assess the water availability and distribution, the study analyzes data from different water supply agencies in the city. It examines the water supply position provided by each agency, including surface water and groundwater sources. Disparities in water distribution between different areas and socioeconomic groups are considered.

The study also investigates the water availability from treatment plants operated by Guwahati Municipal Corporation, Public Health and Engineering Department, Urban Water Supply and Sewerage Board, Guwahati Metropolitan Development Authority, and Northeast Frontier Railway. Details about the capacity and operation of these treatment plants are provided, along with the distribution networks associated with each plant.

Furthermore, the study examines the availability of deep tube wells, spot sources of underground potable water, and treatment plants operated by the Public Health and Engineering Department and Urban Water Supply and Sewerage Board. The role of Guwahati Metropolitan Development Authority in building new drinking water and sewerage systems is also discussed.

The methodology concludes with the analysis of the results obtained from the study, including the assessment of water availability from different treatment plants and the identification of water stress patterns. The study aims to understand the level of water stress, its spatial and socioeconomic distribution, and the factors contributing to water scarcity. Suggestions for improvement and interventions to address water scarcity are also explored based on the study's findings.

3.1 Water Availability Status of the City

Guwahati's water supply relies on surface water, groundwater, and rainfall. The primary sources of water for the city's inhabitants are the Brahmaputra River and the local groundwater aquifers. The responsibility for providing drinking water to the residents rests with three main authorities: Guwahati Municipal Corporation (GMC), Public Health and Engineering Department (Government of Assam), and Urban Water Supply and Sewerage Board (UWSSB).

3.1.1 Departments visited

i. Guwahati Municipal Corporation

Guwahati Municipal Corporation (GMC) is the urban municipal government in charge of Guwahati's governance development, and management. It oversees a 216.79 km2 area of Guwahati city. The GMC is divided into 31 municipal wards, with each municipal ward further subdivided into 2, 3, or 4 Area Sabhas. There are currently 90 Area Sabhas. GMC is part of the Guwahati Development Department in Assam. The Guwahati Municipal Corporation Act of 1971 established the GMC. According to Section 45 of this Act, the corporation was properly formed in 1974 at the first meeting of elected councillors. GMC administers through numerous branches/sections/cells located at its various locations located primarily in Guwahati city.

ii. Public Health Engineering Department

Assam Public Health Engineering Department (APHED) is the State Government's nodal department for rural Assam. APHED has been serving the people of the state since 1956 and is administered by highly skilled and experienced professional employees. This department's purpose is to improve people's quality of life by providing sustainable clean drinking water and sanitation infrastructure and services, as well as promoting hygiene behaviors based on their preferences and cost.

iii. Central Ground Water Board

The Central Ground Water Board (CGWB), a subordinate office of the Ministry of Water Resources, Government of India, is the National Apex Agency charged with providing scientific inputs for the management, exploration, monitoring, assessment, augmentation, and regulation of the country's ground water resources. In 1970, the Central Ground Water Board was formed by rebranding the Exploratory Tube Wells Organization under the Ministry of Agriculture, Government of India UWSSB. The Central Ground Water Board's major activities include macro/micro-level ground water management studies, an exploratory drilling program, monitoring of ground water levels and water quality through a network of ground water observation wells comprised of both large diameter open wells and purpose-built bore/tube wells (piezometers), and the implementation of demonstrative schemes for artificial recharge and rainwater harvesting for recharge augmentation. The Central Ground Water Board also provides technical expertise to diverse stakeholders for scientific ground water discovery, development, and management.

iv. Guwahati Metropolitan Development Authority

Guwahati Metropolitan Development Authority Act 1985 (amended) formed GMDA in 1992. It superseded the 1962-founded Guwahati Development Authority. GMDA adopted the 1992 Master Plan and Zoning Regulations from the Town and Country Planning Department, Govt. of Assam, to ensure planned development of the Metropolitan region and is now creating a new one.

v. Northeast Frontier Railway

Northeast Frontier Railway is one of 18 railway zones. It operates train services across the Northeast, West Bengal, and Bihar from Maligaon, Guwahati, Assam. Divisional Railway Managers, Senior Administrative Grade officers with the rank of Joint Secretary to Government of India, lead each division.The General Manager runs the railways with help from headquarters departments and field divisions. Senior Administrative Grade/Higher Administrative Grade
officers lead engineering, mechanical, electrical, signal & telecom, operations, commercial, safety, accounts, security, personal, and medical departments that support train operations. Bifurcating Lumding division would create another Silchar division.

vi. Guwahati Refinery

On January 1, 1962, Guwahati Refinery opened near Noonmati. Indian Oil Corporation Limited's Guwahati Refinery is India's first public refinery. The first Indian Prime Minister, Late Pandit Jawahar Lal Nehru, inaugurated the refinery. Romanian collaboration created the 1.0 million tonne-per-year refinery. This refinery processes crude oil from Upper Assam Oil Fields, India, to meet regional energy needs.

Authorities deliver 175.48 million liters of water every day. The corporation's water supply plants serve only 4,00,000 people out of 10,00,000. Other plans cover only a fraction of the remaining areas under the corporation's jurisdiction. The UWSSB serves 4,500 households and 70 businesses. The NF Railway water supply scheme serves Bamunimaidum, Panbazar, and Maligaon Railway colonies. The Guwahati Refinery water supply scheme serves only the complex, India Carbon, and Satgaon Army Cantonment.

4. RESULTS

4.1 Water Availability from Treatment Plant (GMC)

Guwahati is presently served by piped water supply in limited quantity and sometimes with deteriorated quality is specific areas. The water supply to the city is provided by five organizations viz: Guwahati Municipal Corporation, Public Health & Engineering Department, NF Railway and the Guwahati Refinery who have their independent water supply systems for their employees' colonies. The establishments like OIL and Defence colony, occupying a large part of Satgaon area, also have

independent distribution systems, which are fed by water from IOC treatment plant (TP) particularly under a mutual agreement between them but it is not adequate to meet the demand. Total quantity of water produced and distributed by GMC, PHED and. UWSSB is about 83.50 MLD, out of which 79.00 MLD is produced in different treatment plants (TP) from surface sources and the balance 4.50 MLD is supplemented by water from deep tube well (DTW), India Mark (IM) -II / HI, and shallow hand pumps installed by GMC.

4.2 Surface Source Plant

There are three surface source plants with independent distribution networks in Guwahati city. These are located at: i) Panbazar, ii) Satpukhuri, and iii) Kamakhya.

4.2.1 Panbazar Plant

The water treatment plant is established in 1960 with a capacity of 10 MGD (45 MLD) and has been a crucial component of the water supply infrastructure. Recognizing the need for upgrades and expansion, several improvements were made during the period of 1992-1997. To enhance the plant's efficiency, a clariflocculator with a capacity of 5 MGD (22.50 MLD) was installed. Additionally, a 350mm diameter clear water main was laid, connecting to the Sarania reservoir. Modifications were made to distribution lines in areas such as Lachit Nagar, BK Kakati Road, GS Road, and Pub-Sarania.

To meet the growing water demands and improve water storage capacity, two service reservoirs were constructed at Sarania Hills, each with a capacity of 10 lakh litres. Furthermore, a boosting station was installed in Sankarpur, enabling improved water distribution and pressure management. In efforts to enhance the operational efficiency, several pump and motor units were replaced, and hydraulic units were repaired. These measures were undertaken to address the deteriorating system conditions as the original design period of 30 years had elapsed by the year 1990.

4.2.1.1 Service Areas

i) *Distribution from Reservoir Located at DC's Residence*

Panbazar, Lakhtokia, Kamarpaty, Fancybazar, Maehkhowa, Kumarpara, Athgaon, and Tokoubari area are served from this reservoir having capacity of 13.50 lakh Gallons.

ii) *Distribution of Reservoir Located at Sarania hills*

Dakshin Sarania, Pubsarania, Gandhibasti, Rajgarah, Lachitnagar, Ulubari, Rehabari and Manipuribasti areas are served from four reservoirs having total capacity of 60 lakh liters.

iii) *Distribution from Boosting Stations*

The drinking water supply in the areas of Santipur and Bharalumukh in Guwahati is facilitated by a reservoir located behind the Panbazar plant. This reservoir has a capacity of 2.25 lakh litres, ensuring a sufficient water supply for the residents in these areas. Additionally, the hilly region of Sankarpur receives its water from a reservoir with a capacity of 45,000 litres. The water is pumped from this reservoir to another reservoir situated at the hilltop of Sankarpur, which has a capacity of 90,000 litres. This arrangement ensures that the residents in Sankarpur have access to an adequate supply of drinking water.

In the areas of Pub Sarania, Dakshin Sarania, and Gandhibasti, the drinking water supply is managed through two reservoirs located near Gandhi Mandap. These reservoirs have a combined capacity of 1,20,000 litres. The water is distributed to these areas through 15 feeder lines, ensuring a widespread coverage of the water supply. Moreover, one of the reservoirs, situated at the top of Gandhi Mandap hills, has a capacity of 11,000 litres. This additional reservoir serves the inhabitants of the surrounding areas, providing them with a reliable source of drinking water.

These reservoirs and distribution systems play a crucial role in ensuring the availability of safe and potable drinking water to the residents of Santipur, Bharalumukh, Sankarpur, Pub Sarania, Dakshin Sarania, and Gandhibasti in Guwahati. The strategic location of the reservoirs and the network of feeder lines enable an efficient distribution of water, catering to the needs of the local population.

iv) *Direct Pumping from the Treatment Plant*

The drinking water supply in the some areas of Guwahati is facilitated through direct pumping from the treatment plant. The water is pumped through different pipeline sizes to cater to specific areas. Firstly, a 150 mm line is used to serve the Panbazar north area. Secondly, a 200 mm line is employed to provide water to parts of Fancybazar and Sukleswar. Lastly, another 200 mm line is used to serve the areas of Satrakar, Professor Colony of Cotton College, and a section of Uzanbazar.

In addition to regular distribution, the Panbazar plant reserves approximately 300,000 liters of water per day for emergency public sale and to address areas with inadequate distribution. These emergency supplies are utilized for various purposes and are occasionally distributed through municipal tankers. This ensures that even during unforeseen circumstances or areas with limited access to the distribution network, the necessary quantity of water can be made available to meet public demand.

4.2.2 Satpukhuri Plant

The water treatment plant has an installed capacity of 5 million gallons per day (MGD), which is equivalent to 22.5 million liters per day (MLD). It was commissioned in the year 1985 with the aim of meeting the water demand for a period of 15 years, specifically until the year 2000. The capacity of the plant was designed to adequately satisfy the water requirements of the area during that time frame. This decision was likely based on projections and assessments of the water demand growth and population increase in the region.

4.2.2.1 Service Areas

The drinking water supply in the region is facilitated through various service reservoirs, boosting stations, and direct pumping from the treatment plant. The first distribution area is served by two reservoirs located at the Housing Colony, with a total capacity of 13.5 lakh litres. This area includes Kamachal, Nizarapar, Nabagraha (Plains), Milanpur, Krisnanagar, and parts of Bamachal.

Another set of reservoirs is situated at Nabagraha Hills, consisting of one RCC reservoir and one steel reservoir, each with a capacity of 30,000 litres. The areas served from these reservoirs include Nabagraha Hill, Golokdham, Hapivilla, and a part of Chenikuthi.

The Chitrachal Reservoir, with a capacity of 25,000 litres, supplies water to Chitrachal, Nabagraha (part), and Chenikuthi (part).

Satpukhuri Reservoir comprises two tanks: the "Beleview tank" located east of the plant, with an underground RCC tank capacity of 36 lakh litres, and the "Athkunia tank" located west of the plant, an RCC tank on a pound with a capacity of 39 lakh litres. The areas served from these tanks include Uzanbazar, Guwahati Club area, Silpukhuri, Chandmari, Bamunimaidam, parts of Rajgarh, Pub Sarania, and parts of Bamachal.

Additionally, there are boosting stations that cater to specific areas. The hilly region of Kharghuli is served by a 45,000 liters capacity reservoir at Beltol, using boosting pumps. The Upper Strand Road area receives water from the boosting station located at the last turning point on the Satpukhuri hillock, diverting water from the "Athkunia" and "Beleview tank" delivery mains.

The hill area of Chenikuthi on the west is served by diverting water from the Panbazar and Satpukhuri distribution mains, through a boosting station located on the road. The hilly areas of Chandmari receive water through diversion from the Satpukhuri plant's distribution main, via a boosting station located near the ASEB sub-divisional office in Chandmari.

Furthermore, the Nabagraha cremation ground and its surrounding hilly areas are supplied water from a 50,000 liters capacity reservoir at the Nabagraha cremation ground. Lastly, the hilly parts of Krishnanagar are served by a 50,000 liters capacity reservoir located in Krishnanagar.

The distribution of water supply in Guwahati is influenced by the region's uneven topography, resulting in varying supply times to different areas. Certain areas such as Uzanbazar, Guwahati Club area, west part of Chenikuthi area, Silpukhuri, Chandmari, Bamunimaidum, part of Rajgarah, and Pubsarania along the railway tract receive water twice a day, in the morning and evening. These areas, situated on the plain, are served by Athkunia and Belleview reservoirs.

Housing colonies in the East and West receive their water supply daily from a service reservoir with a capacity of 45,000 liters located at Housing Hill. In contrast, hilly areas like Kamachal, Nizarapar, Nabagiri, Milanpur, and Krishnanagar are supplied from a "housing reservoir" through a series of valves that are regulated one after another. This method allows for water supply to the entire hilly region once every two days, during both sunrise and sunset.

Kharghuli and Bonkowar areas receive their water supply through direct pumping, while Nabagrah, Chitrachal, and a part of Chenikuthi, as well as Happivilla, are served by reservoirs located at Nabagraha and Chitrachal. These areas receive water supply once a day.

The distribution of water supply in Guwahati takes into account the specific requirements and challenges posed by the varying terrain of the region. By employing different reservoirs and regulating valves, the authorities strive to ensure a consistent and reliable water supply to meet the needs of the diverse areas within the city.In hilly regions, the distribution of water to remote areas and certain pockets is often characterized by low pressure and limited quantity. This can be attributed to several factors:

Uneven geographical locations: The topography of hilly regions presents challenges for water distribution systems. The presence of uneven terrains impedes the flow of water under gravity through pipelines, particularly when attempting to reach higher altitudes. As water encounters a series of these uneven tracts, its movement is impeded, resulting in reduced pressure and limited access to water in those areas.

Deterioration of infrastructure: Over time, the carrying capacity of water pipes can be significantly reduced due to corrosion and incrustation. Aging pipes are prone to rust, scaling, and mineral deposits, which narrow the internal diameter and impede the flow of water. Consequently, the water reaching the furthest ends of the distribution network may experience lower pressure and reduced volume.

Pilferage and unauthorized access: Another significant factor affecting water distribution in hilly regions is the pilferage of water through unauthorized valves. Particularly during night time, miscreants may tamper with valves and divert water for their own purposes. This pilferage leads to additional pressure losses in the system, affecting the overall distribution of water and resulting in low pressure and inadequate quantities reaching certain areas.

4.2.3 Kamakhya Water Supply Scheme

In 1992, a water supply scheme with a capacity of 1 Million Gallons per Day (4.5 Million Liters per Day) was installed. Subsequently, in 1999-2000, a two-stage pumping arrangement was implemented, incorporating the following modifications:

a) A pre-sedimentation tank with a capacity of 151 cubic meters was constructed near the pump house, situated on the banks of the Brahmaputra River.

b) The machinery, originally installed on a barge, was relocated to the pump house on the river bank.

c) Two new pump sets were installed to lift water from the river and supply it to the pre-sedimentation tank.

The water supply to Kamakhya Dham is facilitated through the old water supply scheme, which was initially established by the Public Health Engineering Department (PHED) and later transferred to the former Kamakhya Municipal Committee in 1960. Currently, it is maintained under the Guwahati Municipal Corporation (GMC). Notably, no charges have been levied on the consumers receiving water from the old scheme. Approximately 300,000 liters of water are supplied daily from this scheme to Kamakhya Dham.

4.2.3.1 Distribution

Clear water is stored in two steel tanks situated at Kamakhya Dham. Each tank has a capacity of 60,000 liters. The water from these tanks is distributed to the public through 79 street taps, ensuring access to clean and safe drinking water for the surrounding community. Additionally, the water is supplied to the revered Kamakhya Temple, serving the needs of the religious site and its visitors.

4.2.3.2 Service Reservoirs

A RCC tank of capacity 15,00,000 liters is located at Bhuboneswari hill top from which water is fed to the distribution system.

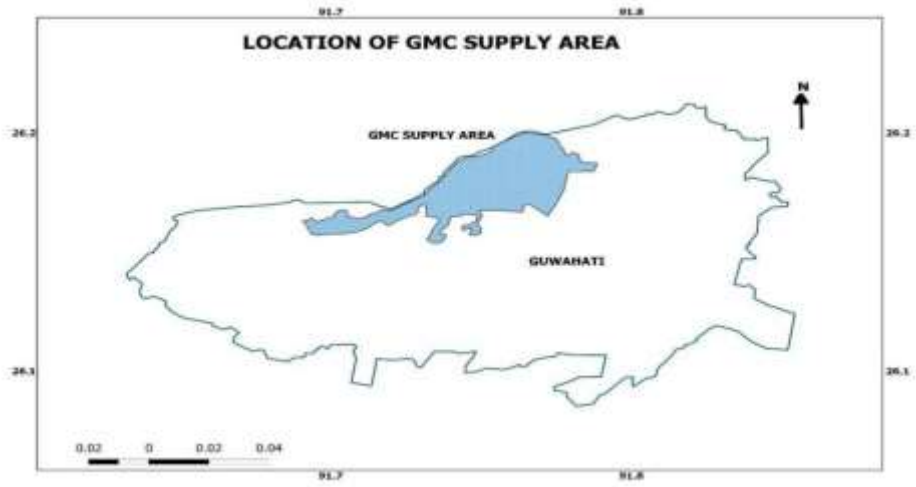

Fig 4.1 Location Map of GMC command area

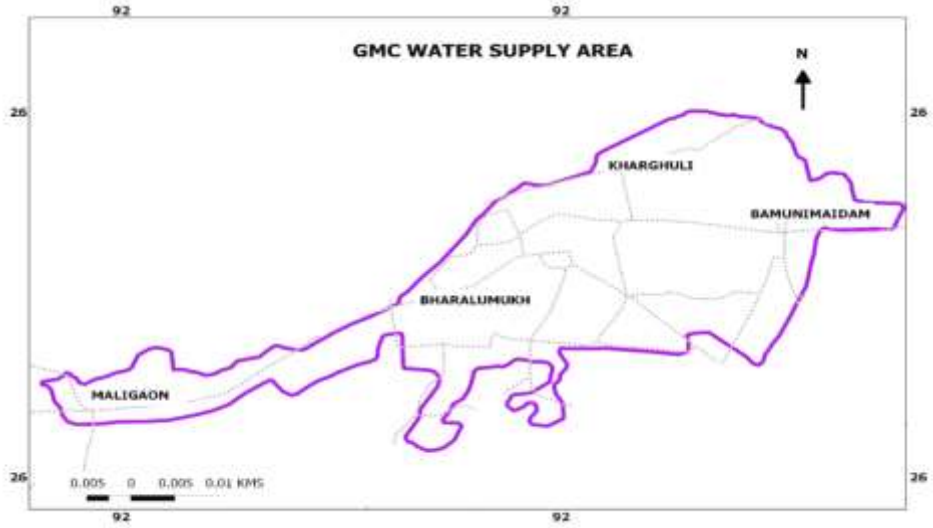

Fig 4.2 GMC Water supply area

4.2.4 Deep Tube Well (DTW) Scheme under GMC

Till date the following deep tube well schemes were functioning under Guwahati Municipal Corporation: (a) Bharalumukh (TR Phukan Park), (b) Santipur, (c) Rangpathar (d) Kalapahar (e) Lalganesh (f) Basisthapur II, (g) New Field, (h) Fatasil Harijan Colony

4.3 Spot Source of Underground Potable Water (India Mark III Deep Well Hand Pump)

The groundwater extracted from considerable depths is generally considered to be biologically safe for consumption. In areas that are not covered by the water supply system of the Guwahati Municipal Corporation (GMC), hand pumps serve as the primary and most cost-effective method of obtaining potable water. However, the hand pumps made from cast iron, which have been in use for several decades, come with certain limitations. These include low discharge capacity beyond a depth of eight meters, susceptibility to wear and tear, and requiring significant manual effort.

To address these drawbacks, the development of India Mark-II and India Mark-EH Deep well hand pumps took place through close collaboration and guidance from the international agency UNICEF/PHED Department. These improved hand pump models were designed to overcome the limitations of traditional cast iron pumps.In an effort to provide better access to clean water, the Guwahati Municipal Corporation has installed a total of 517 India Mark II and Mark III hand pump wells, along with 28 RCC Ring wells and one conventional well. These installations aim to enhance the availability of safe drinking water to the residents of Guwahati.

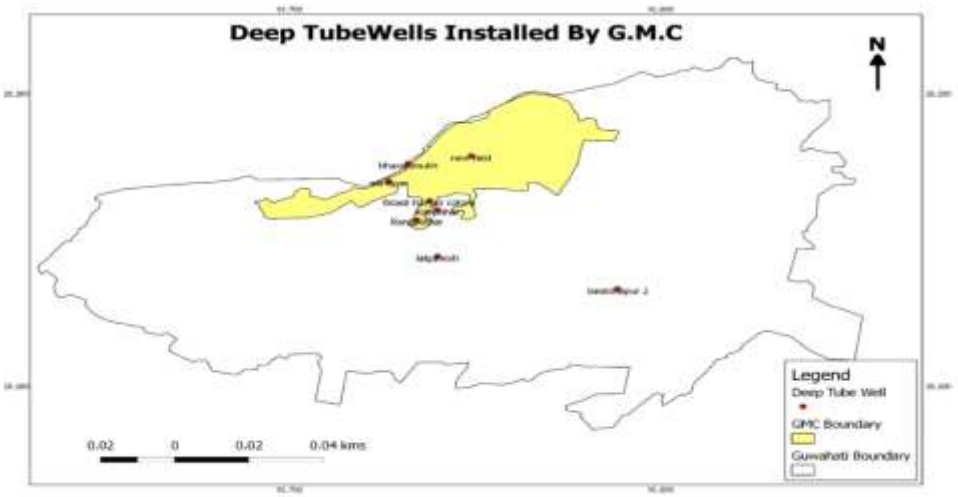

Fig 4.3 Map of Deep Tubewells Installed by GMC

4.4 Daily supplies through water tankers

The demand for mobile water supply in Guwahati is increasing at an alarming rate. Currently, the Panbazar treatment plant supplies an average of 3.0 lakh liters of water per day to the general public and various organizations through its mobile water wing. The distribution of water is facilitated by different types of vehicles, including tankers, tractors, and two-wheeler tankers, operating throughout the city.

To cater to the water distribution needs, the following vehicles are utilized:

i) Two truck-mounted water tankers with a capacity of 8000 liters each - 2 in number.
ii) Two mini truck-mounted water tankers with a capacity of 3000 liters each - 2 in number.
iii) Three tractors employed for carrying two-wheeled tankers.
iv) Three hired truck-mounted tankers with a capacity of 10,000 liters each.

In addition to these vehicles, a total of 53 two-wheeler tankers are deployed for water distribution purposes.

The continuous increase in mobile water demand signifies the significance of the mobile water supply system in Guwahati. The availability of multiple vehicles dedicated to water distribution exemplifies the commitment of the authorities to ensure uninterrupted water supply and meet the growing water requirements of the city's population.Efforts are being made to monitor and manage the distribution system effectively, considering the rising demand and the need for equitable access to water resources. With the cooperation of various stakeholders and continued improvements in the mobile water supply infrastructure, Guwahati aims to address the increasing water demand and ensure a reliable and sustainable water distribution system for its residents and organizations.

Table 4.1 The table below shows the installed capacity and present running capacity of GMC plants

Sl No.	Plant Location	Installed Capacity (Mld)	Year of Commisioning	Present Output from the Plant (Mld)
1	Panbazar	45	1963	25
2	Satpukhuri	22.50	1930	15
3	Kamakhya	4.50	1992	3.00
4	Deep Tube Wells	2.00		1.50
	Total	74.00		44.00

Source: https://gmc.assam.gov.in/portlets/water-supply

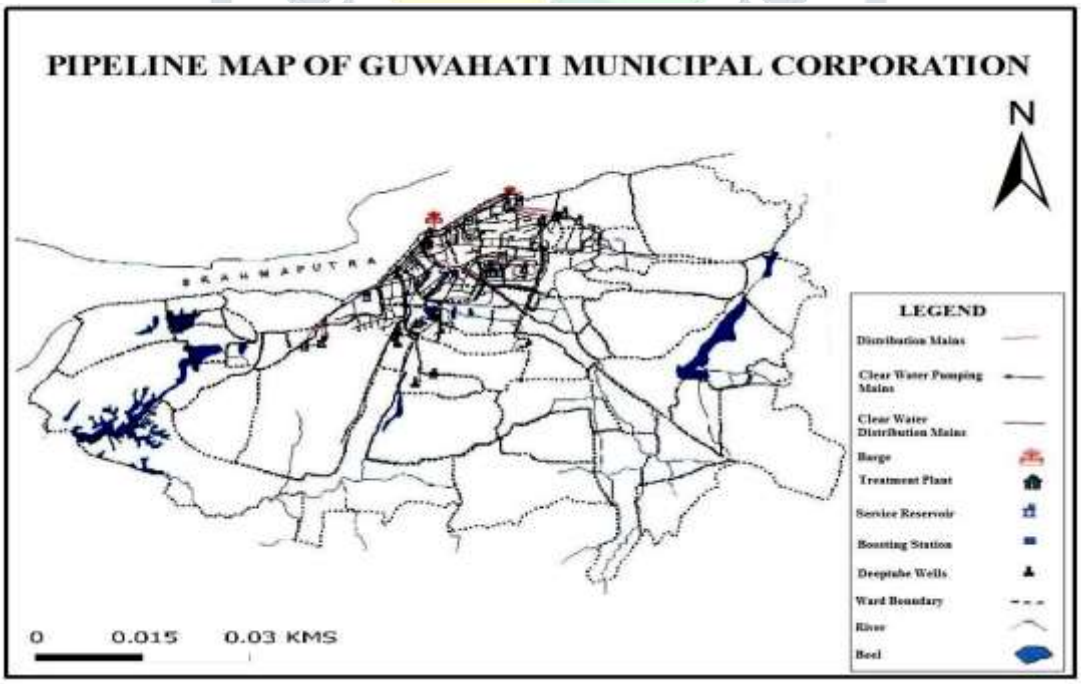

Fig 4.4 Pipeline Map of Guwahati Municipal Corporation

4.5 Water Availability from PHED

Under Public Health and Engineering Department (Div. II) there are two treatment plants located at (i) Panbazar (2.5 MGD) and (ii) Gauhati University hilltop (2 unit of sand filter capacity 10,00,000 litres)

i) *PanbazarTreatment Plant*

The water distribution system in the Panbazar area is facilitated by the Panbazar treatment plant, which supplies water through a boosting station located at Rajgarh. This network covers various important locations, including the state zoo and its staff quarters, Geeta Mandir, Medical College, Dispur Capital Complex, Forensic Laboratory, Kahilipara, CRPF Battalions (10th and 4th), Jyoti Chitraban, and the State Bank office.

The state zoo, being one of the significant recipients of water from the Panbazar treatment plant, has two reservoirs. One reservoir, situated at the Zoo gate, has a capacity of 10,000 gallons, while another reservoir located on the hilltop has a capacity of 2,000 gallons. Additionally, a separate water distribution network with a reservoir capacity of 1,000 gallons serves the Geeta Mandir area.

Within the zoo campus, there are 12 drinking points catering to the needs of 1,000 school children and visitors. Moreover, there are 25 additional drinking points within the animal enclosures. Piped water is also connected to approximately 80 households in the vicinity. The water supply timings for the area are from 7am to 5pm. The zoo itself spans across a total area of 50.00 hectares.

The initiation of the water supply scheme in the zoo area dates back to 1978 when it was established through collaboration with the Public Health Engineering Department (PHED). However, the supply from PHED alone is not sufficient to meet the water demand. To address this, three pumping sets are utilized, drawing water from a lake within the zoo premises and several wells, primarily to fulfill the water requirements of the animal enclosures. Additionally, four more wells are designated for use by the zoo employees. During the months of March and April, challenges arise due to the drying up of wells, often necessitating the use of water tankers.

Furthermore, another pipeline distributes water to various locations, including the Medical College, Dispur Capital Complex, Forensic Laboratory, Jyoti Chitraban, SB Office, Kahilipara, CRPF 10th Battalion and 4th Battalion, Agriculture University Campus, and Dairy farms. The water supply for these areas is boosted by a pump located in Rajgarh. This particular division, falling under Dispur, consists of a total of 41 households. Except for the Dispur Capital Complex, where the supply frequency is continuous, the other areas receive water twice a day, with each supply lasting for half an hour. Public standposts, numbering only two, are located at Ganeshguri. The estimated daily water consumption for this division is 29,45,000 gallons.

ii) *Jalukbari Treatment Plant*

The treatment plant is located atop Gauhati University Hill, encompassing the Assam Engineering College Campus, Ayurvedic College campus, and Gauhati University itself. Within the Gauhati University Campus, the water supply serves a population of only 5,000 individuals. The frequency of water supply is twice a day, with a duration of approximately 6 hours each day. The treatment plant comprises two reservoirs, boasting a combined capacity of 950,000 gallons. Additionally, the entire Gauhati University campus features 15 small storage reservoirs, each with a capacity of up to 60,000 gallons. Furthermore, every hostel within the campus possesses a 2,000-liter water tank, totaling 132 tanks. In the school building, which includes both the Assamese and English sections, there are two water tanks, each with a capacity of 2,000 liters. Apart from Gauhati University, the Assam Engineering College campus and the Assam Ayurvedic College also receive their water supply from this treatment plant.

4.6 Water Availability from Urban Water Supply and Sewerage Board (UWSSB)

The Urban Water Supply and Sewerage Board (UWSSB) is a statutory board under the purview of the Government of India. It is responsible for managing the urban water supply scheme in Guwahati city. The water supply infrastructure in the city is supported by a single water treatment plant with a capacity of 9.5 million liters per day (MLD). The primary source of water for the treatment plant is the Brahmaputra River.

To collect raw water, the treatment plant utilizes a floating barge stationed at Satpukhuri. The treatment facility itself is located atop Hengrabari hill, strategically positioned to efficiently serve the water requirements of the designated areas. The distribution network covers the eastern portion of Geeta Mandir, the western segment of RGB Road, and the southern area of GS Road, extending from Bhangagarh to Ganeshguri. In terms of coverage, the water supply system caters to approximately 4,500 households and 70 commercial units within its designated service area. To ensure uninterrupted access to clean water, the supply is maintained round the clock, providing 24-hour availability to the residents and businesses in the covered regions.

4.7 Water Availability from Guwahati Metropolitan Development Authority (GMDA)

GMDA has undertaken a program of major infrastructure projects to provide new drinking water supply and sewerage facilities that will serve the entire Guwahati Metropolitan Area. The primary objective of these projects is to ensure that the residents of this rapidly developing region have access to affordable, reliable, safe, pressurized, and uninterrupted (24x7) water supply. To facilitate this ambitious endeavor, the Government of Assam has secured substantial funding from the Government of India.

Upon completion of these projects, the Guwahati Jal Board will assume the responsibility of operating and maintaining these newly established facilities. Additionally, the board will play a crucial role in ensuring the long-term sustainability of the entire water supply system. To achieve this, the Guwahati Jal Board will collect fees from its customers based on their actual metered water usage. A carefully designed volumetric tariff structure will be implemented to guarantee that water remains

affordable for all consumers. The revenue generated from these fees will be utilized to cover the annual operating expenses of the water supply system and fund capital replacement costs, thereby ensuring the continued functioning and longevity of the infrastructure.

By implementing these measures, the GMDA and Guwahati Jal Board aim to address the pressing need for a robust and efficient water supply system in the Guwahati Metropolitan Area. This holistic approach not only emphasizes the provision of essential services but also emphasizes the importance of financial sustainability to enable the long-term viability of the water supply infrastructure. Through these concerted efforts, the government aims to enhance the quality of life for the residents of Guwahati by ensuring access to a reliable and affordable water supply system that meets the needs of the rapidly expanding metropolitan area.

Table 4.2 Existing Water Supply Schemes of Guwahati

Water Source Location	Name of WTP	Name of Agency	Design Capacity (Mld)	Present Capacity (Mld)	Areas Covered
Panbazar	Panbazar	GMC	45.00	22.50	Parts of Pan Bazar, Fancy Bazar, Kumarpara, Bharalumukh, Kalibari, Rehabari, Lachit Nagar,Gandhi Basti, Sarania, Rajgarh and Chhatribari
Satpukhuri	Satpukhuri	GMC	22.50	15.75	Parts of Uzan Bazar, Kharghuli, Chenikuthi, Guwahati Club, Silpukhuri, Nabagraha, Dighalipukhuri, Nizarapar, Chandmari, Hedayetpur, Milanpur, Bamunimaidam, Rajgarh Road etc.
Kamakhya	Kamakhya	GMC	4.50	3.00	Parts of Nilachal hill, Kamakhya temple area
Satpukhuri	Zoo Road	GMDW & SB	12.60	7.50	Parts of RGB Road, Zoo-Narengi Road, NarikalBasti, Ganeshguri, Hengerabari, Sarumotoria, Rukminigaon, Jatia, Kahilipara, KachariBasti (Ganeshguri), Christian Basti, Anil Nagar, Nabin Nagar, Lakhinagar, Tarunnagar, Sri nagar, Ambikagirinagar, Bhaskarnagar, Sarbodaynagar, Mathura nagar, Dwarkanagar, Japorigog, Nayanpur, Rajgarh Road (East Side), GMCH Road, Saktigarh and Rupnagar
Panbazar	Panbazar	PHED	11.25	12.15	Secretariat and Dispur Complex, Guwahati Medical College, State Zoo, Administrative Staff College, Assam Agricultural University, Khanapara Police Complex etc.
Pandu	Gauhati University	PHED	4.50	4.00	Gauhati University, Assam Engineering College etc.
Pandu	National Games Village	PHED	3.00	3.00	Games Village at Borsojai in NH-37 and National Games Stadium at Sarusajai in NH-37
Amingaon	Guwahati North	PHED	4.50	4.50	Parts of North Guwahati,Aswaklanta Temple area

Table 4.3 Water Supply Schemes of Guwahati under Execution
Source: https://gdd.assam.gov.in/portlets/water-supply-projects

Water Source Location	Location of WTP	Name of Executing Agency	Funding Agency	Designed Capacity in Mld	Zone	Areas Covered
Pandu	Sadilapur	GMDA	JnNURM	107	South West Guwahati	Bharalumukh (part), Santipur, Kalipur, Maligaon, Gotanagar, Pandu, Adabari,Sankarnagar Jalukbari, Tetelia,Devkota Nagar,Boragaon, Sundarbari, Gorchuk, Katahbari, Manpara, Datalpara, Ganeshpara, Dhirenpara, Fatasil Ambari etc.
Kharguli	Kharguli	GMDA	JICA	191	South Central Guwahati	Bamunimaidam, Chandmari, Silpukhuri, Dr. B. Baruah Road, Gandhi Basti, Dighalipukhuri, Paltan Bazar, Rehabari,Sarabhatti,Birubari, Rupnagar, Ulubari, Sarania, Rajgarh, Lachit Nagar, Anil Nagar, Nabinnagar, Kalapahar, Narakasur, Lalganesh,Odalbakhra, Dakhingaon, Jyotikuchi, Sonaighuli, Kharghuli, Uzan bazar, Chenikuthi, Panbazar, Fancy Bazar, Machkhowa, Athgaon, Bharalumukh, etc.
IOCL Gate Sector-I, Guwahati Refinery	Chunshali	AUIIP	ADB	98	South East Guwahati	Basistha,Bongaon, Kundil Nagar,Krishnapur,Koinadhara, Beltola, Jayanagar, Survey, Last Gate, Dispur,Bhetapara Hatigaon Road (East side), Rukminigaon, Rukmini nagar, Six mile (part), Khanapara, Dwarandha, Juripar,Baghorbari, Nabajyotinagar,Panjabari, etc.
Mazgaon	Mazgaon	GMDA	JICA	37	North Guwahati	Amingaon, Mazgaon, Doulgobinda Temple area, Aswaklanta temple area, Gauripur, Madhyamkhanda, Kadamtol, Bhetamukh, Bottling Plant Road, College Nagar Road, Silsaku, Tiling Gaon, Ghoramara, Rajadwar, Rangmahal, Rudreswar, Bihlongoni, Abhaypur etc.

4.7.1 Ongoing Project Details

i) *South West GMA*:

The water supply for the South-Western GMA is facilitated by a newly constructed water treatment plant near Sadilapara, boasting a capacity of 107 MLD (Million Liters per Day). This important project started in April 2009 and was funded by the Government of India's Jawaharlal Nehru National Urban Renewal Mission (JNNURM).

ii) *North and South Central GMA*:

In the North and South Central GMA, a recently established water treatment plant located in Kharguli ensures the water supply. This state-of-the-art facility has a capacity of 191 MLD and was made possible through funding from the Japanese

International Cooperation Agency (JICA). Construction activities involving pipelines and reservoirs commenced in early 2010, while work on the treatment plant commenced in 2012. However, the distribution of water from this plant is yet to begin.

iii) *South Eastern and Northern GMA*:

The South Eastern GMA benefits from a newly constructed water treatment plant situated at Sunsail Hill, which has a capacity of 98 MLD. This project was successfully funded by the Asian Development Bank (ADB). On the other hand, the Northern GMA receives its water supply from a new treatment plant located in Amingoan. This plant, with a capacity of 38 MLD, received funding from the Japanese International Cooperation Agency (JICA). Construction activities, including the installation of pipelines and reservoirs, commenced in early 2012, and the intake and treatment plant's construction began in October 2012. However, it is important to note that the project in the Northern GMA has not yet been completed.

Table 4.4 Location & Capacity of Service Reservoirs of West Zone

Sl No.	Service Reservoirs	Location	Capacity (Lakh Litres)	Type of Reservoir	Remark
1	West Kamakhya	West Guwahati Hill Top	93	Semi Underground Hill Top Water Reservoir	Existing GMC Reservoir used
2	Kamakhya Hill Top	Near Bhubaneshwari Temple	45	-do-	---
3	Ganeshpara (East)	Fatasil Ambari	53.80	-do	---
4	Ganeshpara (West)	Madhabdeb Nagar Hill Top	34	-do	---
5	Ganeshpara (Central)	Durga Sarobar Hill Top	27	-do	---
6	Jalukbari	G.U Hill Top	64	-do	---

Source: https://gmdwsb.assam.gov.in/portlets/water-supply-projects-0

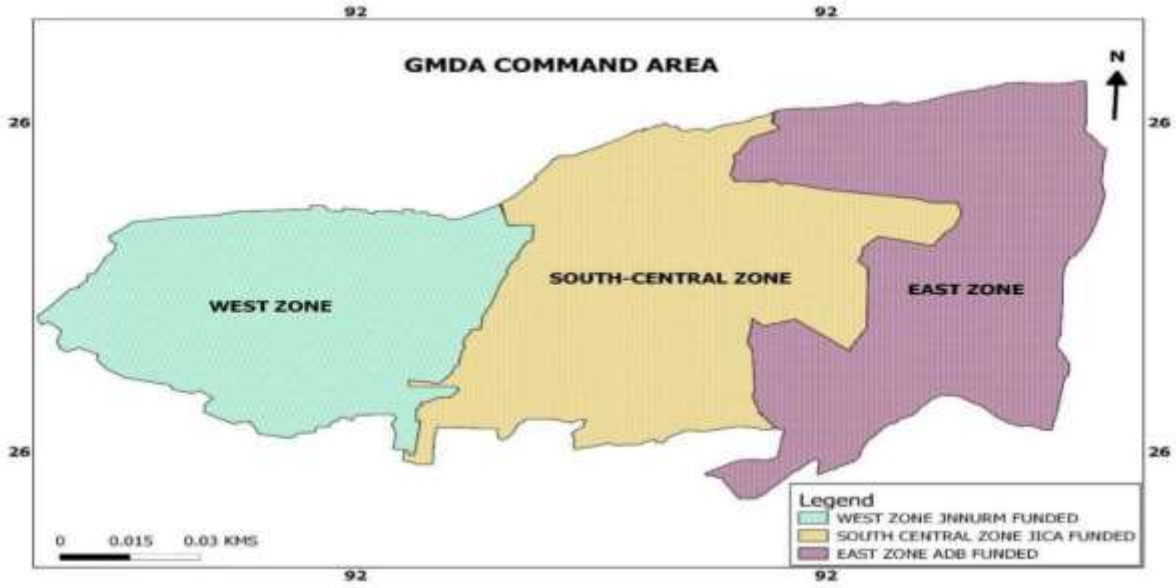

Fig 4.5 Map showing GMDA command area

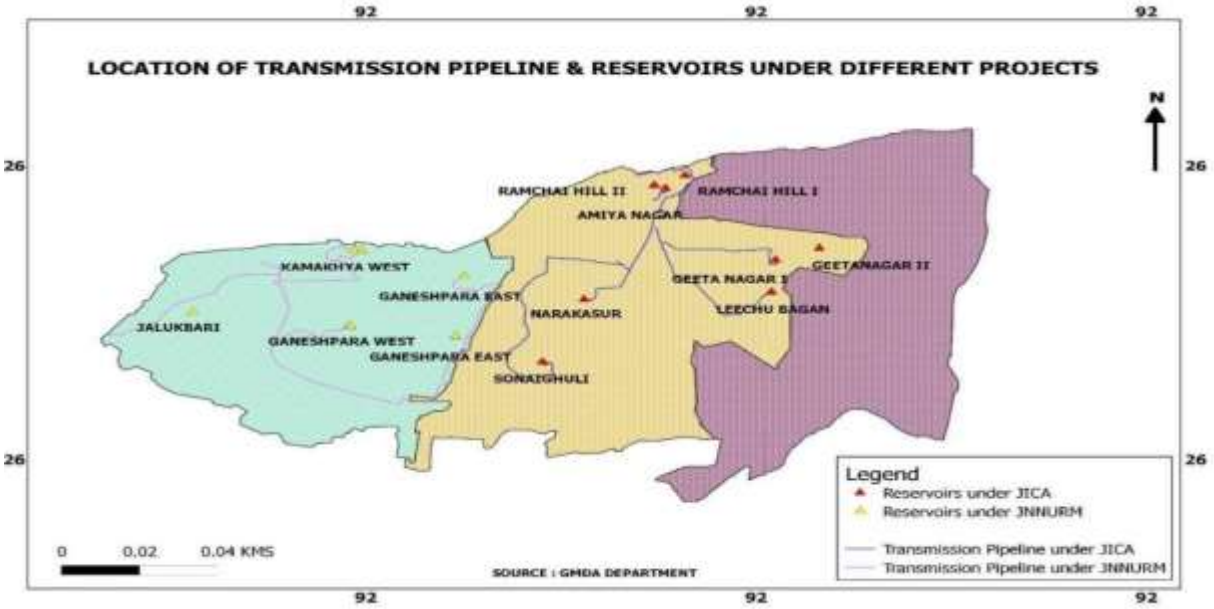

Fig 4.6 Location of Transmission Pipeline & Reservoirs Under Different Projects

4.8 Water Availability from NF Railway Treatment Plant

The NF Railway is a significant consumer of drinking water in the Guwahati metropolitan area. Covering an extensive area of 4,936 bigha 3 katha 6 lessa, the NF Railway is divided into three main service zones: Pandu-Maligaon, which includes the head office; New Guwahati Railway colony, encompassing Guwahati, Satgaon, and Amingaon. The railway infrastructure consists of 9,534 quarters, along with various service buildings, welfare buildings, and station buildings.

The demand for filtered water within the NF Railway is substantial. The total requirement stands at 4,69,000 gallons per day and 1,49,000 gallons per day for Pandu-Maligaon and New Guwahati Railway colony, respectively. This high demand reflects the critical need for a reliable and efficient water supply system to meet the drinking water needs of the railway personnel and associated infrastructure.

4.8.1 The Pandu-Maligaon Division

The primary water source for this division is the Brahmaputra River, which is supplemented by two floating barges. The water treatment plant responsible for catering to the division's water needs spans across an expansive area of 6,360 hectares and has a daily supply capacity of 10.54 lakh liters. To ensure a consistent supply, the plant is equipped with 12 large water reservoirs. Additionally, the entire network is supported by overhead tanks, enhancing the distribution system's efficiency. The underground reservoir has an impressive capacity of 4,91,995 gallons, while the overhead tanks boast a capacity of 40,400 gallons. These reservoirs collectively contribute to the reliable provision of water to meet the demands of the division.

4.8.2 The New Guwahati Division

The primary intake point for the water supply system is situated at Uzanbazar, housed on a floating barge. This treatment plant caters to 1,774 residential quarters and service buildings, providing a daily supply of approximately 480,516 gallons. To ensure an uninterrupted water supply, the system comprises a ground reservoir with a capacity of 138,000 gallons, as well as an overhead tank capable of holding 28,800 gallons. Additionally, the plant also utilizes groundwater as a source for water supply, with approximately 50 service buildings and one station building being served by tube wells. However, the contribution from the groundwater source amounts to only 13,016 gallons per day.

4.9 Water Availability from Guwahati Refinery

Brahmaputra River, utilizing two floating barges for this purpose. The plant's discharge line is an 8-inch drain line that operates at a flow rate of 200 m^3/hr. The water supplied by the plant is distributed to various entities, including the Military Engineering Services (MES), the Assam State Electricity Board (ASEB), and the Indian Carbon company.

To ensure the quality of the water, the refinery has implemented a water treatment plant (WTP) located at sector-H. This WTP has a substantial capacity of 5,130 m^3/hr. Additionally, within the refinery premises, there is another treatment plant with a capacity of 80 m3/hr. This plant is equipped with six overhead tanks, collectively capable of storing up to 40,00,000 liters per day (4 MLD) of water. Furthermore, the treatment plant incorporates three additional reservoirs specifically designated for firefighting purposes, each with a capacity of 5000m^3/hr.

The refinery also operates an Effluent Treatment Plant (ETP) with a capacity of 200 m^3 per day. This ETP is responsible for treating and managing the effluent generated by the refinery's operations. Additionally, the treatment plant caters to the needs of 1,025 quarters located in sectors I, II, III, and IV, ensuring proper water treatment for these residential areas.In addition to supplying water to specific entities and residential quarters, the Guwahati Refinery also provides drinking water for the general public. However, the scope of this service is limited to a small locality, with water being supplied through public standposts.

Table 4.5 The table below shows the present water supply position in the city

Sl No.	Water Supply Agency	Surface Water (Mld)	Ground Water (Mld)	Total Piped Water (Mld)
1	GMC	43	1.50	44.50
2	PHED	10.50	-	10.50
3	UWSSWB	9.50	-	95
4	N.F Railway	3.45	0.0068	3.46
5	Gauhati University	0.52	-	0.52
6	GMDA	107	-	107
	Total	173.97	1.5068	175.48

Source: Various Supply Agencies

5. Conclusion

The current water supply provided by GMC and PHED covers only a small portion of the Guwahati Municipal Corporation area. It primarily serves the eastern part of the city, including the old municipal area, Medical College, part of Dispur, Veterinary College, Assam Police Battalion Campus, R G Baruah Road, Rajgarh Road, G S Road, both sides of Zoo - Narengi Road up to Geetanagar, and the western part, which includes Kamakhya temple and University Complex. However, considering the current population of the area, the water supply in the eastern and western parts is insufficient. Except for Kamakhya and University Complex, the growing population in the western part does not have access to this service. Similarly, large areas in the eastern part of the city are also not covered by the water distribution system.

According to UWSSB, the current gross per capita supply in the aforementioned parts of the city is as follows: 129 liters per capita per day (lpcd) in the eastern part, 312 lpcd in the western part, and 18 lpcd in the northern part. These calculations are based on surface water supply, taking into account the capacity of the treatment plants. However, most of the existing treatment plants are old and may face issues at any time. The study area is located in a hilly terrain, which poses challenges for maintaining a consistent and adequately pressurized water supply. Furthermore, the situation is worsened by losses due to leakage and theft. In summary, the assessment of the current water supply in the Guwahati Municipal Corporation area reveals major deficiencies, including limited coverage, uneven distribution, intermittent supply, low pressure, distribution system leakage, pollution due to leakage and low pressure, and a lack of firefighting provisions. Having a sufficient quantity and quality of piped water supply is a fundamental requirement for urban populations. Inadequacies in this essential resource can pose health hazards to varying degrees. As Guwahati's population continues to grow, reaching a million people, it is crucial to ensure that such facilities are uniformly available to all residents. The availability of water resources, both in terms of location and timing, the rates of replenishment and depletion, and the demands placed on them by water users, are key factors in water management strategies. Due to the instability of surface water sources caused by climate change and human activities, groundwater plays an important role in supplying water to areas facing deficits.

The municipality's water supply scheme covers 69 percent of the city's households. The supply is generally reliable, except during the dry season when it becomes intermittent. The situation is worse in the outskirts of the city, where households

receive water supply only once or twice a month, even though they have municipal water connections. Approximately 65 percent of users in the area are affected by insufficient public water supply and are forced to rely on private water suppliers. Private water suppliers cater to around half of the households in the area. However, in the central area of the city, water supply is consistently available as it is located near the water supply plants.

6. A "Vision" of the future

When developing a vision for managing future water demand, several factors need to be taken into consideration. It is evident that the pressure on water supply and quality is steadily increasing, primarily driven by rapid population growth worldwide. Traditionally, addressing water supply issues involved expanding water systems and transporting water from available sources to areas in need, regardless of the distance. However, these options are becoming less feasible as the most accessible supply opportunities have been utilized, and alternative options are becoming increasingly expensive from financial, economic, and environmental perspectives.

It is evident that effectively managing water demand is the key to ensuring water availability in the future. Through my own research, I have found that demand management policies are significantly more efficient than focusing solely on developing new water supplies. In the context of sustainable development, water demand management takes precedence over simply tapping into existing water resources. It serves as an ideal approach to enhance the sustainability of the water system. Implementing demand management measures becomes a prerequisite for achieving sustainable development. Without comprehensive water demand management practices implemented throughout India, sustainable development of water resources cannot be achieved.

Therefore, before considering any major expansion of water supply, it is crucial to prioritize efforts to regulate and manage demand effectively. In other words, it is undeniable that future expansions of water supply will be necessary to meet various demands. However, while addressing new challenges, it is imperative to thoroughly explore all opportunities, such as changes in water demand, to ensure sustainable water management practices. Until then, implementing demand management measures should be the primary focus. Ignoring this aspect will lead to a depletion of the water required to meet escalating demands.

The Sustainable Development Agenda 2030 comprises 17 new Sustainable Development Goals (SDGs).One of the most important goals is access to improved sources of water.So,to visualize the position of Guwahati city by 2031, we have projected the population trend of Guwahati city up to the year 2031 by the method of interpolation.The population of the city in 2031 will reach up to 16,42,658 following the increasing trend.

Table 6.1 Population of Kamrup (M) as per census of India

Year	Population	Variation since the preceding census (%)
1901	52351	----
1911	58160	11.10
1921	62264	7.06
1931	68102	9.38
1941	81183	19.21
1951	95123	17.17
1961	216357	127.45
1971	315404	45.78
1981	----	----
1991	771477	144.60
2001	1059578	37.34
2011	1253938	18.34

Source: https://censusindia.gov.in/census.website/data/census-tables

Water distribution systems consist of complex networks of underground pipes that are often in a deteriorated condition and difficult to access. Engineers responsible for managing these systems require accurate data to identify water losses caused by leaks or bursts, abnormalities in water quality control, and the impact of operational activities on customer water supply, such as maintenance or repairs. Implementing a smart water sensor system would greatly assist these departments in providing uninterrupted access to high-quality water for their customers.

By deploying sensors and analytic tools throughout the city to create a real-time monitoring and decision support system, the smart water sensor system empowers stakeholders to efficiently manage the water supply network. This ensures that the residents of Guwahati can enjoy a reliable and sustainable water supply for future generations. With improved asset management, proactive maintenance measures can be taken to reduce the occurrence of leaks and water quality issues in high-risk pipes. Additionally, as real-time pressure and water quality sensors are expanded throughout the network, engineers will have access to the necessary data and tools for prompt incident management. At the customer level, real-time water consumption data obtained from automated meter readings will enable customers to make informed choices about water conservation in their homes and businesses.

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