Design of Conventional Water Treatment Plant for the Comprehensive Water Supply Scheme to Mukkam and Adjoining Villages in Kerala using WATPLANT Software

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Abstract— In the present study a comprehensive water supply scheme is designed including conventional water treatment plant for the four rural panchayaths in Kozhikode district of kerala state, India. The water treatment plant is designed by WATPLANT software. For the design of scheme, study of present population, population forecast for the three decades, daily water demand, and survey of the villages is done. The units of water treatment plant including aerator, flash mixer, floculator, clarifier, chemical house, chemical tanks, filter beds, wash water tank , etc designed with the software.

Key words: WATPLANT Software, Design of Conventional Water Treatment Plant

I. INTRODUCTION

A. Rural Water Supply Scheme

A multi village pipelined water supply scheme serves more than one village with drinking water from a common water source. Such schemes may be solutions to provide drinking water to regions facing groundwater scarcity and no perennial non-contaminated surface source of water. Multi village schemes have potential to operate at economy of scale, provide quality service and can also offer long term feasible solution in areas with acute water shortage. However they may require significantly higher investment, substantial technical capabilities and coordinated involvement of multiple agencies. To ensure the availability of sufficient quantity of good quality water, it becomes almost imperative in the modern society to plan and build suitable water supply schemes. The scheme should provide portable water to the various section of community in accordance with the demands and requirement. The provision of such a scheme shall ensure constants and reliable water supply to that section of the people to which it has been designed.

B. WATPLANT

The computer program “WATPLANT” has been developed to design the water treatment plants. The program written in the advanced BASIC language has the acronym as WATPLANT- Water Treatment Plant Design. This program is prepared by the Environmental engineering Department of Sri Jayachamarajendra College of Engineering, Mysore for Central Public Health & Environmental Organisation, New Delhi. This program is written in interactive mode of operation. The units of water treatment plant included in the WATPLANT program are: Cascade aerators, chemical storage room and solution tanks, Flash mixing units, Mechanical flocculation tanks, Rectangular and circular sedimentation basins, Clarifloculator, Filter bed details, Rapid sand filter beds, Chlorine containers and storage room, etc.

II. GENERAL INFORMATION ABOUT SCHEME AREA

A. Scheme Area

The Proposed comprehensive water supply scheme to Mukkom, Omassery, Karassery and Kodiathath Panchayaths is intended to cover the various habitations in the nine villages coming under the four Panchayaths of Kozhikode District of Kerala State. The area is located about 25 km from Calicut city. The main occupation of the people in the scheme area is Agriculture. MukkomPanchayath is a designated as Special Grade Panchayath. A total, 85% is estimated to have access to sanitary latrines. The average literacy percentage is about 92%. The total population of the scheme area as per 2011 Census is 126261

B. Existing Water Supply Schemes

At present the level of water supply is not adequate in the different places coming under the scheme area. There is no major scheme, which is in operation in this area to cater to the existing demand. Localized schemes are in operation for providing water supply in various areas. The existing piped water supply schemes coming under the scheme area are listed below:

1) RWSS to Kodiathath
2) WSS to Koovapara – Mulamkunnu in Karassery Panchayath
3) RWSS to Mukkom
4) WSS to Mampetta
5) KTC Estate

All the above water supply schemes are in a dilapidated condition. The above schemes consist of well cum pump house near the banks of the river, pumping mains, service reservoirs and distribution networks. No schemes having water treatment plants. Only bleaching powder is added at the raw water pump house. There is no filtration or other treatments. During rainy season the water will be high turbid. During summer season the water level considerably reduces and sufficient quantity of water not available. Even though, some of the above schemes having more than one thousand house connections. Rural water systems, even when properly designed and built, commonly experience some type of problem that does not allow some or all of the users to obtain a quantity of water that they feel in sufficient for their daily activities. This may be due to lack of supply, a poorly operating tubing system, or increased use/misuse of water. In addition to the above schemes some small schemes are also in operation, benefiting 10 to 50 families in each panchayaths.
implemented by local bodies.

C. Necessity of the Project

The existing schemes are small and locally centered to feed some particular areas of the panchayaths. They are not properly designed and hence further extension or augmentation is not possible for these schemes. The other areas of these panchayaths have to depend on public and private open wells which will dry up during summer months. Also the treatment adopted is only chlorination by adding bleaching powder. Hence the quality of water is poor due to lack of proper treatment. The recurring charges like establishment expense and electricity charges also get reduced if a comprehensive scheme is worked out. The existing distributions of all schemes are very old and in dilapidated condition. Hence are not considered while designing new distribution networks. The Scheme is intended to implement to Mukkam, Karassery, Kodiyathur and Ommassery Panchayat in which, 7 nos. Quality affected habitations are identified in Mukkam and Kodiyathur panchayaths. Major part of Karassery Panchayat is uncovered area and facing acute scarcity in drinking water.

D. Proposed Water Supply Scheme

- **Location of the source**

  It is proposed to draw water from the upstream side of existing Kavanakkallu regulator cum bridge TheyyathumKadavu. The collecting well will have dimensions 10 M diameter and depth 12m. For the proposed scheme the well can be constructed as a collection well for drawing the raw water through intake channel directly. Sufficient quantity of water will be available from this location even in the summer season.

- **Pumping Machinery for lifting water:**

  The static head comes to 86m. Since the head is on higher side, vertical turbine pump set is proposed and 50% standby is provided. Three numbers 150 HP vertical turbine pump sets are provided one as standby.

- **Raw water pumping main**

  The raw water pumping main is designed to carry 166.91 lps which is ultimate demand required in 2046 considering wastage in treatment and distribution and 23 hours of pumping. 500mm DI K9 pipe is proposed for raw water pumping from for a length of about 1850 M up to the proposed treatment plant site at Chennamangalur. The economic size design as per the guidelines of CPHEEO manual is carried out. Different size of pipes is compared and 500mm diameter is found economical. Sufficient air valves scour valves are to be provided at appropriate points. Surge reduction equipments are not required.

- **Clear water pumping mains and service Reservoirs**

  An OHSR is proposed in the treatment plant site of capacity 16 lakh litres. The distribution to Mukkom Panchayath is done from this tank. This acts as a Master Balancing reservoir to different storage tanks serving other panchayaths. 400 mm DI-K9 of 50 m length is proposed as the clear water pumping main. From this tank (MBR) water is fed by gravity to three sumps (1) at Odatheru. 1.7 Lakh litres capacity, for boosting water to Karassery panchayaths and (2) at GLSR near PTM High School, 7.00 Lakh capacity for distribution to Kodiyathur panchayath and (3) at Sump at Mudoor, 1.5 LL Capacity. Gravity main to Odatheru sump is 300 mm DI-K9 for 2400 m (up to Kakkad junction) and 250 mm DI-K9 for 3100 m up to the sump. From Odatheru sump water is boosted to OHSR at Ellangal (capacity 13.5 lakh litres) for serving Karassery Panchayath. Boosting to OHSR is done through 300 mm DI K9 565m. Gravity main to the Sump at Mudoor is 250mm DI K-9 for 11070m up to the Sump. From Sump at Mudoor water is boosted to the GLSR at Kanangottumula (12.00LL capacity) for serving Ommassery Panchayath. Gravity Main to GLSR near PTM High School is proposed with 250 mm DI-K9 pipe for a length of 2600 m. The average ground level of the tank site at P T M High
School ground is +70.635. The inlet to this tank is +74.00 and Outlet level +70.6. The designs are attached as Annexure 3 and

I. Distribution system
There are number of reasons for dividing networks in to zones but essentially, the aim is to achieve greater control over the distribution of water. The entire project area is divided in to 4 zones according to the area to be fed from reservoirs. PVC/GI/DI pipes are proposed. PVC is adopted up to 250 mm dia and larger diameter Ductile Iron pipes are proposed. The distribution system is designed by the LOOF software. The distribution pipes that existing is not considered for this proposal.

III. MATERIALS AND METHODS
A. Data Collection
For design water supply scheme, the following data were obtained from Kerala Water Authority (KWA) and Panchayath authorities.
1) Collection of the population of last 5 decades of four Panchayaths
2) Road map of Scheme area.
3) Data of previous existing water pipeline.
4) Existing location of OHSR
5) Capacity of existing OHSR

B. Population Projection
The total population of the project area’s per 2011 Census is 126261. The proposed water supply schemes have designed for a period of 30 years. 20016 is taken as base year and the population in the middle year 2031 and design year 2046 have been worked out by 1) Arithmetic increase method 2) Geometric progression method 3) Incremental increase method. The census population for the census year 1971 to 2011 is considered. These figures obtained from the census records. The highest value obtained by the method of Geometric increase. The middle value obtained by Arithmetic increase method. This method matches the current scenario of population growth. The projected population calculation is shown given in Appendix- A. The ultimate population of 171596 in the year 2046 is considered for the design of the components of the scheme.

C. Water Demand
The per capita supply rate provided for this comprehensive rural water supply scheme is 70 litres per capita per day as per CPHEEO Manual. The water demand of the four Panchayaths is tabulated below.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Name of the Panchayath</th>
<th>Water demand in mld</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mukkam</td>
<td>3.19</td>
</tr>
<tr>
<td>2</td>
<td>Kodiyathur</td>
<td>2.22</td>
</tr>
<tr>
<td>3</td>
<td>Karassery</td>
<td>2.54</td>
</tr>
<tr>
<td>4</td>
<td>Omassey</td>
<td>2.74</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>10.68</td>
</tr>
</tbody>
</table>

Table 1: Water demand

1) Water Treatment Facilities
A conventional water treatment plant of 15 mld is proposed. The various treatments units proposed to be constructed as a part of the water treatment plant includes cascade aerator, flash mixer, clariflocculator, rapid sand filters and chlorinators. Sometimes the turbidity of water may rise up to 200 NTU. Since the intake of water is directly from river, a treatment plant is necessary. The major drawback of small schemes serving in this area is the lack of proper treatment. The proposed scheme being a comprehensive scheme intended to benefit a large population, aeration followed by conventional treatment proposed. Approximately 200 cents of land is required to house the plant, OH tank (Main Balancing Reservoir (MBR) and other components. The site proposed is near the Chennamangallur HSS. The capacity of plant for the ultimate stage including 15% wastage comes to 15 mld. The average ground level of the site is +76.60. The top of the plant is fixed as +80.00 and Outlet of Clear Water Sump (for the treatment plant) as +70.50.

D. Design Criteria
- The major design criteria adopted for this project are as listed below. The proposed scheme is designed based on the norms prescribed to water supply schemes. The design period is considered as 30 years. The base year is taken as 2016 providing one year gestation period.
- The Arithmetic increase method is taken for population projection.
- The per capita supply rate provided is 70 Liters per capital per day.
- Hours of pumping are adopted as 23 hours. Life span of pumps and motors is taken as 15 years. Cumulative efficiency of pumps and motors is taken as 70%.
- Wastage at treatment plant is taken as 4% and other distribution Losses as 15%
- Velocity through gravity and pumping main is taken as 1-1.2m/sec.
- The material for pumping/gravity mains is internally mortar line DI pipe with external zinc coating.
- Capacity of storage reservoirs is taken considering storage for 8 Hours for main distribution tanks and 1 hour for sump from which pumping/gravity flow is resorted to.
- For distribution network PVC/GI/DI pipes are proposed. PVC is adopted up to 250 mm dia and Class 6. Peak factor is adopted as 2.5 and minimum terminal head as 7.00 m. Class of pipe is determined based on the inlet and terminal pressured based on the

![Fig. 2: Population forecasting graph](image-url)
outlet level. The HWC co-efficient is taken as 140 as it is PVC/lined DI pipes.

IV. RESULT AND DISCUSSION

WATPLANT software saves the time and manpower. The input parameters for each subprogram are to be entered during the design run. This program is very simple one and can be easily used for the engineers. To get accurate result the design parameters has to be entered correctly. Design results are displayed on the screen at the different phases of the design so that the designer can evaluate the design results of individual design phases and decide on their acceptability. Options are also built into facilitate redesign at each phase of the computation if the designer wishes so.

The presented results are based on the WATPLANT software and tabulated below.

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Component</th>
<th>Size/Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Aerator</td>
<td>Size of inlet pipe 800 mm Dia of bottom most step 5.1 m Dia of 5th tray 1.5 m Dia of collection tray 6.1 m Depth 1.25m</td>
</tr>
<tr>
<td>2</td>
<td>Raw water channel</td>
<td>Size of channel 60x90 cm</td>
</tr>
<tr>
<td>3</td>
<td>Flash mixer</td>
<td>Diameter 1.9 m Depth 2.3 m</td>
</tr>
<tr>
<td>4</td>
<td>Alum tank</td>
<td>Size of tank-2 Nos 1.6x1.6x1.3m</td>
</tr>
<tr>
<td>5</td>
<td>Lime tank</td>
<td>Size of tank-2 Nos 1.6x1.6x1.3m</td>
</tr>
<tr>
<td>6</td>
<td>Bleaching powder tank</td>
<td>Size of tank-2 Nos 1.1x1.1x0.6m</td>
</tr>
<tr>
<td>7</td>
<td>Chemical storage</td>
<td>Room size 12x8.5x4.5m</td>
</tr>
<tr>
<td>8</td>
<td>Clariflocculator</td>
<td>Dia of inlet pipe 700 mm Dia of the flocculator 11.0 m SWD 3.5 m No of blades 4 Diameter of clarifier 25.0 m Collecting channel 0.5x0.6m</td>
</tr>
<tr>
<td>9</td>
<td>Rapid sand filter</td>
<td>Filter box size- 6 nos 5.5x4.5 m Thickness of sand 75 cm Thickness of gravel 65 cm Manifold size 0.5x0.5m</td>
</tr>
<tr>
<td>10</td>
<td>Wash water trough</td>
<td>Size 0.4x0.45m</td>
</tr>
<tr>
<td>11</td>
<td>Gullet</td>
<td>Size 0.80x0.40m</td>
</tr>
<tr>
<td>12</td>
<td>Wash water tank</td>
<td>Size 9.0x7.50x3.30m</td>
</tr>
</tbody>
</table>

Table 2: Results obtained from WATPLANT

REFERENCES