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24 X 7 Water Supply, Sachin City

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ABSTRACT:

The present paper discusses the design of the water supply system carried out for Sachin city, with a population of about 28,000 in the Surat district of Gujarat state. The city under consideration plays an important role in the economy of the Surat district as it has the district's biggest Gujarat Industrial Development Corporation (GIDC) area. A household survey of the existing conditions and the level of services of the water supply system has been undertaken. The existing services were compared with the benchmark of water systems. The problems faced by the residents of Sachin city and its solutions for the water supply are included in the paper as 24X7 water supply. The study is essential in the improvement of the level of service in terms of safe and healthy water supply systems in Sachin city of these utility services and to create a healthy environment in Sachin city.

KEYWORDS: Sachin, Water supply, Water GEMS, 24*7 Water Supply

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1 INTRODUCTION

Cities and towns play a vital role in countries' economic and social development. Urbanization creates dynamic economies, which give rise to productivity, and creates jobs and wealth. It also provides essential services as a function of population growth and becomes the essential engine of economic and social advancement [1, 2] . Thus, efficient and productive cities are important for the growth of the nation and welfare [3]. Basic utility services such as water supply, sanitation, and stormwater systems are essential services that play an important role in the economic and social development of cities or towns [4]. There are 1.8 million deaths worldwide due to water scarcity every year [5]. There is great disproportionality in Gujarat’s water resources and population. It holds 2% of India’s water resources, but its population is 5% of the country's population. Out of the 50 BCM available, water resources of 38 BCM are utilized for irrigation and agriculture, which leaves around 12 BCM for drinking and industrial purposes [6].

The present study will provide the basic data, an assessment of the existing utility services, a proposal for improving the existing network, and the development of a new network with the design and analysis. Sachin is a growing city with a large industrial area, and the city's economy mainly depends on that industry. Mainly the workers of those industries live within the boundary of Sachin municipality. As services like water supply, sewerage, and storm-water system are basic requirements to create a better and healthy living environment, the design of the same becomes integral. To match the level of services of the city with the service level benchmark, 24 X 7 water supply system needs to be designed. Currently, people depend upon private bore wells for their source of water. Thus, a water supply system is required to ensure access to water for everyone and resolve the existing water supply problems in Sachin.

1.1 Scenario of basic utility services in India

1.1.1 Water supply

For the main drinking water supply in the urban area, only 43.5% of India's households have a tap water connection as the main source of drinking water. According to the Ministry of Urban Development, only 72% of households have a water supply, and its availability is within the premises [7]. Only 32% of India’s population receives treated water.

1.2 City profile of Sachin

As per the 2011 census, the population of Sachin city was 28,102 [8]. Sachin is part of the Surat Urban Development Authority (SUDA) in Gujarat. Sachin Municipality is also part of the Surat Metropolitan Region. Sachin is an industrial hub managed by the Gujarat Industrial Development Corporation (GIDC) and Surat Special Economic Zone (SurSEZ). Because of the advantage of its location in the city, the biggest GIDC of the Surat district was established here. In 2015, Sachin was recognized as a municipality to provide better amenities to residents of the city

1.2.1 Location and connectivity

Sachin city is located at a latitude of 21.08^0 N and a longitude of 72.88^0 E. It is located at the southwest part of the SUDA and the south of Surat city.

1.2.2 Existing land use pattern

The maximum land is used for residential purposes, which is 34% of the entire area of Sachin. 15% of the area is vacant, which shows great potential for future development. The city has an industrial area as a part of its municipality which is 13%. The city has a lake and a creek which pass through Sachin. 1% area of the city has water bodies. 10% of the total area is used for agricultural purposes. 23% of the area is used as roads, and the remaining 4% area is used for commercial, institutional, and public use.

1.3 Topography

Sachin has a flat terrain. The natural slope of the town is towards the south of the city. The highest point in the city is 17.43m from the mean sea level and the lowest point in the city is 4.37 m from the mean sea level. The average elevation is 12m. Figure 1 shows the land use distribution in Sachin.

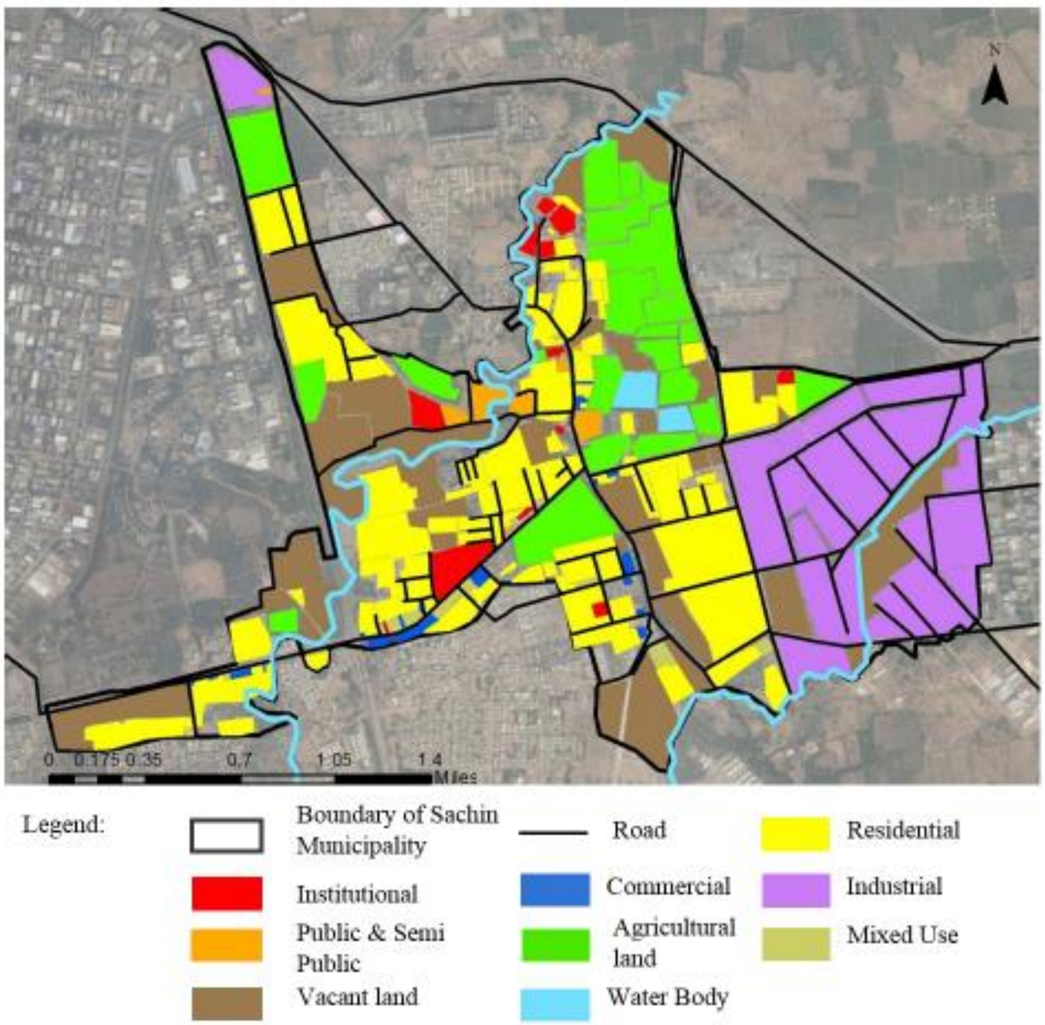

Figure 1 Existing land use map

2 MATERIALS AND METHODS

2.1 Current Scenario in Sachin city

2.1.1 Scenario of water supply in Sachin city

A household survey can aid researchers in understanding the journey of water from supply to consumption [9]. According to the primary survey of 5% of households (350 households), the dependence on bottled water for drinking purpose is quite high which is 36%. 30% of households use filtered water for drinking. 20% of households use piped untreated water. Figure 2 shows the main source of drinking water for the households according to the household survey.

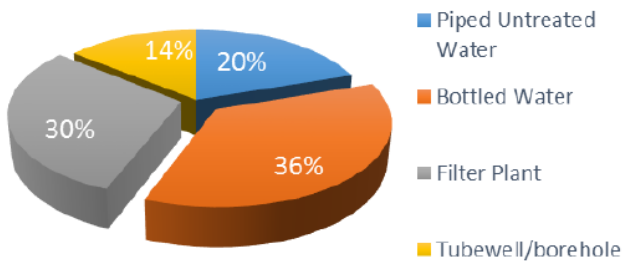

Figure 2

Main Source of Drinking water – Household survey

For other domestic use of water, 44% of households depend on private tube well/bore wells and the remaining household uses the water supplied by the municipality. Only 34% of households have a drinking water facility within the premises and 28% of households have this facility away from the premises, while others have near the premises. Based on the primary household survey, it is concluded that the average water consumed by the household is 130 lpcd.

2.1.2 Existing Water distribution system

The water distribution system is divided into five different operational zones as shown in Figure 3.

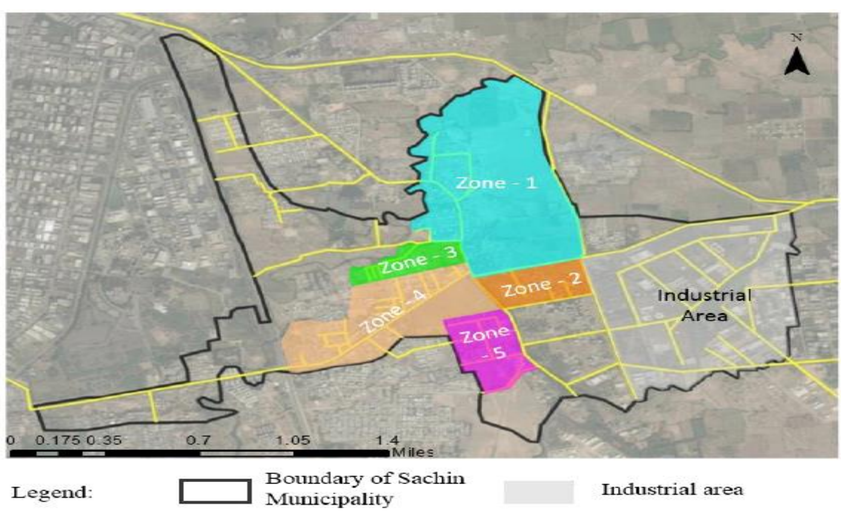

Figure 3 Water distribution zones in Sachin

An intermediate water supply system is provided. The water is distributed for limited hours of the day. These zones are isolated from the neighboring zones. Some part of the Sachin industrial area is within the boundary of Sachin municipality, but Sachin municipality is not obligated to provide services. The water is supplied by the Government of Gujarat in this industrial area. Each operation zones have a different number of bore wells. Operation zones 4 and 5 have elevated storage reservoirs (ESR), connected to the distribution network. The timing of supplying water is different in each zone as shown in Table 1.

Table 1. Zone-wise detail of water supply

Operation Zone	No. of bore wells	Pumping Hours	Connected to	Capacity of ESR (ML)
Zone - 1	3	3	Distribution network	-
Zone - 2	1	4	Distribution network	-
Zone - 3	1	4	Distribution network	-
Zone - 4	3	2	ESR	7
Zone - 5	2	2	ESR	0.3

The total water supplied by Sachin municipality is 3.37 MLD. This water is supplied to only 56% of households in Sachin municipality. The quantity of water supplied by the municipality is 149 lpcd, but according to the household survey, the average water consumption is 130 lpcd. This shows that the loss of water during transmission is 13%. The other 44% of households remain unserved.

Table 2. Minimum Water demand according to the CPHEEO manual using the Geometric Increase Method

	Population	Minimum Water Demand (MLD)	Existing Water supply (MLD)	Gap (MLD)
Present	40,332	6.26	3.37	2.89
Future(2032)	99,629	15.46	3.37	12.09
Future(2047)	2,64,276	41.03	3.37	37.66

Presently the gap between the existing water supply and the minimum water requirement is 2.89 MLD is 45% of the existing water supply. The ultimate water requirement for 2047 is 41.03 MLD which is 37.66 MLD greater than the current water supply. The lacuna is 92% which needs to be filled. Table 2 shows the gap between the existing water supply and water demand.

2.1.3 Comparison of existing service level with service level benchmark of the water supply system

The gap between the existing level of service and the service level benchmark needs to be filled. Table 3 compares the existing service level with the service level benchmark.

Table 3 Comparison of service level benchmark with the existing level of service of the water supply system

Parameter	Service level Benchmark	Existing Level of service	Gap
Coverage of water supply connection (%)	100	58	42 %
Per Capita Supply of water (lpcd)	135	149	-14 lpcd
Continuity of Water Supply (hr)	24	3-4	21-20 h
Extent of metering of water connection (%)	100	0	100

2.2 Design – 24 x 7 Water supply system

It is now recognized that the intermittent water supply system will result in health risks to consumers because of the possibility of higher water contamination through the joints during non-supply hours. The other problems, such as the requirement of large-size pipes, the requirement of storage at the household level, etc., can be overcome by providing a continuous water supply system.

The main features of the continuous water supply system are:

1. Supply safe water for 24 hours of the day with sufficient pressure.
2. The coverage of the distribution network should be 100%.

Bentley Water GEMS software is used for the present study to analyze and design the water distribution network.

2.2.1 Proposed Water Distribution network

For a continuous water supply system, it is not feasible to provide water through pumping in the whole city [10 11 12]. It is important to provide water to households by gravity; thus, it is necessary to provide an elevated storage reservoir. The flow diagram of the water is presented in figure 4.

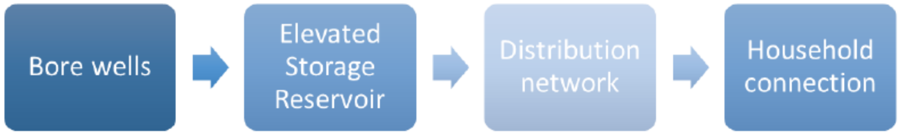

Figure 4 Proposed flow of water

Table 4 The capacity of the different ESR

	Supply Water To	Required Storage Capacity (ML)
ESR - 1	Zone - 1	4.67
ESR – 2	Zone – 2	3.54
ESR – 3	Zone – 5	2.6
ESR – 4	Zone – 4 and Zone – 6	7
ESR – 5	Zone – 3	0.9
ESR - 6	Zone - 7	1.62

The location of the new elevated storage reservoir has been selected based on the location of the existing elevated storage reservoir, the elevation profile of the city, and land availability. There is a need to construct three new elevated storage reservoirs. The capacity of the existing elevated storage reservoir in the zone – 5 is less than its requirement. Thus five elevated storage reservoirs need to be constructed. Table 4 shows the required storage capacity of ESR. Figure 5 shows the location of the ESR and figure 6 shows the design of the proposed water distribution network. The arrows shown in figure 6 represent the flow of water in the pipe. Table 4 shows the capacity of the different ESR.

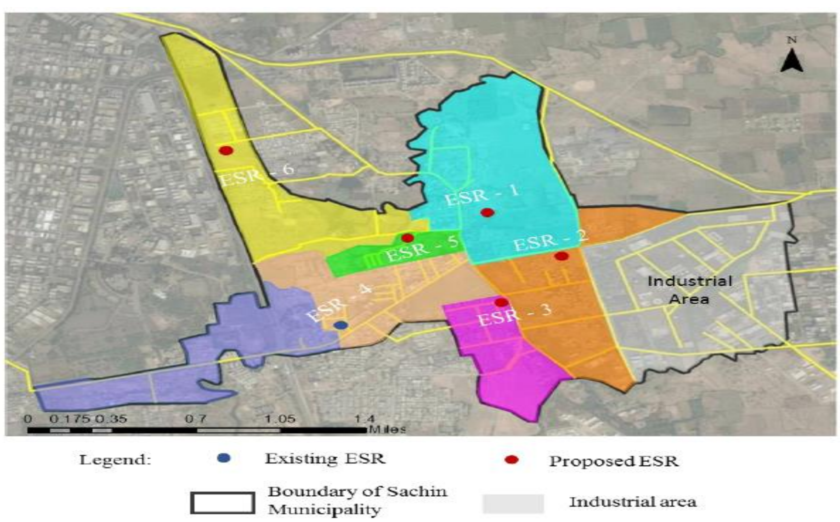

Figure 5 The location of the proposed and existing elevated storage reservoirs

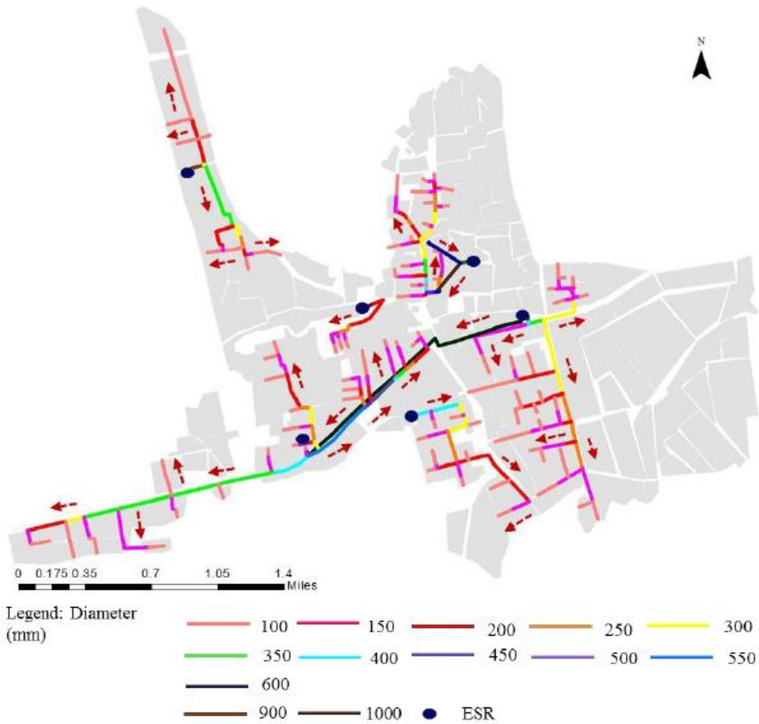

Figure 6 Diameter of the proposed water distribution network

The distribution network is designed based on the recommendations of the CPHEEO manual on water supply and treatment. 44% of the unserved area is covered in the proposed water distribution network. The circular ductile iron pipes are used in the design as ductile iron is cost effective as compared to the other pipes. As per the CPHEEO manual, the minimum diameter of the pipe is taken as 150mm, but at the dead ends, 100 mm pipes are provided. The total length of the water distribution network is 1^{8}.68 km. The highest diameter of the pipe provided is 1000mm.

3 RESULTS & DISCUSSION

Table 5 compares the service level benchmark and the proposed level of service.

Table 5 Comparison of service level benchmark with the proposed level of service of the water supply system

Parameter	The service level of benchmark	The proposed level of service
Coverage of water supply connections (%)	100	100
Per Capita Supply of water (lpcd)	135	135
Continuity of water supply (hr)	24	24
The extent of metering of water connections	100	100

3.1 Velocity of water in pipes for existing peak demand

According to the CPHEEO manual on water supply and treatment, for ductile iron pipes, the velocity of the water should be between 0.3 to 1.8 m/s. In existing conditions, only 42 % of pipes, water flow with sufficient velocity for the current peak demand.

3.1.1 Velocity in the pipes of the proposed distribution network

The proposed water distribution network's velocity is within the CPHEEO manual's range.

3.2 Pressure at junctions for existing and future peak demand

71% of the junction has sufficient water pressure for the current peak water demand. The station area and some parts of the slum area do not receive water or receive water with insufficient pressure. According to the primary household survey, 69% and 80% of the household suffer from the problem of insufficient water pressure in the station area and slum area, respectively. If the same water distribution network carries the future water demand, 41.03MLD water, then only 19% of junctions will have a pressure of more than 7m. 81% of junctions will not be able to distribute with sufficient pressure required for the one-story building.

3.2.1 Pressure at the junction of the proposed distribution network

According to the CPHEEO manual on water supply and treatment, the Hazen – William formula is used for the calculation of the head loss in the pipes during the flow of water and the Hazen - William coefficient of friction for the ductile iron pipe is 130. The pressure at the different junctions ranges from 7 m to 28 m. The material of pipe considered is ductile iron of circular conduit section. The total length of the water supply system required is 18.68 km. Table 6 shows the approximate cost of the water supply system.

Table 6 Capital cost required to establish the proposed water supply system

Description	Cost, Rs.
Cost of the elevated storage reservoir	19,99,50,000
Cost of the pipe network	5,09,06,400
Cost of meters	2,11,00,000
Total Cost	27,19,56,400

4 CONCLUSION

Sachin is a fast-growing city and in its growing stage, the city's existing water supply system is insufficient to take the present load. The people of the city have to depend on private bore wells as the municipality is not supplying adequate water. Thus, the level of services provided by the municipality also needs to be increased. There is a need to redesign the water supply system.

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