WATER SUPPLY SYSTEM IN RURAL AREA

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BACHELOR OF TECHNOLOGY

in

Civil Engineering

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CERTIFICATE

Certified that **Deepanshu Srivastava (1160431019), Avinash Kumar Tiwari (1170431015), Ashish Yadav (1170431014), Belal Ahmad (1170431016), Akhilesh Yadav (1170431007)** has carried out the research work presented in this Project entitled **"Water Supply System In Rural Area"** for the award of **Bachelor of Technology** from BBD University, Lucknow under my supervision. The Project embodies results of original work, and studies are carried out by the student himself and the contents of the Project do not form the basis for the award of any other degree to the candidate or to anybody else from this or any other University.

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DECLARATION

I hereby declare that work which is being presented in the project entitled **"Water Supply System In Rural Area"** in partial fulfillment of the requirement for the award of the degree of **Bachelor of Technology** in **Civil Engineering** of **BBD University, Lucknow,** is an authentic record under the guidance of **Mr. Ravi Maurya, (Om Prakash Neutla)** Head of department civil engineering of **BBD University Lucknow,**

The matter being presented in the project has not been submitted by me/us for the award of any other degree or diploma of this or any other institute/university.

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ABSTRACT

Rural water supply schemes in India are generally designed for domestic uses. However, the multiple water use priorities of poor rural households in order to reduce their hardship and enhance food production, health and income mean that in water-scarce areas, domestic water use can run into conflict with productive water use. The failure of water supply agencies to design a water supply system for multiple uses results in communities not being able to realize the full potential of water as a social good. This chapter identifies various domestic and productive water requirements of rural households. Thereafter, a composite index which captures the vulnerability of rural households to problems associated with lack of water for multiple needs was assessed for three selected regions of Maharashtra, each representing a different agro-ecological and socioeconomic setting.

ACKNOWLEDGEMENT

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CHAPTER 1

1. INTRODUCTION

Water Supply in India is now previewed as community based demand driven system, under which it is essential to enhance capacity of local community residing in villages and small towns to develop and manage their own water supply systems. Role of community groups is to ensure effective and participatory implementation of water supply system in their village/town, water quality control, financial management and effective operation and maintenance of water supply system established. Hence, it is evitable that such community groups are aware about the basics of water supply system, operation and maintenance of water assets and water supply system as well as basics of sanitation and waste management. This training course series has been formulated in order to enhance capacity of community groups for enhanced operation and maintenance of water supply and sanitation systems in their village/town. Module on Basics of Water Supply System provides insights on basics component of water supply system, installation and distribution of water supply systems, estimation and measurement of components of water supply system and drinking water quality control.

1.2 Objectives

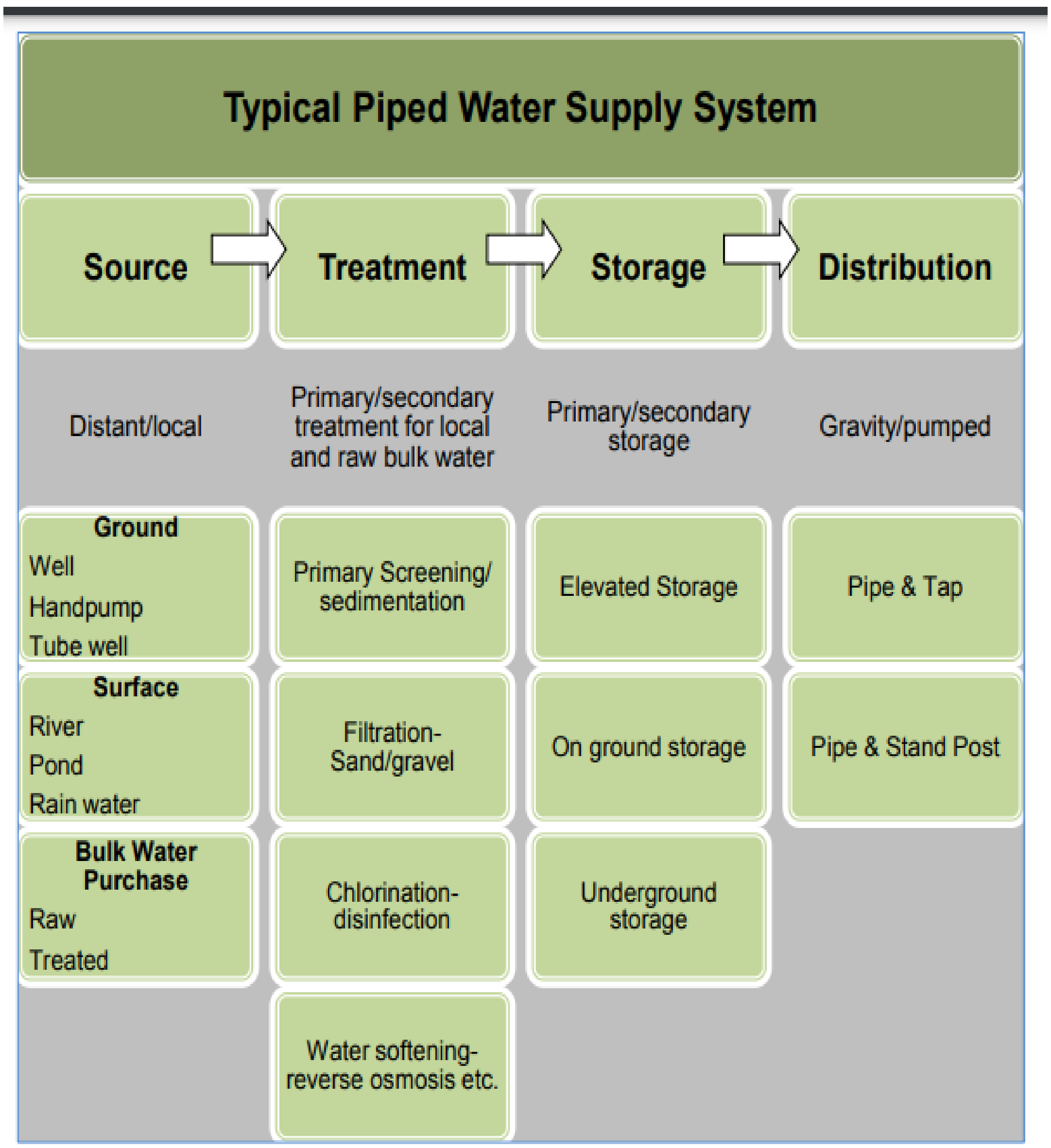
a) To know basic components of village/town water supply

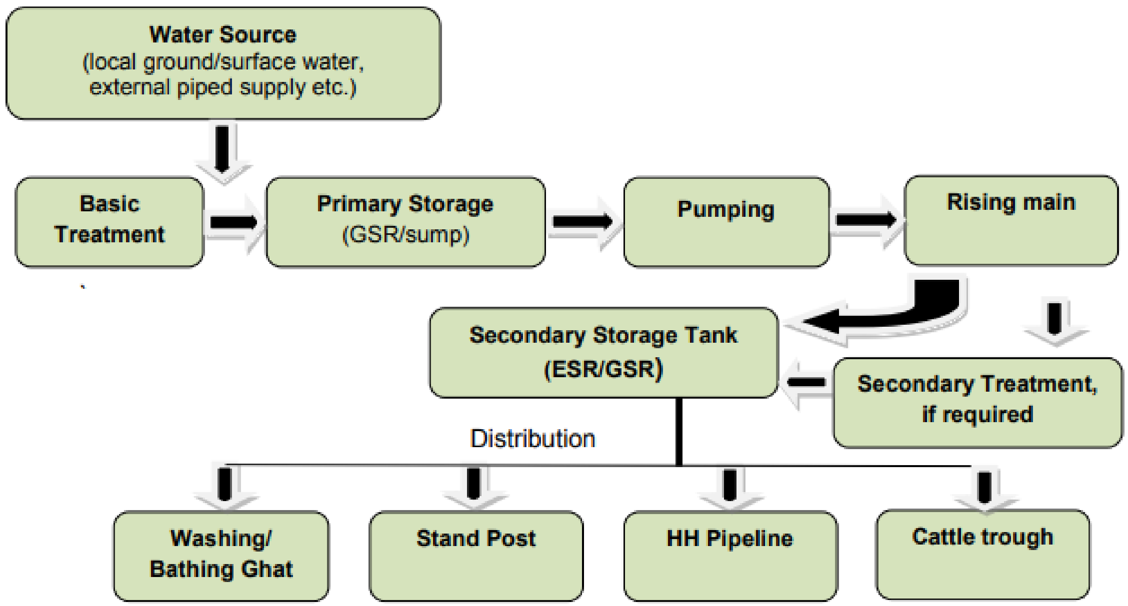
b) To know various sources of water

c) To understand water supply mechanism, storage facilities, distribution system.

A1 Typical Water Supply System

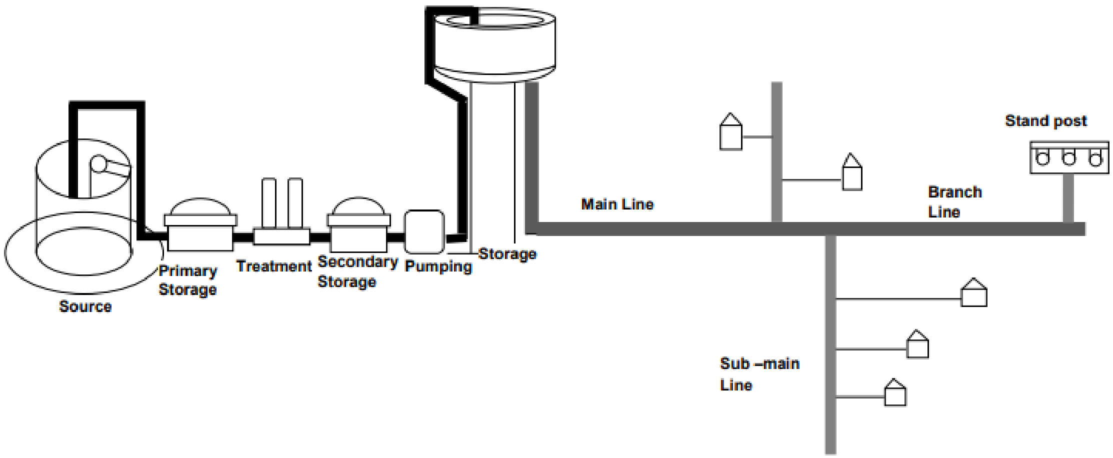
Typical Village/town water supply system constitutes of a gravity/pumping based transmission and distribution system from local/distant water source with needed water treatment system.





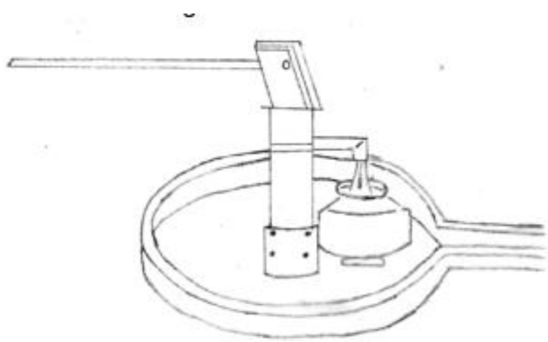
Standard Water supply System in village/town

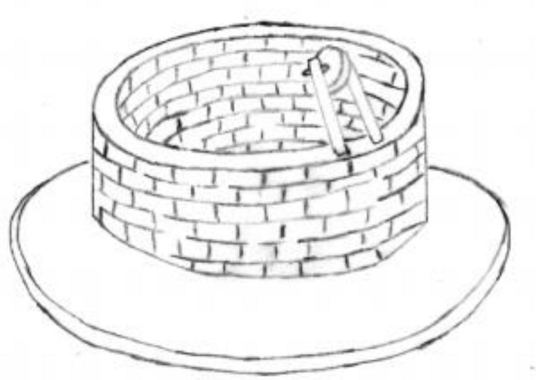
Sources	Open Well, Tube Well, Hand pump, Pond, Dam Site, External Pipe Supply, Rain Water Harvesting System/Tank
Village/town level Treatment	Reverse Osmosis System (RO), Chlorination, Sedimentation, Sand Filter, etc
Storage	Elevated Surface Reservoirs (ESR), Ground Service Reservoirs (GSR), Sump
Distribution	Main Line, Sub-Main Line, Branch Pipe Line, Household Level Tape, Stand Post, Washing Unit.



A2 Sources of Water

Ground water: Open well, tube well/bore well, hand pump are sources which make water available from ground.





Open Well: Where ground water is available at low depth (less than 15 meters - and water is available all year round, open well is used.

Hand Pump: Where safe ground water is available upto 60 m depth, hand pump is ideal choice for a cluster or habitation.

Bore Well/Tube Well: Where ground water is at greater depth and open wells or hand pumps are not viable, bore well or tube well is installed.

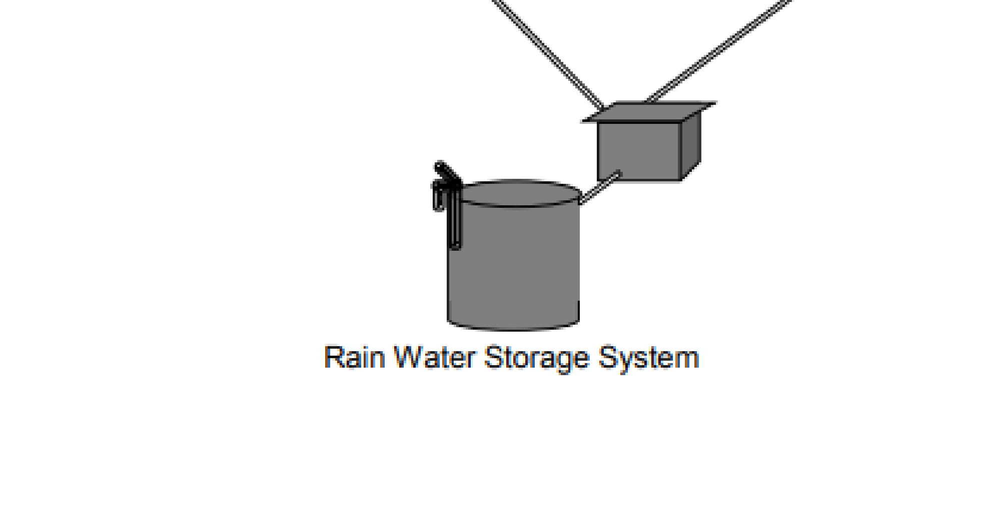
Surface Water: River, pond, dam site are sources where surface water is available.

Moreover, rain water can be harvested and stored directly in storage tanks. This water is potable after first rain and can be used for drinking purpose also.

Classification of Water based on its Availability

A. Local Source: Sources which are available at village/town level likeriver, pond, open wells and bore wells.

B. Distant Source: When perennial reliable and safe source is not available, pipeline from distant sources can be laid. This bulk water is available from river, pond, dam, bore wells or storage tank itself, where water is available.



Rain Water Storage System

A3. Water Treatment

Water from source is treated at village level and even at household level, if needed. If bulk water available from the distant source is treated and potable, then further treatment may not be required at village level. There are various processes of treatment based on the source and quality of water in specific region.

• Village/town level water treatment systems are located mainly near head works. The treatment units are located in such a manner, where possible that flow of water from one unit to other can be done by gravity, so that additional pumping of water is not required. Sufficient area should be reserved near the treatment units for further expansion in future. Basic treatment system at village/town level involves removal of suspended solids through sedimentation, removal of micro-organisms and colloidal matter through sand/gravel filters, water softening through reverse osmosis (RO) system, disinfection through chlorination and any other chemical/specialised treatment for removal of fluoride, salinity etc.

• Treatment at household level is needed as there may be chances of water contamination while transmission of water. This mainly includes basic filtration for removal of any silt, etc.; boiling for removal of micro organisms or chlorination for disinfection.

It is very important to carry out water test in order to decide upon the type of treatment. It is also essential to carry regular water testing from various points starting from source to distribution points to maintain potable water quality. Details of water testing and treatment are discussed in detail in Module E.

1.3 Water Supply Mechanism

Pump House and Pumping Machinery: Pump is used to fetch water from source like bore well, open well, sump or ground water storage and supply it to pipelines or elevated storage. There are three main components: a) pump, b) electrical or oil engine, c) panel board. Pump house is constructed for security and safety of machineries.

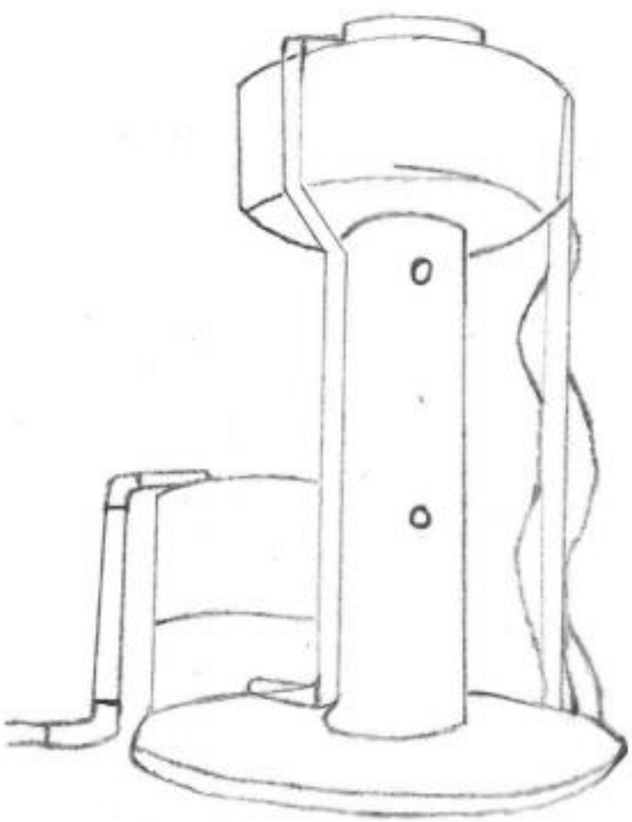
Rising Main: The delivery line carrying water from pump to storage tank (elevated or ground) is called rising main.

1.4 Storage Facilities

Elevated Surface Reservoir (ESR) or elevated storage tank: ESR is constructed, where water is to be supplied at elevated height (less than the level of ESR) or where the distance is large and topography is undulating. Generally, ESR is at height more than 15 m. Water can be distributed directly from this storage tank by gravity or pump.

1.5 Ground Service Reservoir (GSR):

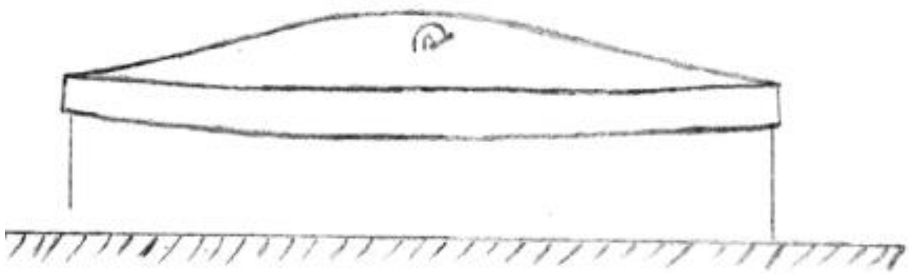
GSR is ground level or plinth level storage tank. The plinth level is generally not more than 3 m.



8

GSR & ESR

Storage capacity of the service reservoirs is estimated based on pumping hours, demand and hours of supply, electricity available for pumping. Systems with higher pumping hours require less storage capacity. Normally, such reservoirs are calculated to store half to one day daily water requirement.



Sump

Sump: Sump is used as additional storage at village/town level or cluster level. It is not used for direct distribution of water. Rather, it is used as intermediate or contingency storage, to store water before it is pumped to ESR/GSR. The underground storage tank in circular shape with dome line covering is called sump. Generally, the capacity of sump is more (one and half to two times) than ESR or GSR or two to five days water requirement, so that if the supply is disturbed for that time, the water is available for the people.

1.6 Water Distribution

For efficient distribution, it is required that water should reach end use with required flow rate with needed pressure in the piping system. There are three main types of distribution system that can be adopted in villages/towns:

a. Gravity Fed Distribution

When the ground level of water source/storage is sufficiently raised than the core village/town area, such system can be utilised for distribution. The water in the distribution pipeline flow due to gravity and no pumping is required. Such system is highly reliable and economical.

1.7 Pumping System

In such system, water is supplied by continuous pumping. Treated water is directly pumped into the distribution main with contant pressure without intermediate storing..Supply can be affected during power failure and breakdown of pumps. Hence, diesel pumps also in addition to electrical pumps as stand by to be maintained. Such system works only in condition where there is continous power supply, reliable water source and where intermediate storage system cannot be installed.

c. Dual/Combination

In such system, both gravity as well pumping systems are used. Such systems are used where there are variations in topography in town/village.

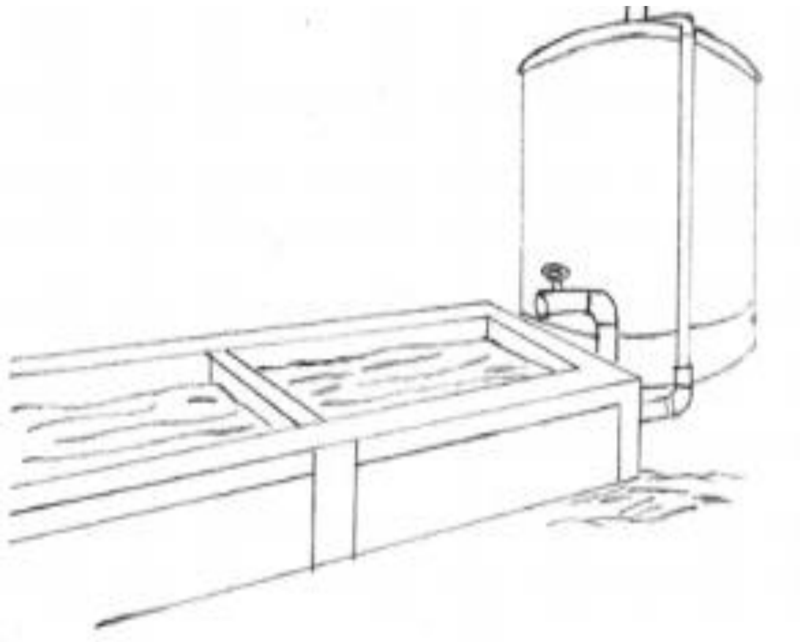
Minimum Residual Pressure in a distribution system should be 7 m for single storied, 12 m for two storied and 17 m for three storied building (Source: CPHEEO)

1.8 Distribution Lines:

The lines carrying water from storage to its end use (stand post/ household tap etc.) are called distribution lines. Distribution pipelines consist of main pipeline connected from secondary storage; sub-main pipes connected from main pipeline and service/branch pipes connected from sub-main for distribution to households. Generally, Mild Steel (MS), Galvanised Iron (GI), High Density Polyethylene (HDPE)/ Poly Vinyl Chloride (PVC) pipes, Ductile Iron (DI) pipe with 15-200 mm diameter are used in distribution. These lines are generally underground (1-3 feet below ground). Valves are used to control the distribution.

1.9 Stand Post:

Stand post with one or more taps are installed at cluster level or near the storage tank, in the villages/towns where household tap connection is not available or possible. Stand posts are constructed of masonry or concrete structures. Stand posts should have normal output of 12 litres/minute. One stand post is estimated for every 250 persons. In case of independent habitation, even if population is less than 250 and there is no potable water source, once stand post is provided. Moreover, stand posts should not be more than 500 m from any such targeted household.



Cattle Trough

Cattle Trough: These are masonry/RCC structures to provide water to cattle.

Bathing or Washing Cubicles:

These masonry structures are generally constructed to facilitate washing clothes and bathing.

1.10 Type of Water Supply

a. Continuous

In this system, there is continuous water supply (for 24 hours). This is possible where adequate quantity of water is available. The major advantage of such system is that due to continuous water supply, water remains fresh and rusting of pipes will be low. However, losses of water will be more in case of any leakage.

b. Intermittent

In such system, supply of water is either done in whole village/town for fixed hours or supply of water is divided into zones and each zone is supplied with water for fixed hours in a day or as per specified day. Such system is followed when there is low water availability, however, in certain cases, wastage of water is more due to tendency of community for storing higher amount of water than required. In such system, pipelines are likely to rust faster due to wetting and drying. However, maintenance can be easily done during no-supply hours.

1.11 Activity Sheet

Section A Components of Village/Town Water Supply System

1. List various components of water supply system

2. Mention various sources of water in village/town used for drinking/domestic purpose

3. Mention various storage facilities and its basic use for water supply system

4. Mention types of distribution system in water supply system

1.12 BASICS ON PLANNING AND ESTIMATING COMPONENTS OF WATER SUPPLY

Basic Planning Principles of Water Supply System

• Rural water supply system should be designed to provide :

a. Atleast 70 liter per capita per day (lpcd) for piped water supply with household tap connections, b. Atleast 55 lpcd for mix system with household (HH) tap supply + public taps/standpost + handpump c. Atleast 40 lpcd where no other source except hand pump, open wells, protected ponds etc are available. Such areas can be augmented with alternative sources. (Source: Strategic Plan 2011-22, "Ensuring Drinking Water Security in Rural India", Department of Drinking Water and Sanitation, Ministry of Rural Development, Government of India)

• Stand posts/hand pumps should be provided where household water supply is not possible. They should have normal output of 12 litres/minute. Generally, one stand post/hand pump is estimated for every 250 persons. In case of independent habitation, even if population is less than 250 and there is no potable water source, once stand post/hand pump is provided. Moreover, stand posts/hand pump should not be more than 500 m from targetted household. (Source: Accelerated Rural Water Supply Programme (ARWSP), Ministry of Rural Development, Government of India)

• For towns, water supply is designed to provide atleast 40 litres/person/day where water is made available through standposts,70 litres/person/day where piped supply is provided but sewerage system is not available. For urban areas with piped supply and sewerage system, water supply is designed for 135 litres/person/day (Source: Manual on Water Supply & Treatment, CPHEEO, 1999)

• The water supply system should be designed for at least 20-30 years.

• Population forecast needs to be done while designing of system. There are various methodologies for population forecast. However, population for 15 years can be considered 1.1 times current population and for 20 years can be considered 1.2 times current population for design.

• Public storage tanks are designed to store at least 50 percent of total daily requirement (or for atleast 12 hours supply) or requirement of peak period (Water Demand in peak period =

average water demand * peak factor). Peak factor is about 3 for population upto 50,000 persons, 2.25 for population ranging from 50,000- 2,00,000 and 2 for population over 2,00,000. Such tanks can be installed at cluster/falia level or one single tank can be installed for a village/town.

Population	Length of total distribution pipeline
Upto 300	750 m
301- 750	1,500 m
751-1500	2,250 m
1501-3000	3000 m
>3000	3,750 m

Design service life of various components (Source: CPHEEO):

Storage by dams	50 years
Infiltration works	30 years
Civil Works (pump house, water treatment civil work building etc)	30 years
Service reservoirs (overhead or underground)	15 years
Electric Pump and Motor	15 years
Pipeline	30 years

1.13 Calculate Domestic Need of Water per Day in Your Village/Town

Government has laid standard of 40 -135 lpcd for villages and towns. The total per day consumption can be worked out by multiplying this demand to number of people residing in the village/town.

Table 1 (Yearly Water Demand of Village/town)			
Total population of village/town	Water requirement per person per day	Total water requirement per day at village/town level	Total water requirement in a year
(a)	(b)	C= (a*b)	C* 365
	40/70/135 lpcd		

1.14 Assess Domestic/Drinking Water Availability:

Water availability for water supply system can be calculated based on water availability and usage from surface, ground source as well as rain water harvesting system.

Sources which can be utilised for domestic/drinking purpose should only be computed. Those source used for irrigation should not be computed. Moreover, sources with high contamination of water should not be considered unless the water is treated considerably.

Consider only public water sources here. Compute yearly water availability in Table 2 for each source type. Detailed method of computing water availability for source type is explained in Tables 2.1 to 2.5. (Details for Grey coloured boxes in each table can be put in Table 2).

1.15 Estimating water availability from ponds/lakes

Estimating water availability from ponds/lakes

Table 2.1 Estimating water availability from ponds/lakes					
	Name of source	Size/capacity		No. of filling per year*	Total capacity of storage (litres)
		(cu. m)	Litre (cu. m. *1000)		
			(a)	(b)	a*b
1					
2					
3					
				TOTAL	

*partial (0.25-0.75), full (1), over flow (more than>1)

Estimating water availability from community hand pumps

Table 2.2 Estimating water availability from community hand pumps					
No. of source	Average working hours per day*	Average discharge rate per hour**	Per day water availability	No. of functional days in year	Total water availability in year (litres)
(a)	(b)	(c)	d=(a*b*c)	e	d*e
				TOTAL	

*Can be presumed to about 6 hours

**Can be assumed as 12 litres/minutes or 720 litres/hour if data not available

Estimating water availability from community bore/tube well Water availability from bore well can be determined from discharge rate of pump placed for drafting water.

Table 2.3 Estimating water availability from bore/tubewell					
Bore well	Discharge rate of water (litres/hour)*	Average hours of pumping in a day**	Total water availability (litres/day)	Average no. of days of water availability in a year	Water availability in a year (litres/year)
	a	b	c=a*b	d	c*d
1					
2					
3					
				Total	

*Discharge rate can be estimated from average volume of tank filling in an hour.

**Normally, pumping is done from 8-12 hours/day.

1.16 Estimating water availability from community open well

Water availability from open well can be calculated based on size of well (cu. m.) multiplied by number of times the well is filled in year. However, number of times well is filled needs to be calculated based on geo-hydrology of region with support of expert. Hence, easier way is to calculate based on average extraction of water per day by local community multiplied with number of day of water availability in well.

If the well is being pumped through motor, then calculation should be based on water discharge rate of pump and number of hours of operation of pump per day (as listed in section of bore/tubewells).

Table 2.4 Estimating water availability from open well

Open well	Average no. of people extracting water from well daily	Average water that a person extracts in a day (litres)	Total water extracted in day (litres)	Average no. of day of water availability in a year	Water availability in a year (litres/year)
	a	b	c=a*b	d	c*d
1					
2					
3					
				Total	

Estimating water availability from external piped supply Various methods can be adopted for estimating water availability from external piped supply

Table 2.5 Estimating water availability from external piped supply				
		Water availability Litres/day	Average days of water supply in year	Total yearly water availability
		a	b	a*b
Method 1	Through average volumetric measurement through water meters installed	_____ litres /day		
Method 2	Number of filling of head work/sump/main storage tank at village/town level in day	No. of fillings of tank per day * capacity of tank= _____ litres/day		

1.18 Basics on Calculating Roof Top Water Harvesting

- Roof top rain water harvesting is a simple method to collect and store rain water from roof top.
- Such system can be installed at household as well as community level like schools, panchayat building etc.
- Typical rain water harvesting unit consists of

a. Gutter pipes for conveying water from sloped roofs.
b. Conveyance pipes connected from gutter pipes (sloped roofs) or directly from roof outlet.
c. Valve prior to filter unit for flushing impure water, mainly first rain.
d. Filter unit consisting of sand-gravel bed for basic filtration.
e. Storage tank (normally 5,000-10,000 litres tank can be installed at HH level for family of five. At community level storage size can be decided on water that can be harvested and funds available). Storage tank normally should be underground.
f. Hand pump/motorised pump to withdraw water from the tank

- Normally, first rain water is not filled in tank as the roof top gets cleaned. Even for subsequent rains, allow rain water for first 5-10 minutes to flush away for getting rid of impurities from roof.
- Calculation for water that can be harvested from roof top in litres:

Area of roof in m2 (a) X run-off coefficient (c) X annual rainfall in region in meter X 1000 (for converting m3 into litres).

— Area of roof is measured as length in meter X breath in meter.

— Run off co-efficient caters to spillage, leakage, absorption by roof material.

CHAPTER 2

2. LITERATURE REVIEW

2.1 Water sector reforms

Current policy drives and reforms in the water sector include:

• Expanding water and sanitation coverage in areas with high levels of unserved people in order to meet the Millennium Development Goals e.g. many rural areas within southern Africa. The dominant model to achieve this is community management which aims to encourage sustainability through community involvement at all stages but especially operation and maintenance of systems.

• Integrated water resources management focusing on the establishment of catchment or river basin level institutions to plan, allocate and regulate the use of surface and groundwater resources

Integrated Water Resources Management (IWRM) has emerged during recent years as a response to a perceived water crisis, to a large extent driven by the environmental movements and interests that emerged in the 1980s and 1990s. The facts are relatively well known and rehearsed: that the proportion of the world's population living in countries of significant water stress will increase from approximately 34% in 1995 to 63% in 2025; that only a small percentage of wastewater is treated before it is disposed back into fresh water bodies; that in some areas water resources are already over-abstracted, leading to severe, and sometimes irreversible, impacts on eco-systems; that 1.1 billion people lack access so safe drinking water, and 2.6 billion people do not have access to safe sanitation (Moriarty and Butterworth, 2004; Scott et al., 2004; WHO/UNICEF, 2005). However it is increasingly realised that the heart of the water crisis is poor management or governance. With careful management and wise selection of priorities there is no reason that even in the driest parts of the world there should not be sufficient water to go around, and viable solutions do exist to many of the problems faced.

IWRM seeks to tackle some of the root causes of the management crisis, namely the inefficiencies and conflicts that arise from uncoordinated development and use of water resources. IWRM is being promoted by many organisations, implemented in some areas and piloted in others. A huge effort involving the reform of water laws, institutions and capacity building is underway based upon the IWRM 'recipe'. In most southern African countries new laws have been enacted to develop catchment level authorities to plan and manage water resources, and the EC water framework directive now requires .

There are many definitions of IWRM, but the most commonly used is that “IWRM is a process which promotes the co-ordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems” (GWP, 2000). IWRM means a move away from traditional sub-sector based approaches (WATSAN, irrigation, industry, etc) to a more holistic or integrated approach to water management based upon a set of agreed key principles. Taken together, the principles offer a framework for analysing, and subsequently managing multiple uses of water in situations of increasing competition and conflict and where water resources are scarce (or polluted).

2.2 Links between water and sanitation services and IWRM

Moriarty & Butterworth (2004) review water resources management issues in water and sanitation service delivery with a focus on the south. In essence water and sanitation services interacts with water resources management at two points – inlets and outlets. While IWRM principles can be of great use in ensuring good practice within a domestic water supply system (for example when applied to decentralised management), IWRM is most obvious at those points where water for domestic use (and sewage disposal) directly interacts with other uses and the environment. The classic domestic water cycle has the following stages: abstraction, water treatment, supply to households and, where waterborne sewerage exists, removal from the household through sewers, wastewater treatment and discharge to a water body. In this cycle the most critical elements from the IWRM viewpoint are the abstraction from the source (quantity, quality, and reliability issues), and discharge into watercourses (quantity and quality issues) or, indeed, leakage to groundwater.

2.3 BASICS ON WATER PUMPING AND DISTRIBUTION

Basics on Water Pumping

• Pumping Machinery is used for transfer of water from one place to another and pumping of water from water source. Pumping is required for

a) Lifting water from the source (surface or ground) to purification works or the service reservoir.

b) Transfer of water from source to distribution system.

c) Pumping water from sump to elevated/ground surface tanks.

• Pump house (civil works) is constructed for installation of pumping machinery.

• Pump House is designed for life of atleast 30 years, while pumping machinery is designed for atleast 15 years lifespan.

• Pumping Machinery consists of 3 major components:

a. Pump for lifting of water

The function of pump is to transfer water to higher elevation or at higher pressure. Pumps are driven by electricity or diesel or even solar power. They are helpful in pumping water from the sources, that is from intake to the treatment plant and from treatment plant to the distribution system or service reservoir.

b. Electric/diesel/solar powered motor

For pumping, 3 phase electric connection is required.

c. Panel board

Panel board consists of circuit breaker or switch and fuse, starter level controls etc for transmission of electric supply.

• For water supply system, three main types of pumps are used:

a. Centrifugal Pump which is used for pumping water from well/sump. It is a type of velocity pump where water is moved through continuous application of power. This type of pumps are used widely in water supply schemes containing sand, silt etc. Centrifugal force is made use of in lifting water. Electrical energy is converted to potential or pressure energy of water. The pump consist of following part:

• Casing

• Delivery Pipe

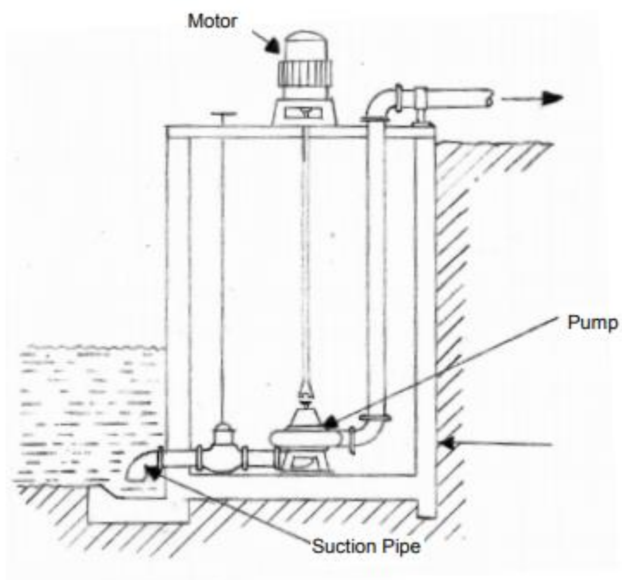
• Delivery Valve

• Impeller

• Prime Mover

• Suction Pipe

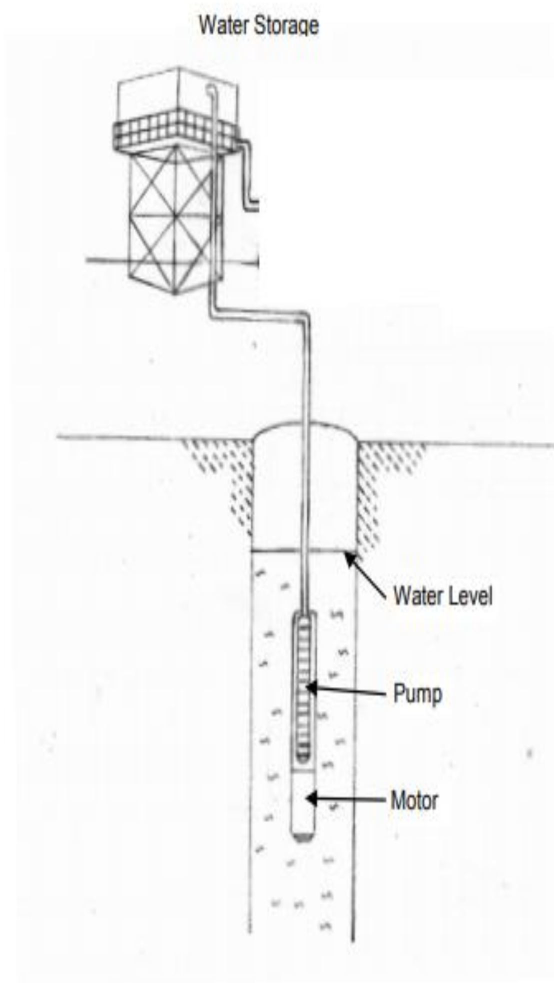
• Strainer and Foot Valve



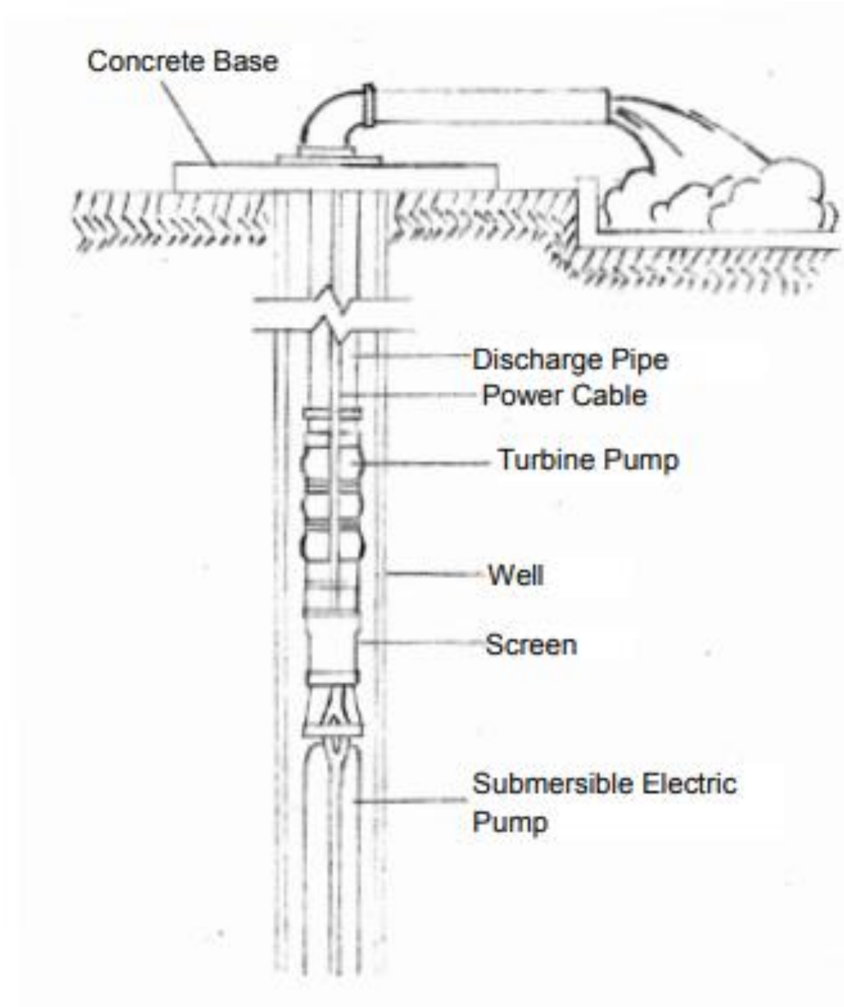
The pump consists of an Impeller which is enclosed in a water tight casing. Water at lower level is sucked into the impellor through a suction pipe. Suction pipe is air tight. A strainer foot valve is connected at the bottom of the suction pipe to prevent entry of foreign matter and to hold water during pumping. Suction pipe is kept larger in diameter than delivery pipe to reduce cavitations and losses due to friction.

2.4 Turbine Pump

The principle of a pump used as turbine: When water flows back through a pump, the impeller will run in reverse and the pump will function as a turbine. The energy recovered from pressure differences, heads or flow can be fed back into the system or into the mains. Turbine pumps are mainly used in elevation of water from ground level storage to elevated areas/storage or pumping from deep wells/tube wells. If the water requirement is large and there is a large source of falling water (head and flow rate) nearby, turbine-pump sets can provide the best solution.



Submersible pump is designed such that it can be introduced into well casing and lowered to the bottom of the well. It is highly used for pumping from bore well and underground sumps. Such pumps are used for water yield of 100 litres per minute. It is driven by an electric motor, which is directly attached to the pumping element and therefore totally submerged. This pump type is mainly used where electric power is available or ideally in combination with a Solar Pumping System. The main parts of a submersible pump are:



a) Electric motor enclosed in a stainless steel sleeve.

b) Pump body with multiple impellers, foot valve and strainer.

c) Rising main of GI or stainless steel pipes connected with sockets or PVChose. If a hose is used, the motor with connected pump body has to be hung from the top of the well by a stainless steel cable.

d) Electrical cable for connecting the motor to the starting panel (power source).

e) Starting panel. Various sizes of submersible pumps are available, which can be installed in casings of diameter 4”, 6”, 8”, 10” and 12”. Submersible pump have high efficiency and durability, low operation cost and high resistance to sand content.

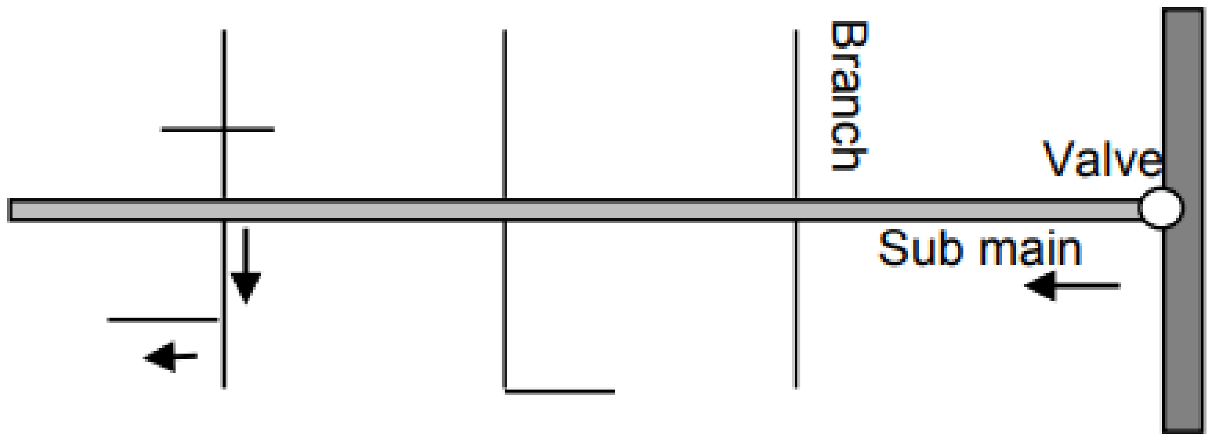
• Criteria for Pump Selection for water supply

a) Type of pumping required, i.e. whether continuous, intermittent or cyclic.
b) Present and projected demand and pattern of change in demand.
c) The details of head and flow rate required.
d) Type and duration of the availability of the power supply.
e) Selecting the operating speed of the pump and suitable drive/driving gear.
f) The efficiency of the pumps and consequent influence on power consumption and the running costs.
g) Ease in installation.

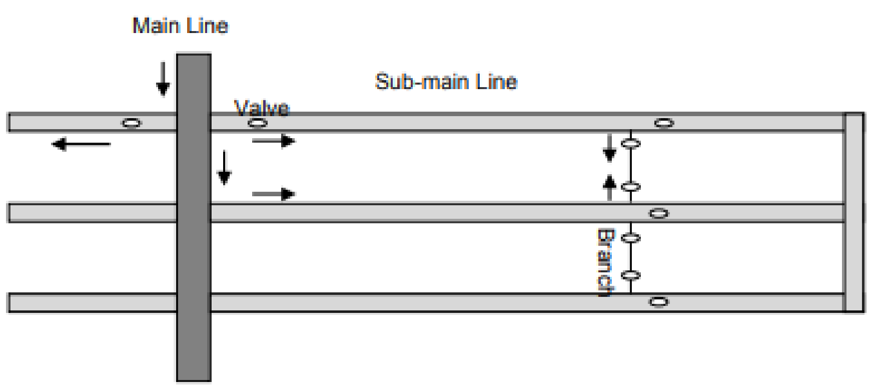
2.5 Pipeline Distribution Networks

Pipeline distribution networks are aimed at design of suitable routes for piping. It is very important for proper water pressure, capital cost and operation and maintenance cost. Different types of networks are adopted looking to the pressure requirement, operation and maintenance (O&M) strategy adopted, cost parameter and over all length of distribution system.

a. Dead end distribution system In such system, sub main pipes are connected at right angles from main pipeline and branch pipes are connected to sub mains at right angles. This system is easy to lay. However, in case of failure in pipeline, it will be difficult to supply water to the area ahead of affected area. Also pressure at the tail end will be low compared to other area and there will be stagnation of water.

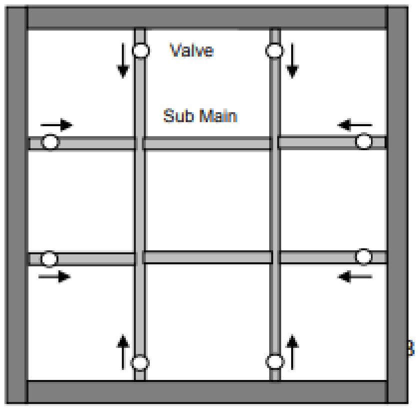


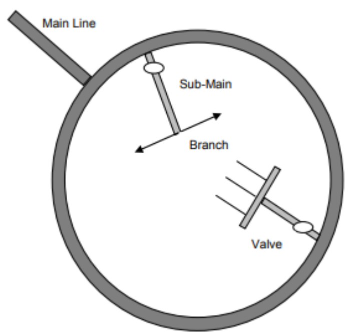
b. Grid Iron System In such system; main, sub main and brach pipes are interconn ected to each other. A grid sytem is laid. Here, total length of pipeline required is high, but this helps in equitable water pressure. Also, blockage of piepes in one area does not affect the supply in the rest of area as there are multiple supply points to any area. This will also help in avoiding water stagnation. The system required higher number of valves.



2.6 Ring System

The whole system is enclosed by main pipeline in radial or rectangular shape. Smaller areas are enclosed by sub main pipeline. In case of failure of system, very small area will be affected. The area ahead of affected area can get water from other point. The system requires higher number of valves. Here water can be supplied to any point from two directions.





c. Radial System

The area is divided into different zones. The water is pumped into the distribution reservoir kept in the middle of each zone and the supply pipes are laid radially ending towards the periphery.

CHAPTER 3

3. Methodology

The findings for Maharashtra state have been summarised and organised based on the identified themes and indicators.

The household surveys were done to provide state-level estimates for different city categories (population size and administration) and for variations in services for slum and non-slum households. A total of 7,680 households were surveyed across 40 cities of Maharashtra. Four categories of cities were covered: Large Corporations, Small Corporations, Class A towns and Small Towns.

The housing typologies were classified into slum and non-slum households. The households interviewed in the Large Corporations (with larger variation of housing differences) was 2A40, in Small Corporations 2,200 households, while in Class A and Small Towns 1,840 and 1,200 households, respectively, were interviewed. Within each category, the sample across the selected towns was distributed in proportion to its population. To the extent possible, an equal number of slum and non-slum neighbourhoods were covered in each selected city. The estimations for the slum and non-slum categories, city categories and urban Maharashtra were arrived at after applying weights on the sample data.

Apart from the household interviews, water quality sample tests were carried out for 100 samples taken from different cities and across slum and non-slum neighbourhoods. The water samples were taken from the water source end, the distribution network and from consumer premises, to understand the water quality issues in different stages of water transmission through the piped water network. The tests were conducted by recognised laboratories on various (physical, chemical and bacteriological) parameters and categorised into potable and non-potable water quality.

Additionally, a small sub-sample of 100 households was covered for ran...owl:v.:it of the actual water consumption for domestic purposes by the households. This was undertaken to validate (on sample basis) the water consumption data captured through verbal recall methodology in the household survey. The consumption was tracked over three consecutive days to arrive at reliable estimates of water consumption by different members of the households for independent usage, as well as the household's water consumption for common uses such as cooking, washing utensils, cleaning the house, etc, to arrive at a more scientific and objective consumption estimate.

3.1 TYPE OF PIPE MATERIAL FOR PIPELINES FOR WATER DISTRIBUTION

Various types of pipes are used for water supply system including metallic and non-metallic pipes. Most common types of pipes used for water supply system are:

a. Galvanised Iron Pipes – metal pipe
b. Mild Steel Pipes metal pipe
c. Poly Vinyl Chloride pipes - non- metal pipe
d. High Density Poly Ethylene Pipes - non metal pipe
e. Ductile Iron Pipes

For water mains, mainly GI and MS pipes or even large HDPE pipes are used, while for branch/service pipes, most commonly used are galvanised iron and HDPE/PVC pipes. DI pipes are used for both purposes.

3.1.1 Mild Steel Pipes

a. Number of joints are less as they are available in longer length.
b. Pipes are durable and can resist high internal water pressure and highly suitable for long distance high pressure piping.
c. Flexible to lay in certain curves.
d. Light weight and easy to transport. Damage in transportation is minimal.

e. Pipes are prone to rust and require higher maintenance.
f. Require more time for repairs and not very suitable for distribution piping.
g. Available in diameter of 150-250 mm for water supply and cut lengths of 4 - 7 m (2.6-4.5 mm wall thickness).
h. Steel Pipes are joined with flanged joints or welding.

3.1.2 Galvanised Iron (GI) Pipes

- Cheap in cost and light in weight.
- Light in weight and easy to join.
- Affected by acidic or alkaline water.
- GI pipes are highly suitable for distribution system. They are available in light (yellow colour code), medium (blue colour code) and heavy grades (red colour code) depending on the thickness of pipe used. Normally, medium grade pipes (wall thickness 2.6-4.8 mm) are used for water supply system. Normally, 15-150 mm size pipes (nominal internal diameter) are used for distribution system. They are available in length of 3 m.
- GI pipes can be used in non-corrosive water with pH value greater than 6.5.
- GI pipes can be used for rising main as well as distribution.
- GI pipes are normally joined with lead putty on threaded end.

3.1.3 Poly Vinyl Chloride (PVC unplasticised) Pipes

- Cheap in cost and light in weight.
- Economical in laying and jointing.
- They are rigid pipes.
- Highly durable and suitable for distribution network..
- Free from corrosion and tough against chemical attack.
- Good electric insulation.
- Highly suitable for distribution piping and branch pipes.
- Less resistance to heat and direct exposure to sun. Hence, not very suitable for piping above the ground.
- PVC pipes weigh only 1/5th of steel pipes of same diameter.
- Certain types of low quality plastic impart taste to water.

- Available in size 20-315 mm (nominal internal diameter) for water supply with pressure class of 2.5, 4, 6, 8 & 10 kg/cm2 for water supply. Ideally pipes with 6 kg/cm2 should be used.
- Classification of pipes is done according to its pressure class.

Class	Working Pressure
Class 1	2.5 kg/cm^2
Class 2	4 kg/cm^2
Class 3	6 kg/cm^2
Class 4	8 kg/cm^2
Class 5	10 kg/cm^2
Class 6	12.5 kg/cm^2

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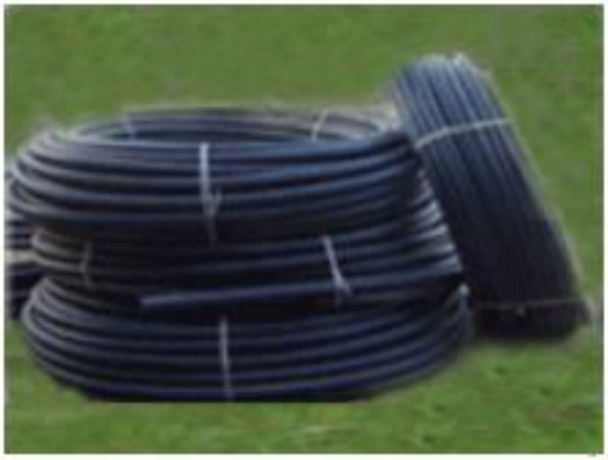
- Available in lengths of 2, 3, 4, 6 m. For plain ended pipes, the overall length shall be measured from end to end. For socketed pipe for solvent cement jointing the effective length of pipe shall be determined by subtracting from the overall length, the socket length.
- Jointing of PVC can be made by solvent cement or rubber ring joint.

3.2 HDPE

- Light in weight.
- Flexible than PVC pipes.
- HDPE pipes are black in colour.
- Suitable for underground piping and can withstand movement of heavy traffic.
- Allows free flowing of water.
- Highly durable and suitable for distribution network.
- Free from corrosion..
- Good electric insulation.
- Useful for water conveyance as they do not constitute toxic hazard and does not support microbial growth.



Normally, 20-315 mm diameter pipes are used for water supply and distribution system with pressure ranging from 6- 10 kg/cm2 . Available in coils in small diameters. Above 110 mm diameter, available in lengths starting from 6 m.

5. Ductile Iron Pipes

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- Ductile Iron pipes are better version of cast iron pipes with better tensile strength.
- DI pipes are prepared using centrifugal cast process.
- DI pipes have high impact resistance, high wear and tear resistance, high tensile strength, ductility and good internal and external corrosion resistance.
- DI pipes are provided with cement mortar lining on inside surface which provides smooth surface and is suitable for providing chemical and physical barriers to water. Such pipes reduce water contamination.

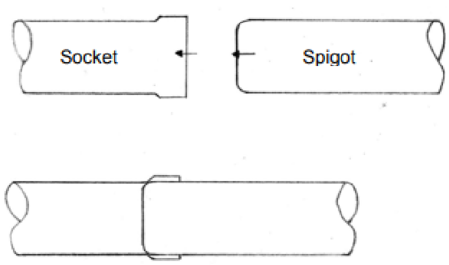
- The outer coating of such pipes is done with bituminous or Zinc paint.
- DI pressure pipes are available in range from 80-1000 mm diameter in lengths from 5.5-6 m.
- Available in thickness class K7 and K9 with barrel wall thickness ranging from 5-13.5 mm. Also available in pressure class (Like C25, C30, C40 etc.).
- They are about 30 percent lighter than conventional cast iron pipes.
- DI pipes lower pumping cost due to lower frictional resistance.

3.3 What is spigot and socket end in pipes?

Spigot and sockets are type of pipe ends.

Spigot is the pipe end which is inserted into socket.

Spigot and socket are joined with rubber seals, lubricants etc.

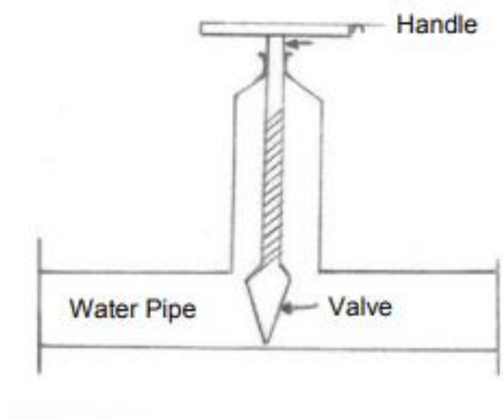


3.4 What is flanged end in pipes?

Pipes have flanged at their ends which are joined with nuts and bolts.

Type of Valves for Water Flow Control and Estimation

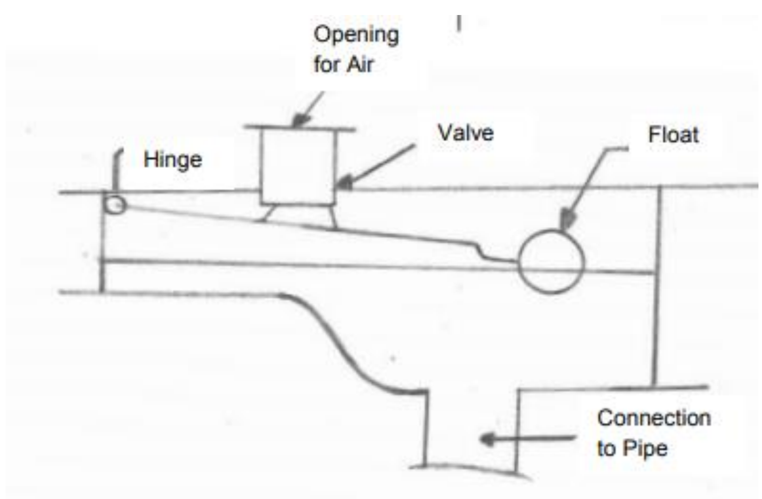
Sluice Valve



It is used for control on water flow in pipeline. It is fixed in main line and at start of branch line. It is also used as scour valve for cleaning of pipeline. They are provided in straight pipeline at 150-200 m intervals. When two pipes lines interest, valves are fixed in both sides of intersection.

3.5 Air Valve A

ir valve are fixed in order to allow air circulation in pipeline. It is placed in pumping main line and distribution line mainly which are at higher levels. Air valves may be placed at every 1000 m for pipe lines upto 600 mm dia.



3.6 Water Meters

- These are devices installed on pipes to measure quantity of water flowing in particular area. These are installed to keep control on water usage in case of metered water supply.
- Meters installed to measure household consumption are called domestic water meters. Water meters can also be installed for measuring quantity at stand posts.
- Water meters having sizes from 15 mm to 50 mm are considered for domestic water meters.
- Water meters are made normally of cast iron/brass/plastic body and plastic gears.
- Meters are classified according to the operating principle, type of end connections, the standard by which the same are covered, constructional features, method of coupling between the counter and primary sensor, the metrological characteristics etc.
- Automatic water meter reading system are used now in order to collect data from all the meters at central point through GSM/internet. This help in saving time for collecting data from each individual place. This system helps in collection, displaying and processing of data at one single place. It also helps in monitoring of data daily.

- Sizing of water meter Water meter has to be selected according to the flow to be measured and not necessarily to suit a certain size of water main. The maximum flow shall not exceed the maximum flow rating. The nominal flow should not be greater than the nominal flow rating.
- Installation guidelines and sizing reccomendations for water meters are normally given by the supplier.

3.7 Flow Meters

- Flow meters are devices installed mainly to measure velocity/speed of water and also derive quantity of water.
- Flow meters are placed near water intake/head works, transfer mains, storage tanks/reservoirs, distribution network like branch/main/sublines etc.
- Various type of flow meters are available based on characteristic and performance line accuracy of measurement, range, resolution etc. Difference of water meter against flow meter
- Water meter is a quantity meter and not a flow rate meter.
- Water meter is a mechanical device whereas flow meter is mechanical or an
- electronic device.
- Water meter is always specified in two accuracies i.e. lower range and upper range accuracies whereas a flow meter it is specified in a single range accuracy.
- The upper range and lower range accuracies are 2 percent and 5 percent of the actual quantity respectively for the water meter whereas it is variable for flow meter as per the customer's requirement.

3.8 Installation of Water Meters

• Installation manual is normally given by the meter supplier.

• Domestic Water Meters can fixed at household level in case there is 24 hours supply and water tariff is collected based on actual water consumption.

• A masonry pit is constructed around the meter to protect it. A lid should be placed on pit for taking readings. The protective lid should normally be kept closed and should be opened only for reading the dial.

• Technical parameter for fixing of water meters

a) Water meters must be fitted in the right direction of flow and positioned to allow easy visibility for manually reading the meter and for viewing the serial number.

b) The length of pipe that accommodates the water meter must be completely filled with water immediately upstream and downstream of the meter under all operating conditions.

c) Install meter such that top of the meter is below the level of the communication pipes so that meters always contain water.

d) Water meters are to be located to avoid damage (eg. vehicles, livestock, vandalism, flooding) a protective box/masonry pit may be necessary in some situations.

e) Water meters are to be installed as close as practicable to the extraction point and must be located upstream of any valves (except air valves), tees, takeoffs, diversions or branches.

f) Water meters are to be installed above ground if possible and located outside of wells to allow for safe and easy meter reading. If a water meter is required to be located below ground, or down a well then it should not be deeper than 500 mm below ground level.

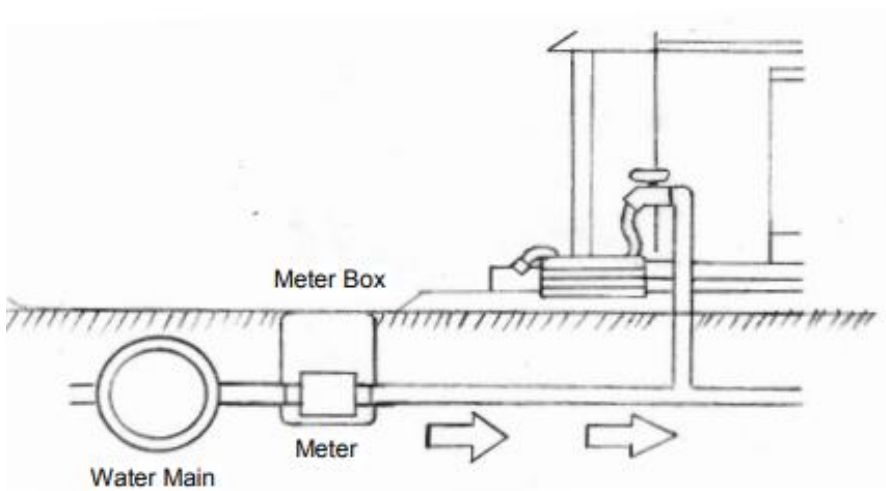
g) Water meters fitted onto PVC, or HDPE pipeline must be adequately supported by a concrete block, or fabricated steel bracing to ensure stability.

h) Before connecting the meter to the water pipe, it should be thoroughly cleaned by installing in the place of the water meter a pipe of suitable length and diameter and letting the passage of a fair amount of water flow through the pipe work to avoid formation of air pockets. It is advisable that the level of the pipeline where the meter is proposed to be installed should be checked by a spirit level.

i) Before fitting the meter to the pipeline check the unions nuts in the tail pieces and then insert the washers. Thereafter screw the tail pieces on the pipes and install the meter in between the nuts by screwing. In order to avoid its rotation during the operation, the meter should be kept fixed with suitable non-metallicclamps. Care should be taken that the washer does not obstruct the inlet and outlet flow of water.

j) Where intermittent supply is likely to be encountered the meter may be provided with a suitable air valve before the meter in order to reduce inaccuracy and to protect the meter from being damaged.

k) Test and calibrate the water meter before use and at regular intervals as per instructions given by manufacturer.



Typical Installation System for Domestic Water Meter

CHAPTER 4

4. DATA CALCULATION AND ANALYSIS

Mali is a landlocked nation covering an area of 1,240,000 square kilometers, the northern three-quarters of which lie within the Saharan and Sahelian zones. The country is home to approximately 11 million residents, 72% of whom live in the rural sector (Toulmin et al. 2000). Rain-fed subsistence farming of cereals (millet and sorghum), animal husbandry, and irrigated paddy rice cultivation along the major rivers remain the principal agricultural activities despite poor soil fertility and highly variable rainfall. The specific zone of interest for this study is the district of Koro (Cercle de Koro) which corresponds with the first intervention zone of the WAWI project (Figure 1). This district is characterized as semiarid with an annual precipitation of approximately 500 mm per year, and daytime temperatures typically exceed C throughout the year. There are three main seasons: the rainy season°33 (mid-June – September), the cooler Harmattan period (October – January), and the hot season (February – mid-June).

Koro's water resources are severely limited as there are no permanent rivers or lakes in the district. During the rainy season, small surface water reservoirs fill with water and become the primary water resource for the rural villages of the district. At the onset of the dry season, these surface reservoirs begin to dry up and groundwater becomes the only available source of water for the remaining seven to eight months of the year. This groundwater is typically located in discontinuous, slowly recharging aquifers at 50 – 100 meters below the sandy surface layers of Arenosol type soils, and confined under a thick impermeable layer of rock (30 – 60 meters). The aquifers are highly fragmented and subsurface conditions may vary drastically across relatively short horizontal distances.

The three villages of this study, Yadianga, Ogodouroukoro and Benebourou for example, are all located within 12 kilometers of Koro and yet they demonstrate very different groundwater availability characteristics. The village of Yadianga (pop. 2,473 est. 2001) typically has yearly access to a superficial unconfined aquifer at ~28 meters, but the wells accessing this aquifer begin to dry up during the dry season. The village of Ogodouroukoro (pop. 612 est. 2001) has no viable amount of water stored within the shallow superficial aquifer and their only groundwater source is the deeper confined aquifer (~75 meters). As for the village of Benebourou (pop. 1,570 est. 2001), they benefit from a plentiful shallow aquifer (~5 meters).

4.1 Water Quality and Testing

Water from ground or surface sources are not always potable for drinking and need some level of water treatment prior to supply for water supply system. Following are some of the quality issues that are normally seen in various types of water sources:

Water Source	Type of quality issues
Surface water	
Lakes and ponds	Development of algae on top, development of Micro organisms, high turbidity in bottom layers. May be affected by organic and chemical pollutants by disposal of wastewater.
River, irrigation canals	Organic debris, mineral salts May be affected by organic and chemical pollutants by disposal of wastewater.
Ground Water	
Well, tube wells, hand pump etc	Salinity, fluoride, alkalinity, hardness Chemical contaminations due to disposal of domestic waste/industrial chemical near by

There are certain parameters for potable drinking water, recommended by Government of India (IS 10500 -1991) which are enlisted below:

Parameter	Desirable Value	Maximum Permissible Value	Effects if not controlled
Colour	5 hazen unit	25 hazen unit	Unacceptable by people
Odour	odourless	Odourless	Unacceptable by people
Turbidity	5 NTU	10 NTU	Unacceptable by people
Soluble Salts/TDS	500 mg/l	2000 mg/l	Stomach ache
pH	6.5- 8.5	6.5- 8.5	Intestinal problems
Hardness	300 mg/l	600 mg/l	Not appropriate for cooking, washing clothes. flaking in pipes
Calcium	75 mg/l	200 mg/l	Not appropriate for cooking,
Chlorides	250 mg/l	1000 mg/l	Corrosion, taste differs
Sulphate	200 mg/l	400 mg/l	Indigestion, stomach problems
Magnesium	30 mg/l	100 mg/l	Stomach ache
Nitrates	45 mg/l	100 mg/l	Can lead to Blue baby (1-6 months child)
Fluorides	1.00 mg/l	1.50 mg/l	Fluorosis of teeth, bones and muscles
Alkalinity	200 mg/l	600 mg/l	Taste differs
E-coli	Count 0 in 100 ml		Infectious disease and intestinal problems
Coliform	<10 in 100 ml	Not detected in more than 50% sample in year	

For testing of water, services can be availed from Maharasthra Jeevan Pradhikaran, Public Health Engineering Department (PHED) and health department offices located at block/taluka level, or other water testing laboratories in the region.

Types of tests to be conducted

a. Physical test including temperature, turbidity, colour, taste, and odour.
b. Chemical tests including pH, alkalinity, acidity, hardness, calcium, magnesium, iron, manganese, copper, zinc, aluminum, sulphates, fluorides, chlorides, nitrates, total dissolved and suspended solids, tests for toxic chemicals (lead, mercury etc.), test for radio-activity.
c. Bacteriological examination for presence of bacteria like coliform, E-coli

4.2 Sampling Frequency

Water from all the sources like wells/tubewell/hand pump or collection point like stand post or HH level/intermediate storage tank should be tested at regular intervals. Normally, one sample for every 5000 population should be tested in each month. Additional tests should be conducted during monsoon and epidemics as per need. Where there are issues of biological contaminations, samples should be taken every week from the specified water source.

Following chart enlists the minimum sampling frequency from distribution system as per CPHEEO guidelines:

Minimum Sampling Frequency and number from Distribution System		
Population	Maximum intervals between successive sampling	Minimum number of samples to be taken from entire distribution system
Upto 20,000	One month	1 sample per 5,000 population per month
20,000-50,000	Two weeks	
50,000-100,000	Four days	
>100,000	One day	1 sample per 10,000 of population per month

4.3 Sampling Methods

a. Sampling for physical and chemical test

- Samples should be collected in inert materials like glass or polythene.
- Sample bottle must be cleaned prior to taking samples as directed by laboratories.
- About 2.5 litres is required for testing from each sample.
- Prior to filling, the sample bottle must be rinsed 2-3 times with water to be collected.
- Sample should reach the testing place within 72 hours of collection.
- Certain parameters like pH, temperature chlorine etc may change during transport and it is advisable if they are tested on spot by specific kits.
- Samples collected from wells should be taken only after the well has been pumped for sufficient times so that the sample will represent ground water.

b. Sampling for bacteriological test

- Sterilised bottle, as directed by laboratory should be used for sample collection.
- While collecting sample, hand should not touch the bottle neck or stopper. Bottle should be held from the base, filled without rinsing and stopper be closed immediately. Bottle should have some air space left and should not be filled completely. Finally, brown paper should be wrapped for avoiding further contamination of water.
- Size of sample should be at least 250 ml (1/4th of litre).
- The sample should preferably be analysed within one hour after collection. The test of the sample should be done maximum within 24 hours.

4.4 Note for collecting sample from various sources

- While taking sample from river, lake, etc. sample should be taken from middle of bank. Stagnant water should be avoided for sample.
- While taking sample from tap (HH or stand post), water should be allowed to flow for two to three minutes prior to taking sample. Tap from which sample is collected

should be clean and free from grease etc. • While taking sample from hand pump, water should be allowed to flow for four to five minutes prior to collection of sample.

- While collecting sample from well/bore well, sample be collected from discharge end through fitted mechanical pump.

Water Testing Kits

Several testing kits are available in market to test water quality at village/town level. Use of these kits need specialised training appropriate for tools and equipments of the kit.

Water Testing Kits in India 1. FTC (Field test kits)

- As per National Rural Drinking Water Quality Monitoring and Surveillance Programme, field testing kits are provided at Gram Panchayat level for testing of various parameters at village/town level. These Kits are meant for water quality monitoring and testing by PHED engineer, NGOs, Voluntary agencies, Women group etc. Such kits are used for primary detection of chemical and biological contamination of water sources in village/town. All the water sources should be tested twice a year for bacteriological contamination and once a year for chemical contamination.
- Such kits include testing of water for turbidity, pH, hardness, chloride, iron, nitrate, fluoride, residual chlorine, arsenic and bacteriological quality.

4.5 Jal Tara Water Testing Kits (Designed by Development Alternatives)

• Jal Tara Kits are developed by Development Alternatives, New Delhi

• The kit is available for testing various parameters. These kits are validated by UNICEF.

• A standard Jal Tara kit can test 14 parameters Physical: pH, Temperature, turbidity, hardness Chemical: chlorine, fluoride, iron, nitrate, residual chlorine, dissolved oxygen phosphorous, ammonia Biological: Coliform bacteria 100 tests can be performed by this kit. However, 10 test for coliform can be done

4.6 Water Treatment Systems

Normally, water supplied for drinking is treated at head works under the water supply system. However, water needs treatment even at household level as there may me chances of water contamination while transmission of water. Type of treatment depends on quality of raw water and source. Chart below enlists some of the common methods of water treatment used in water supply system:

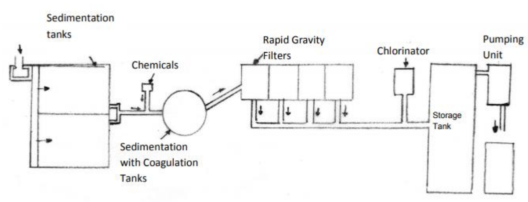
Type of Filtration	Purpose	Type of unit
Sedimentation	Removal of suspended solids like sand, clay, silt etc.	Sedimentation tanks
Sedimentation with coagulation	Removal of suspended solids, colour, odour, taste, turbidity etc.	Sedimentation with chemical input
Filtration	Removal of micro organism and colloidal matter	Slow/rapid sand filter
Water softening plant	Removal of water hardness/salts	RO (reverse osmosis plant)
Disinfection	Removal of pathogenic bacteria	Chlorination
specialised water treatment plants	Removal of fluoride	De-fluoridation units, Nalgonda System
	Excessive salinity	De-salination plants

4.7 Village/Town Level Water Treatment Systems

• Village/town level water treatment systems are located mainly near head works, and should be located near to village/town if possible so as to avoid contamination in further water conveyance.

• The treatment units should be located in such a manner where possible that flow of water from one unit to other can be done by gravity, so that additional pumping of water is not required.

• Sufficient area should be reserved near the treatment units for further expansion in future.



4.8 Types of Water Treatment System at Village/Town Level

1. Primary Screening

• Screens are fixed in the intake works or at the entrance of treatment plant so as to remove the floating matters as leaves, dead animals etc.

2. Sedimentation

• In this process, suspended solids are made to settle by gravity under still water conditions. The sedimentation tanks may be rectangular or circular in shape.

Advantages

• Plain sedimentation lightens the load on the subsequent process.

— The operation of subsequent purification process can be controlled in better way.

— Less quantity of chemicals is required in the subsequent treatment processes.

4.9 Sedimentation with coagulation

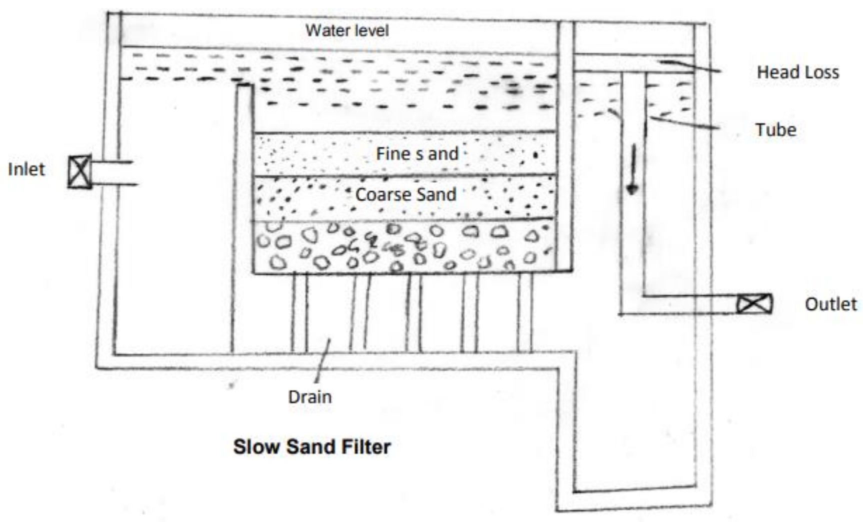
• This process is used when raw water contains fine clay and colloidal impurities and needs extra chemical treatment for them to settle unlike plain sedimentation. In this process certain chemical/coagulant are added in the process along with sedimentation for impurities to settle down. This process is useful in removal of colour, odour and taste from water. Turbidity and bacteria can also be removed to certain extent.

• Coagulants are added based on pH of water. Alum or aluminium sulphate is common and cheaper coagulants added in the process. They are added in powder or solution form to raw water through some mechanical means.

4.10 Filtration

• This involves treatment of water by passing it through bed of sand, gravel and other granular materials. This system is useful in removal of bacteria, colour, odour, taste.

• This system is highly useful in removal of suspended impurities.



Slow Sand Filter

• The common type of filtration system is slow sand filter mainly used in rural/small urban areas. Such filter is made up of tank containing sand in top layer (size 0.2-0.3mm) upto thickness of 750-900 mm. Course sand layer is placed below fine sand layer upto 300 mm. The last layer is of graded gravel (2- 45 mm) upto thickness of 200-300 mm. Water from sedimentation tank is passed through sand filter tank. Average flow of water from such filter is about 2400-3600 litres/m2 /day. Hence, size of tank is decided upon daily requirement of water to be treated. The sand needs to be replaced every 6-8 weeks as it gets clogged with impurities. Gravel can be washed and cleaned and replaced again.

4.11 Household Water Treatment Systems

- Basic filtration and boiling.
- Domestic chlorination. 1. Boiling at household level
- Water heating is effective in killing micro-organisms.
- Water should be heated in container for at least 10 minutes.
- Prior to boiling water should be filtered with sieve or clean cloth. Sieving will remove any particulate matter in water.
- Potential problems — The water becomes re-contaminated after boiling; — Fuel for boiling the water is scarce and, consequently, expensive; — Boiled water tastes flat – this may be corrected by adding herbs to the water during boiling and not drinking it for six hours after it has been boiled. 2. Water chlorination at household level
- Chlorination of water is a form of disinfection of water, mainly for removal of micro organisms causing water borne diseases like diarrhoea etc.
- This method is used mainly for drinking water to be consumed at household level.
- Chlorination at household level can be done through addition of chlorine pills. Such pills are available with PHED/Health Department/Asha worker. The chlorine pill should be allowed to dissolve in water and the mixture should be used only after half an hour.

CHAPTER 5

5. RESULTS

Observations of the use and management of water resources in the three villages of study were recorded during the dry season of 2004. The following section will address the type of access to groundwater in the villages of study, the way in which the groundwater was drawn to the surface, water-use at the household level and for livestock and gardening purposes, local preferences for various water supply infrastructure, manual pump sustainability on a regional level, and hygiene and sanitation conditions in the villages of study.

Groundwater Access

The villages of study were found to have two major types of access to groundwater: large-diameter wells and manual pumps. Large-diameter wells were classified into three main categories: reinforced, modern or traditional. Wells having both concrete linings to the depth of the confining rock stratum and also a concrete margin at the opening of the well were classified as 'reinforced.' Wells having only the concrete margin and no concrete lining were classified as 'modern.' Within these two classifications, most of the wells were equipped with a structurally solid crossbar, either metallic or wooden, where the men and women attach their pulleys to more easily hoist the water. Wells that did not meet these conditions were classified as traditional.

The manual pumps found in the villages of study included the India-Mali and UPM pumps. Both pumps are positive displacement pumps (piston pumps) that are operated by pressing down on a single metal lever that is connected to a series of tubes that mechanically lift the water. India-Mali pumps were reported to be easier to use than the UPM and are approximately

1 meter high, while UPM pumps, known throughout the region as the 'big green pumps,' are about 3 meters tall and require the user to pull down a 2.5- meter lever from above their head to the ground. Across the district, foot pumps (Vergnet) and various solar-, diesel-, and wind-powered pumps were found as well.

5.1 Types of Water Treatment System at Village/Town Level

1. Primary Screening

• Screens are fixed in the intake works or at the entrance of treatment plant so as to remove the floating matters as leaves, dead animals etc.

2. Sedimentation

• In this process, suspended solids are made to settle by gravity under still water conditions. The sedimentation tanks may be rectangular or circular in shape.

Advantages

• Plain sedimentation lightens the load on the subsequent process.

— The operation of subsequent purification process can be controlled in better way.

— Less quantity of chemicals is required in the subsequent treatment processes.

3. Sedimentation with coagulation

• This process is used when raw water contains fine clay and colloidal impurities and needs extra chemical treatment for them to settle unlike plain sedimentation. In this process certain chemical/coagulant are added in the process along with sedimentation for impurities to settle down. This process is useful in removal of colour, odour and taste from water. Turbidity and bacteria can also be removed to certain extent.

• Coagulants are added based on pH of water. Alum or aluminium sulphate is common and cheaper coagulants added in the process. They are added in powder or solution form to raw water through some mechanical means.

5.2 Filtration

• This involves treatment of water by passing it through bed of sand, gravel and other granular materials. This system is useful in removal of bacteria, colour, odour, taste.

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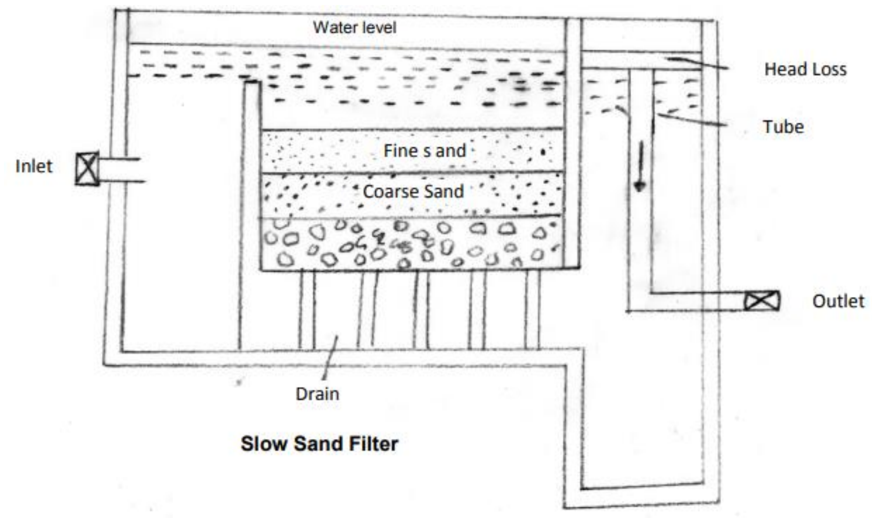

• The common type of filtration system is slow sand filter mainly used in rural/small urban areas. Such filter is made up of tank containing sand in top layer (size 0.2-0.3mm) upto thickness of 750-900 mm. Course sand layer is placed below fine sand layer upto 300 mm. The last layer is of graded gravel (2- 45 mm) upto thickness of 200-300 mm. Water from sedimentation tank is passed through sand filter tank. Average flow of water from such filter is about 2400-3600 litres/m2 /day. Hence, size of tank is decided upon daily requirement of water to be treated. The sand needs to be replaced every 6-8 weeks as it gets clogged with impurities. Gravel can be washed and cleaned and replaced again.

5.3 Household Water Treatment Systems

- Basic filtration and boiling.
- Domestic chlorination. 1. Boiling at household level
- Water heating is effective in killing micro-organisms.
- Water should be heated in container for at least 10 minutes.
- Prior to boiling water should be filtered with sieve or clean cloth. Sieving will remove any particulate matter in water.

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- This method is used mainly for drinking water to be consumed at household level.
- Chlorination at household level can be done through addition of chlorine pills. Such pills are available with PHED/Health Department/Asha worker. The chlorine pill should be allowed to dissolve in water and the mixture should be used only after half an hour.
- Based on the water quality, dosage of chlorine will vary. Instruction about the dosage can be sought from Asha worker/Health Department in your region.
- Chlorination should be done specially in monsoon.

CONCLUSIONS AND RECOMMENDATIONS

hanges in the use of water—whether in the point of diversion, location of use, or type of use, and whether or not accompanied by changes in ownership of water rights —are necessary and desirable in a dynamic society. Changes in use often are driven by changes in the perceived economic value of a particular water use. For most of the West's history since settlement, diversions have been from natural watercourses and instream uses to storage and off-stream use, initially for mining, later for agricultural and municipal purposes. These demands led to the construction of major storage and conveyance facilities, including systems for interbasin transfers within and among states.

Economic reality and environmental concerns limit the construc- tion of additional water development projects designed to increase supplies. As demand approaches the limits of available supplies, the movement of currently available water from relatively low-valued to relatively high-valued uses becomes an increasingly attractive alternative. Furthermore, the water transfer agenda now includes acquisition of water rights and changes in water project operations to restore and protect instream flows and associated values that were degraded by past patterns of water development and use.

The committee supports water transfers as one component of efficient water management, provided that such transfers are accomplished equitably. One problem is that existing laws, policies, and procedures concerning water market transactions and other transfers often fail to ensure either that third parties are protected from negative effects or that they share the benefits. Affected parties can include existing rights holders, rural communities, unique cultures, the environment, and other interests beyond the willing seller and willing buyer. The impacts can be obvious—increased per capita costs for irrigation system maintenance and operation, and loss of county tax revenues —or subtle—the diminished viability of rural economies, a loss of confidence in the community's future, and the erosion of unique cultural values of water-dependent communities. Examples of possible environmental impacts include instream flow losses and water quality alterations affecting fish and wildlife; changes in aquatic and riparian habitats, stream channel integrity, and esthetic values; and the loss of recreational uses.

RECOMMENDATION:

All levels of government should recognize the potential usefulness of water transfers as a means of responding to changing de- mands for use of water resources and should facilitate voluntary water transfers as a component of policies for overall water allocation and management, subject to processes designed to protect well-defined third party interests.

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Appendix

सामान्य सूचना/आधारभूत आंकडे

क्रम सं0	ग्राम का नाम	जुग्गौर
1	ग्राम प्रधान का नाम	श्रीमती सुमिरता
2	ग्राम पंचायत सचिव का नाम	श्री घनेन्द्र सिह
3	राजस्व ग्राम का नाम	जुग्गौर
4	ग्राम पंचायत का नाम	जुग्गौर
5	न्याय पंचायत का नाम	जुग्गौर
6	विकास खण्ड का नाम	चिनहट
7	भौगोलिक क्षेत्रफल	882.02 हे0
8	कुल जनसंख्या	9478 (जनगणना 2011 के अनुसार)
9	कुल परिवार	1590
10	कुल पुरूष जनसंख्या	4983
11	कुल महिला जनसंख्या	4495
12	बी0पी0एल0 परिवार संख्या	734
13	आंगनबाडी केन्द्र	11
14	राजकीय होम्योपैथिक चिकित्सालय	1
15	प्राथमिक/पूर्व माध्यमिक विद्यालय	9
16	विकास खण्ड से दूरी	14 कि0मी0
17	तहसील मुख्यालय से दूरी	6 कि0मी0
18	पशु चिकित्सालय	1
19	प्राथमिक स्वास्थ्य केन्द्र	1

4

BBD
UNIVERSITY
LUCKNOW

Date : 24/12/2020

To,

General Manager, Jalkal Vibhag,

Nagar Nigam, Aishbagh,

Lucknow.

Subject : Site vis t permission for academic purpose.

Sir,

This is to bring you kind notice that the following final year students of B.Tech Civil Engineering, Bab a Banarasi Das University are doing the project on the Rural Water Supply and Treatment Water Plant. So they need a detailed data of all the necessary topics to be covered in the project for the academic purpose.

Kindly do the needful for the same.

Student Details:

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Avinash Kumar Tiwari (1170431015)

Ashish Yadav (1170431014)

Belal Ahmed (1170431016)

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Thanking you.

24/12/2020

HOD (CE)

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