

Design of Water Distribution System In WATERGEMS For KharwalVillage

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Abstract - In tribal village of Kharwal, water scarcity has been one of the major issues for several decades. Villagers travel long distances just to obtain few litres of water from the well. The objective of our study was to understand the water scarcity problems of villagers and how we can eradicate their day-to-day complexities of travelling long miles to obtain water. For this purpose, different methods and processes were used. Forecasting water demand which will meet daily requirements of villagers is a very first aspect we started with. Then, by understanding the topography of village helped us in planning an efficient water distribution system for the village in WATERGEMS. Consequently, pump selection was done which remains crucial as it would help deliver water from source using distribution network to the overhead tank in the village. Cost estimation of the plan was also done. This paper presents the glimpses of our experience and gives analysis of different sectors.

Key Words: Water Distribution System, WATERGEMS, Pump Selection, Cost Estimation.

1. INTRODUCTION

Kharwal is a Village in Trimbak Taluka in Nashik District of Maharashtra State, India. It is situated in the Northern Maharashtra region & belongs to Nashik Division. It is located 45 KM towards west from District headquarters Nashik. 7 KM from Trimbak. 153 KM from State capital Mumbai. Kharwal consists of 6 hamlets, Fanaspada being the largest in area. Gavatha, Harsul, Nandgaon, Thanapada, Dalpatpur are the nearby Villages to Kharwal. Kharwal is surrounded by Peth Taluka towards North, Mokhada Taluka towards South, Jawhar Taluka towards west, Kaprada Taluka towards North. The village is situated on the hill and has valley on the both sides. It has a population of around 1245 according to Population Census 2011[2] and area of 4.42 sq.km. The region receives annual rainfall of about 2585 mm during monsoon season (June – September), but faces severe water scarcity in the months of April and May. Table 1.1 shows the co-ordinates of the Kharwal.

Table -1.1 : Co-ordinates of Village

Habitation	Latitude	Longitude
Kharwal	19.0705N	73.4505E



Fig -1.1: Kharwal Village Map

1.1 POPULATION AND LITERACY RATE

People of Kharwal Village mainly speak Marathi with konkni dialect. Kharwal Village has a total population of 1245 and number of houses are 160 [2]. Female Population is 48.6% of the total population. Village literacy rate is 51.1% and the Female Literacy rate is 21.1%.

Table -1.2: Population & Literacy rate [Census 2011 Data]

Census Parameter	Census Data
Total Population	1245
Total No of Houses	160
Female Population %	48.6 % (605)
Working Population %	57.3 %

1.2 WATER SOURCES

The major sources of water in the village are water supply through wells. Kharwal does not have a perennial surface water source in terms of lakes or rivers. It however is transgressed by a network of streams. The major water resource for Kharwal is ground water. Water for agriculture in Kharwal is majorly obtained through rainfall. The water needs and availability in a region dictate the cropping pattern followed by the cultivators in the region. In summers water is very scarce thus people mostly prefer to fetch water from well.

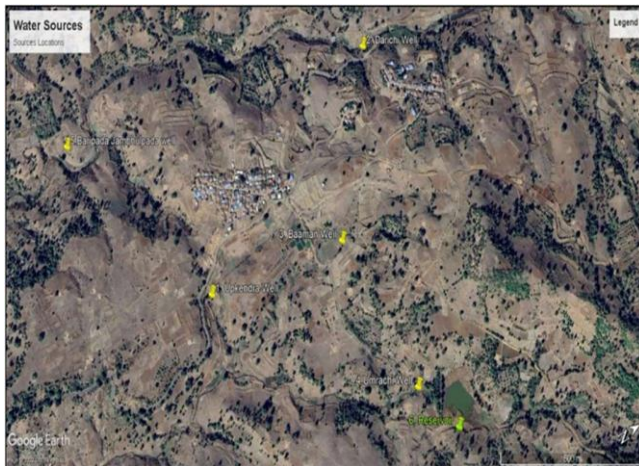


Fig -1.2: Water Sources in Kharwal

2. LITERATURE REVIEW

Vidya et al. [5] studied how a structured form survey was conducted in the Chondwade Bk tribal village, Dhadgaon Tehsil, Nandurbar district, Maharashtra. Their main aim was to study and understand the village ecosystem and the daily problems they faced. PRA Technique was used to collect Data by Household survey, Water Resources Survey, Health Survey, Livelihood Survey etc. They had closely interacted with the villagers and concern officials of Gram Panchayat and the Govt. Authorities like Gramsevak, Talathi, and Agriculture Officers to have comprehensive understand of village. Having various difficulties in village they tried to implement solutions like solar household lighting system, CSR proposal for malnutrition program & many more.

Hemant et al. [6] Investigated the single village drinking water scheme and understand the reasons for its failure from technical and social perspectives. The village receives annual rainfall of about 3500mm during monsoon season but faces severe drinking water scarcity during the summer

season. Their source of water supply is a well situated 2kms south of target region which comprises of 637 people (536 of Talwadi and 101 of Morewadi). The geology and geography of the region is such that the groundwater there was not abundant despite of receiving high rainfall during the monsoon season because of the typical nature of the Deccan traps. The paper explained the faults in the ongoing piped water schemes such as the people were not willing to pay regular tariff. The paper also listed the technical issues such as the GSR (Ground service reservoir) which was supposed to distribute water by gravity to Talwadi and Morewadi but failed because it was slightly lower in elevation than the Morewadi's stand post. Irregular electric supply and irregularity of the operator were also some of the reasons responsible for failure of the implemented schemes.

Amit Kumar et al. [7] The paper we have referred to tells us about different problems faced by people of Juwi village situated in Gadchiroli District which is located in state of Maharashtra. Parched lands, seasonal availability of water, agricultural issues, educational problems. The issue which mainly pertains to our project is water scarcity problems. In, Juwi village it was solved by using GSDA's Dual Pump Scheme, the scheme is designed for existing well only. The package consists of overhead reservoir, steel frame, D.C submersible motor, Solar panel with frame, water supply pipes and taps. The disadvantages of this scheme are during rainy and winter season, sunlight is low and panel is cold then system efficiency decreases.

Pravinkumar et al. [8] Studied the hydraulic analysis of Shivaji Nagar of Panvel City. The steady state analysis has been carried out for calculation of hydraulic parameter such as head pressure and discharge flow. In their project WaterGEMS software is used for obtaining optimal design of water supply network they calculated different alternative optimal design solution considering pipe diameter and pipe material.

3. METHODOLOGY

This section discusses the various methods and tools we adopted for the collection of primary and secondary data for the village. This is important to understand about the behavior and mindsets of people.

The Village Report methodology includes,

- I. Primary data collection.
- II. Secondary data collection.
- III. Other field work activities.

Each of these methods is described below: -

3.1 PRIMARY DATA COLLECTION

We adopted standard practices of understanding the basic geography of the region, conducting village surveys & transect walk. During the process we understood how to extract information from people. Sometimes it is difficult to get out information, in such case we need to extract information through indirect means like through informal talks, activities, each of which is discussed in the following sub-section.

Methods of collecting primary data -

- Basic Geography of the Region
- Village Survey
- Transect Walk

Each of these methods is described below: -

3.1.1 Basic Geography of the Region

The map of Kharwal Gram Panchayat area was studied to get more information about the land use pattern and vegetation cover near the village. Kharwal village consists of 12 small hamlets which are located on a top of a hill surrounded by forest; hence the agricultural land is very less when compared to the forest cover. Apart from this a satellite map had been used as a reference. The map helped to understand the topography of village and helped us to understand the land use pattern and vegetation cover of the village. Base map gives a picture of different land usages like forest, agricultural land, water bodies and roads.

3.1.2 Transect Walk

We with other local people helped in observation of things around and walk with consistent steps and make note of various things like slope, type of soil and trees, hills, habitations, infrastructure. Though walk in and around the village we have gather important document and observations, documented the living and non-living things that surround. Transect walk is such a tool which helps us understand above said aspects.

Transect walk is focused to cover all types of resources of the village. We started from top of the hill which is towards the south of the village. The village is located on a small valley where houses are on both the sides of the valley at upper elevations. It was about 50 m height and all the village spread round the top of valley. Around 500 m walk down the slope we got to the village community well which was the only source for drinking water for village apart from the small stream flowing by which is

seasonal and feeds the well itself. This activity had given us a glance of whole village and helped us to know how much variations are there in the village in all aspects like social, economic, physical, etc.

3.2 Secondary Data Collection

To understand the administrative setup, it is very necessary to look at the secondary data related to the village. Table 3.1 describes the list of secondary data collected during the visit.

Table -3.1: Secondary Data Collection

Source of Secondary Data	Outcome
Gram Sevak's Office water	Detailed data of total population, no of households, no of bodies, Wells, Agricultural produce, etc.
Talathi Office	Detail Partition of Agricultural/ Nonagricultural lands Detail Partition of Land utilization Detail Partition of Forest land Resource map

4. CONCEPT DESIGN

4.1 Domestic need of water per day in Kharwal

Daily water demands for per person per day is taken 20 litres per person per day, which includes water for drinking and cooking. The system is designed considering the 40 years of the service. Population estimation for next 40 years is done considering the decadal growth rate of 8.4% for rural India.

Table -4.1: Present and Forecasted Population

Year	Population
2020	1245
2060	1650

Table -4.2: Total water requirement per day

Per Capita Water Need (liter)	Total Population	Daily Water Req. for Village
A	B	A*B
20	1,650	29,330 liters

water from a source in the adequate quantity, quality and at satisfactory pressure to all individual consumers.

Water distribution network is designed with an objective of minimizing the overall cost while meeting the water demand requirements at adequate pressures. The system is a pipeline network consisting of one source node and several demand nodes is considered to find its optimal geometrical layout which delivers to required demands from source to destination. The software uses hydraulic model results which help in optimizing the design of complex water distribution systems and utilize built-in scenario management features to keep track of design alternatives. Water demand peak factor is taken 3 as per GOI guidelines [14]. Considering this, the demand at each node is taken as 30 Litres/min. Also, for each Junction(node) elevation value was assigned as shown in table 5.2 according to the village topography.

Water Distribution system modelling in WaterGEMS software-

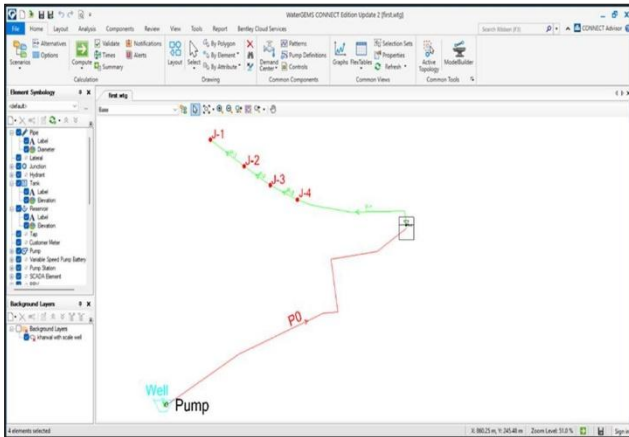


Fig -5.2: Pipeline network diagram in WaterGEMS software

5.3 Simulation Results

For each Junction the value of hydraulic Grade (Hydraulic Head) is calculated. Simulation Results are shown in the table 5.3. The data is arranged in ascending of Hydraulic grade. Such as Junction 1 has the least hydraulic grade of 4.77 m and Junction 4 has maximum grade of 6.14 m at 30 L/min demand.

Table -5.3: Pipeline Junction

Label	Demand (L/min)	Hydraulic Grade (m)	Pressure (kPa)
Junction 1	30	4.77	47
Junction 2	30	4.92	48
Junction 3	30	5.31	52
Junction 4	30	6.14	60

Chart 4 : Water Quality at Junction

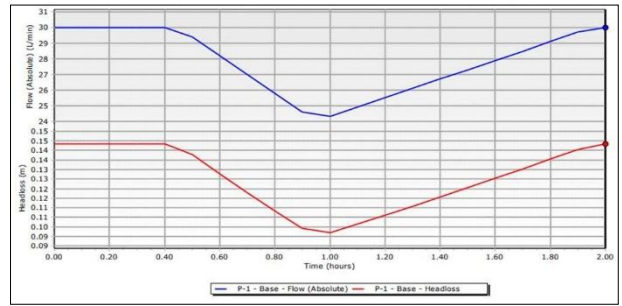
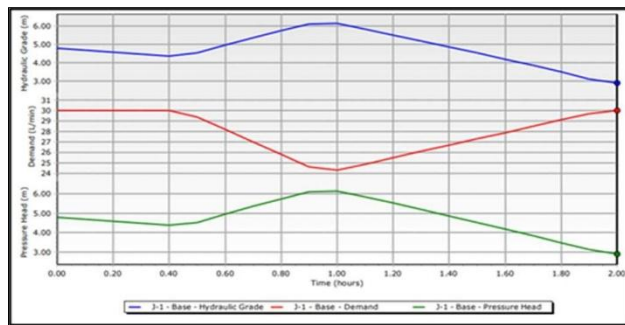


Chart- 5: Water flow and Losses

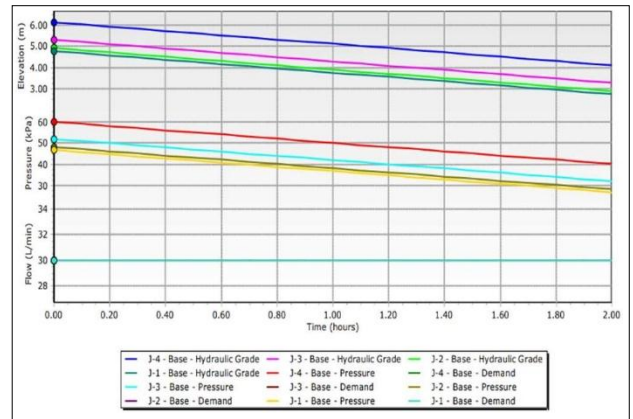


Chart- 6: Pipeline network diagram in WaterGEMS software

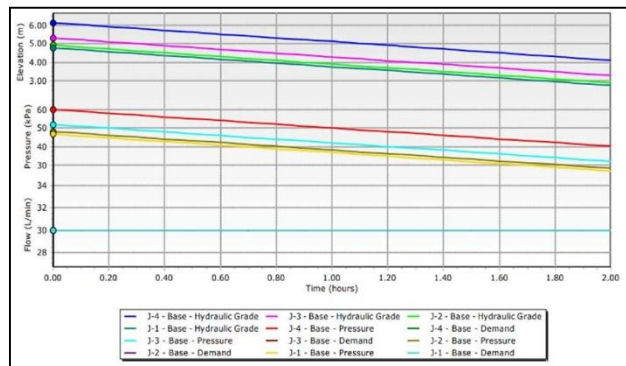


Chart- 7: Time taken to fill the tank at flow rate of 150 LPM

5.4 Cost Estimation

The purpose of cost estimation was to predict the Capital &

Resources required to check the financial feasibility of project. For cost estimation we approached local contractors who have been working in the area for past few years & got the following data as shown in table 5.4.

Table -5.4: Cost Estimation

Sr No	Description of Item	Rate	Quantity	Amount in INR
1	Drilling & Construction of Well	-	1	5,52,000
2	Construction of Tank	-	1	4,80,000
3	HDPE pipe (50 mm)	70 □/m	800 m	56,000
4	PVC pipe (50 mm)	76 □/m	500 m	38,000
5	Cost of Pump	30,000	1	30,000
6	Cost of Electrical Connections	-	1	2,000

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6.CONCLUSION

From several group discussions carried out with villagers of Kharwal we were able to understand water scenario of village in summer season and how it has affected the lives of the people. We carried out various surveys to understand the topography and potential aquifers which would help to fulfill the water needs of people. After finding potential water source, water distribution system was designed and cost estimation of entire project was calculated. With the effective use of water from structures like network of Wells and ponds, will improve the overall water availability of village. This will facilitate percolation and recharge the ground water table and hence contribute to the overall development of village.

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