PART I
WATER SUPPLY ENGINEERING

1

Introduction

1.1 GENERAL

It is nearly impossible to get pure water in nature. Since it is a very good solvent, it accumulates several types of impurities.

India was much ahead in the field of water purification. In the ancient medical books is written that the foul water should be treated by boiling or exposing it to sunlight, by dipping a hot piece of copper seven times into the water or filtering it through coarse sand then by cooling the water in earthen vessels. The Indus Valley Civilization and that of Mohen-jo-Daro also confirms the existence of public water supply and drainage etc even in the primitive age.

Water supply and sanitary measures are considered essential requisites of the community life of a civilized country. As the provision of such facilities serves as an index of progress in every sphere of activity, it should be given highest priority. While rapid progress has been achieved in other countries, our country is pogressing very slowly in this direction. The reports submitted by different National Committees to the International Association of Water Works are quite interesting.

(i) Netherlands: The Government had undertaken the responsibility of supplying safe water to drink to each and every individual. The country has successfully achieved the target and is supplying safe drinking water to 100% of its population.

(ii) Great Britain: In 1944, the Government formulated a definite policy. At present, the Water Division of the Ministry of Housing and Local Government is responsible for the administration of the statutes relating to water supply and sewerage, river pollution-prevention, the conservation of water resources, effective execution of a coordinated policy by water undertakers, etc. About 98% of the population take drinking water from a Central Supply System.

(iii) Germany: About 84% of the population were being served by Central Water Supply Systems by 1957 and all the works are required to fulfil the specified hygienic requirements as well as specified quantity of water.

(iv) Denmark: About 80% of the population is supplied by Central Water Works Systems. The largest unit serves one million people whereas the smallest unit serves 50 people. The city waterworks are managed by the cooperative societies. The local health authorities have a check on the quality of water.

(v) Belgium: About 80% of the population is served with protected public water supply.

(vi) France: By 1961, France has achieved the target of supplying protected water to 70% of its population. The Government exercises control as regards the hygiene, technical, outlay, works economy and finance aspects of the water supply schemes.

(vii) Japan: About 44% of the population is being supplied by water works. Most of the other waterworks are local organizations run by towns or villages. The Government is insisting on

amalgamation of many small undertakings so that the waterworks would be of sufficient size to justify the provision of competent staff to maintain the high hygienic and technical standards.

(viii) India: The importance of safe water supply and disposal of excreta and garbage was known even in the earlier days and mentioned in the Rig Veda. Even the emperors of those days took special care on the provision of safe water supply before building up towns or camps. Later on, with the invasion of the country by foreign powers, not much progress was made in this field. Only three Presidency towns, *viz.*, Kolkata, Bombay and Madras in the late' seventies attempted to introduce an organized water supply. Ultimately when sanitation was transferred as a provincial subject, the Provincial Governments in their turns transferred the heavy burden on the weak shoulders of the local bodies which neither had the funds nor the technical personnel for implementing any satisfactory progress.

In the post-war developmental era, the Bhore Committee for the first time pinpointed attention to the importance of safe water supply and sanitation and this assumed importance in the national development plans. The Madras Government in 1947 appointed a special Committee for examining the question of water supply and drainage for urban and rural areas in the entire State and the Committee made valuable recommendations not only on technical matters but also on organization, finance materials for construction, etc. In 1948-49, the Environmental Hygiene Committee was appointed by the Union Government. The Committee made notable recommendations in the broader field of environmental hygiene. It recommended specifically a comprehensive plan to provide water supply and sanitation facilities for 90% of the population within a period of 40 years and also suggested a scheme of priorities for certain areas. However, no concerted measures were taken to implement their recommendations.

Then came the First Five-Year Plan (1951-56). In the initial stage of the Plan, provision of water supply and sanitation schemes in the States was made from the fund under Community Developmental Works and Local Developmental Works. There was however no central direction or leadership provided in the matter. In 1953, the Union Health Ministry as a result of enquiry from the different States found that not much headway had been made in regard to these items and the States also regretted their inability to take up schemes from their own resources. As a result of this, the Union Health Ministry announced their National Water Supply and Sanitation Programme in 1954 as part of the Health Schemes under the Plan, and made specific provisions to assist the States in the implementation of their urban and rural water supply and sanitation schemes. Approved urban schemes would receive assistance by way of loans while rural schemes limited to population not exceeding 5000 would be given a 50% grant-in-aid by the Centre and the other 50% by the State Government partly as grant-in-aid and partly as contributions from the villagers either in cash or in labour or in material. The programme started with an aid of about Rs. 3 crores offered by the TCM to provide materials, equipment and technical services.

In 1960, a Committee called National Water Supply and Sanitation Committee was formed by the Ministry of Health for reviewing the progress of work of the national water supply and sanitation programme and to make a correct and comprehensive assessment of urban and rural requirements including the problems of financing and organization of a Public Health Engineering Department. The report (Appendices 1.1 to 1.3) shows that 60% of the towns in India covering only 6.5% of the total population (48.5% of the urban population) are supplied with safe water. The supply varies from 10 to 150 litres per capita per day.

Fourth Plan

The Fourth Plan outlay is Rs. 339 crores on water supply and sewerage. In metropolitan areas,

water supply schemes would, as far as possible, be accompanied by sewerage and drainage schemes. Local bodies will contribute to the programme. In the remaining urban area, priority will be given to the completion of spillover schemes. A number of schemes will be taken up in areas endemic to water-borne diseases. The bulk of the provision of about Rs. 100 crores for rural water supply will be utilized in areas of acute scarcity. Other areas will meet their need from programmes for community development, welfare of backward classes or through local effort.

Under a Centrally-sponsored programme, assistance is being given to State Governments for special investigation divisions attached to their Public Health Engineering Departments. They well prepare technical designs and estimates of rural water supply schemes, particularly in difficult areas, making use of the data available from the Exploratory Tubewells Organization and the Geological Survey of India. In designing these schemes, water available from major or medium irrigation projects would also be integrated for supplying drinking water. A provision of Rs. 2 crores has been made for this purpose.

Central assistance is being given to institutions for training in public health engineering. Courses for waterworks supervisors and other categories of workers are being conducted by the Union Government. The training programme is proposed to be continued with a provision of Rs. 25 lakhs.

In India, the execution of water supply schemes is generaly entrusted to specialized firms on a lump sum contract basis. The works will cost much less if execution by item rate control is insisted on. With the help of available knowhow in this field, the reorientation of the present day methods of designing, estimating, execution and of maintenance should be carried out.

About ten universities are now running post-graduate courses in public health engineering. The National Environmental Engineering Research Institute, Nagpur, is also engaged in research work of high order. According to UNIS, New Delhi, dated July 22, 1966, a sum of Rs. 30 lakhs has been allotted during the Fourth Five Year Plan to process iodized salts to meet the demand of 40 million people living in the goitre belt. Goitre is prevalent in the entire northern submountanious region of India. The Goitre Control Scheme, started all over India with the help of UNICEF, includes the survey of the country to estimate the extent of area and population at risk and making available iodized salts to the affected areas in place of and in complete substitution of ordinary salt. Also, it is observed that most of the outbreaks of Asiatic Cholera have been caused by Cholera *El Tor,* a biotype of vibrio cholera which are capable of rapid spread. In 1965, this water-borne disease affected 23 countries, killing at least 14,000 people. It invaded new territories extending towards the West and hence necessitated cooperation amongst all countries of the world. It is worth appreciating that WHO has intensified its programme of assistance in cholera control.

It will be worthwhile to quote the Report on "Basic Development Plan for Kolkata Metropolitan District (1966-1986)", published by the Kolkata Metropolitan Planning Organization (CMPO), Development and Planning (T & CP) Department, Government of West Bengal, 1966.

Water Supply

"The deterioration of services with rapid population increase is nowhere better illustrated than in the single set of figures for water supply shown for Kolkata City in Table 10.

"Between 1931 and 1965, as the figures show, the per capita supply of filtered water declined from 52.3 gallons a day to 28.0 gallons a day; and there was a simultaneous and substantial decline in the per capita availability of unfiltered water. Though the absolute supply of filtered water increased, the city grew in population so quickly over these thirty years that the population of 1960 had a substantially smaller per capita supply than in 1931.

Table 10: Water Supply for Kolkata City (1931–65).

	1931-32[1]	1941-42[1]	1950-5[11]	1964-65[2]
Average daily supply of filtered water in million gallons	59.6	72.8	67.5	84.0
Average daily supply per capita in gallons	52.3	34.2	26.5	28.0
Average daily supply of unfiltered water in million gallons	50.3	67.9	98.3	90.0
Average daily total supply per capita in gallons	44.1	32.2	38.6	30.0

1. Census Superintendent. 1951 Census—Kolkata City.
2. CMPO Estimates.

"The above statements omit the additional supply from large-diameter tubewells, 114 of which gave an estimated 16 million gallons per day in 1965; and from the several thousand small-diameter tubewells now supplying approximately five million gallons per day. The additional supply from these two sources totalled approximately seven gallons per capita.

"The unfiltered water supply of 90 million gallons per day in the Kolkata Corporation area direct from the River Hooghly is intended, and is generally used, for non-drinking purposes such as street-cleaning, fire-fighting, toilet-flushing and sewer maintenance. In actual practice, however, considerable use is also made of this water—particularly in *bustees*—for washing foodstuffs and utensils, and for drinking. An examination of this unfiltered supply in 1958-59 and later, showed the presence of cholera vibrio in five per cent of the samples taken. At the urgent recommendation of CMPO and WHO officials, chlorination of the unfiltered supply was started by the Kolkata Corporation in 1963 as an interim measure for controlling the disease. Apart from the serious health hazard, the unfiltered water presented the additional problem of a heavy silt content leading to blockages of the distribution and sewerage systems, which cause serious maintenance difficulties. The gradual elimination of the dual system and its replacement by a single system of filtered and safe water supply are essential.

"In other areas of the CMD outside the Kolkata Corporation, the supply of filtered water is inadequate and in some areas there is no filtered supply at all. Only in the new township of Kalyani, there is a continuous supply of 40 gallons per capita per day. Excluding Kolkata Corporation, the remaining two corporations and 31 municipalities in the CMD, with a total population of just over 2 millions, have an average total public supply of water of only 12.3 gallons per capita per day. The remaining of the CMD, with a population of 1.7 millions, has no public water supply system whatsoever.

"The CMD thus has a long-standing problem of inadequacy in water supply for meeting present population needs, let alone for coping with projected growth of population over the next few decades. The domestic water requirements to 1986 cited in UN Special Fund—WHO Survey of the Water Supply Resources go Greater Kolkata : Status Report, Section III, March 1965, (at standards of 60 gallons per capita daily for the Kolkata Corporation area and of 50 gallons per capita daily for the remainder of the CMD) total about 790 million gallons per day, apart from industrial water requirements of an estimated 427 million gallons per day. These figures represent an immense and costly increase in the present water supply provision throughout the CMD if the necessary facilities are to be developed to meet expected future population needs."

A central design organization for public health engineering works should be established. There should be separate public health engineering departments in each state which should be manned

with well qualified persons in this discipline. If such changes are made, we can expect an early solution of the complex problem of drinking water and environmental sanitation even within the limited resources.

Besides solid, liquid and gaseous matter, water also carries insoluble matter and bacteria. The rain water when it comes in contact with the atmosphere, dissolves oxygen, carbon dioxide and other gases and particles. When it reaches the ground, it dissolves the clay, silt, mud, inorganic substances, etc. And when it flows in stream, it passes through destroying vegetable matter and thus organic acid also enters into the water which further increases the dissolving power of the water and thus several kinds of salts get dissolved in the water. Specially the carbonates, sulphates, chlorides and nitrates of calcium, magnesium, sodium and potassium are dissolved in water. These substances render the water hard, saline and alkaline. Along with the above mentioned impurities the salts of iron, manganese, copper, zinc, aluminium, etc may also be found in water.

There are certain bacteria which cause diseases and are called pathogenic ones. The algae cause bad smell. Some salts are corrosive. The dissolved gases often cause the smell and alkalinity. There is a belief that hard water causes stomachache or causes stones in kidneys or creates such other troubles. But there is no proof of it. Actually, when a man drinks a new type of water, he feels certain difficulty for some time and then he gets accustomed to the same water. Man does not feel any difficulty afterwards but instead he dislikes the water which he was liking before.

1.2. IMPURE WATER

The water becomes impure due to two reasons, *viz*:

(i) Due to inorganic impurity; and

(ii) Due to organic impurity.

All these substances are either in a dissolved condition or in suspended and colloidal state. The inorganic impurity is caused due to clay, salts and dissolved metals and organic impurity is caused due to nature's contribution to organic load through marshes, and due to decomposition of animal and vegetable matter due to sewage or due to industrial waste. And such water cannot be considered as potable (drinkable) unless it is purified.

In fact, the potable water should be clear and free from suspended matter and smell, and should not contain excess of dissolved inorganics. The potable water should not contain bacteria also. Moreover, the allowable contents of various impurities are generally fixed by public health departments and that is why the water is first tested before it is used. The minimum standards of purity should be maintained.

1.3. NEED OF PROTECTED PUBLIC WATER SUPPLY

It has already been mentioned that water contains various impurities and bacteria. Due to these, diseases like dysentery, typhoid and Asiatic cholera may spread. These diseases are called "water-born diseases" and, therefore, it becomes necessary to supply such water as may not be harmful to health. Though this basic fact was known in olden times; except in India, China and Rome no significant progress was made in achieving the objective in other countries.

The pathogenic bacteria do not multiply in water like that in milk but they do survive, *i.e.,* water may be considered as a carrier for bacteria and not multiplier. Thus, the control of pathogenic bacteria is possible.

If we control the purity of water completely, the chances of outbreak of water-borne communicable diseases will be much less. Besides communicable diseases like typhoid, dysentery, cholera, etc certain other diseases like goitre, spotted tooth (mottled enamel) are attributable to chemical content of the water.

In 1829, James Simpson built his first sand filter in London. In 1880, slow sand filters were installed in Kolkata, Madras and Delhi according to British practice. Rapid sand filters were first installed in 1916 which were specially meant for British military officers. Now, there are numerous rapid sand filters which filters millions of litres of water daily. Pressure filters have also been installed. The small filters, installed in railway colonies, private firms and organizations and factories etc are in large numbers.

The water is needed first wherever there is a settlement and that is why most of the cities are located along the rivers. The public health departments are also now taking measures against water-borne diseases. The protected water supply has also been arranged in villages and a number of good open wells and tubewells, hand pumps, etc have been installed (Appendices 1.1 to 1.3). The engineers of Planning and Development Department are specially engaged in this work.

1.4. POINTS TO BE CONSIDERED FOR PUBLIC WATER SUPPLY

The following factors should be kept in view for the water supply of a particular place.

(i) The source should be selected which may sufficiently provide water in all the seasons. The sources may be wells, streams, natural lakes, deep ponds in rivers or reservoirs, perennial rivers, etc. From all these sources the water may be supplied to various parts of towns by gravitation and pumping.

(ii) The quantity of water can be estimated considering need for the present population and for 30-50% future population growth. Also, some quantity of water will be required for fire fighting, public conveniences, street washing, and horticultural purposes. In addition to these, some water is usually wasted by the consumers. Thus the total quantity of water may be estimated for a particular locality considering all these factors.

(iii) After the above calculations are completed, we should again confirm whether or not the source of water will provide the required amount of water specially in the summer season of the driest year.

(iv) Next, we should see the levels of the town with respect to the level of the source. As far as possible, the water should be under enough pressure in service pipes so that it may reach up to 10-15 metres.

(v) If any part of the town is high, it will be economical to supply water in this part by pumping so that the water in the town may be distributed under high pressure. If the source is some well, the pumping becomes a necessity.

(vi) The impounding reservoir may only be provided if its provision at higher elevation is not uneconomical and when the minimum daily flow of the river is more than the minimum daily demand of water. However, provision of impounding reservoir at suitable level is necessary to keep pressure in lines, if direct pumping is not adopted.

(vii) After this, the quality of water should be tested. In all the seasons, a little water is collected and then tested because there are chances of pollution in sources of water other than deep wells and tubewells. The treatment units should be installed according to the degree of pollution in the source. The water of deep wells gets automatically filtered through the sandy layers and is, therefore, comparatively better than other types of waters.

(viiii) The methods of purification of water for drinking purposes may be divided in five parts (which will be described in details), *viz.*

(a) "Screening" in which the fine and coarse particles, rags, papers, etc, are separated through fine and coarse screens.

(b) "Plan sedimentation" in which the sedimentation of suspended solids in large tanks is effected.

(c) "Precipitation" which is adopted when there is much turbidity. The alum solution is generally mixed in water and the precipitate is formed which is later separated.

(d) "Filtration" in which water is passed through layers of small pieces of stones and sand.

(e) "Disinfection" in which the pathogenic bacteria are destroyed.

Note: In addition to these, some special methods like softening, aeration, iron removal, etc are also resorted to remove colour, bad taste, smell etc.

(ix) Such a pure water may be stored at a high elevation in the town which is called a service reservoir. From these reservoirs, the water may be supplied in the hours of peak demand.

(x) The water from the service reservoir is served to consumers through a network of mains, submains, laterals, etc.

1.5. ARRANGEMENTS FOR DISTRIBUTION OF WATER

The following arrangements may be made for the water supply :

(i) The water may first be pumped into low-level storage reservoir after final treatment and then to the service reservoir at higher elevation from where the water may be distributed to all the consumers (Fig 1.1).

Note: If the site for the reservoir is not high enough, an elevated tank may be constructed for storage of water so that the water may be distributed to the entire town under gravity or direct pumping into mains or combination of the two.

(ii) A second type of arrangement is shown in Fig 1.2. Here, the water is stored with the help of a dam. This reservoir of water is called the impounding reservoir. It is at quite a high place from where the water, after it is treated, is distributed due to its own pressure under gravity in the entire city. Here is service reservoir is not required.

(iii) A third type of arrangement is shown in Fig. 1.3. Here, the water goes under gravity from river to the settling tank and the filter but the advantage is being taken of a high natural place at which the service reservoir is provided from where the water may be distributed.

(iv) Another type of arrangement is shown in Fig 1.4. Here, it has been made possible to send the water from the river to the settling tank and filter under gravity and then it can be pumped to a service reservoir and distributed to the entire city. Such arrangement is called the arrangement of partial pumping.

A complete general layout of waterworks is shown in Fig 1.5.

1.6. FINANCING OF PUBLIC WATER SUPPLY

The total cost of a water supply scheme should be estimated as given below:

(i) If the source is an impounding reservoir, the cost of construction of a dam and its maintenance, the cost of land acquisition and the rehabilitation should be included in the cost of the scheme.

(ii) If the source like wells and perennial rivers are at lower level, the cost of pump house and that of running the pumps should be taken into account.

(iii) The cost of pipelines from source to the distribution system is also accounted for, which is the major portion of the total cost of the scheme.

(iv) The cost of purification of water depends upon the quality of water. If the water is not to be treated much, the scheme will be comparatively less costly.

(v) The cost of sluice valves, fire hydrants, meters, etc is also included. The maintenance cost of these is also accounted for.

(vi) Sometimes due to maximum and varying demand of consumers, a service reservoir is needed and hence its value should be added to the cost of the scheme.

In a similar way, the cost should be determined separately for each source in case there are more than one source. And the easy arrangement (preferably of economical cost) should be finally decided.

Care should be taken that the financial burden in such that after making allowance for the free grant of Provincial or Central Government, the loan to be raised should be easily repayable with its interest within a maximum period of 30-40 years from taxes which will be reasonable and payable by an average house-owner.

Appendix 1.4 gives recommendations of the WHO Expert Committee on 'Community Water Supply'.

EXERCISE

1.1. What are the common impurities in water ? What is meant by "potable water" ?
1.2. Describe why protected public water supply is needed ?
1.3. What are the general considerations for a water supply scheme ?
1.4. What do you mean by finance of a water supply scheme ?

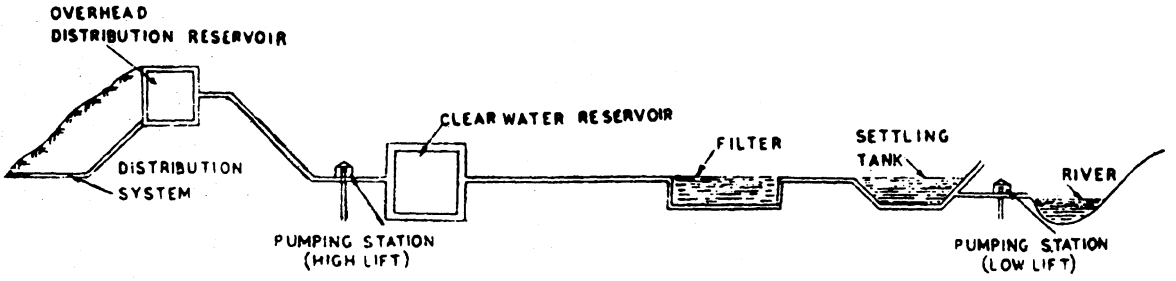

Figure 1.1: Arrangement of Water Supply.

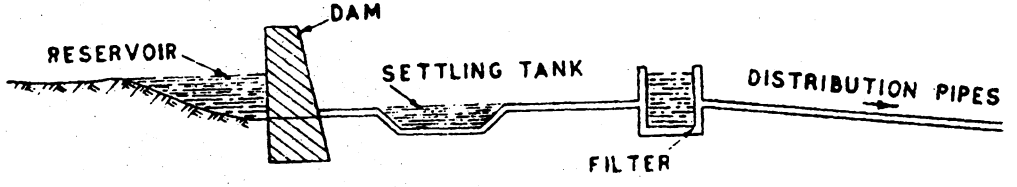

Figure 1.2: Arrangement of Water Supply.

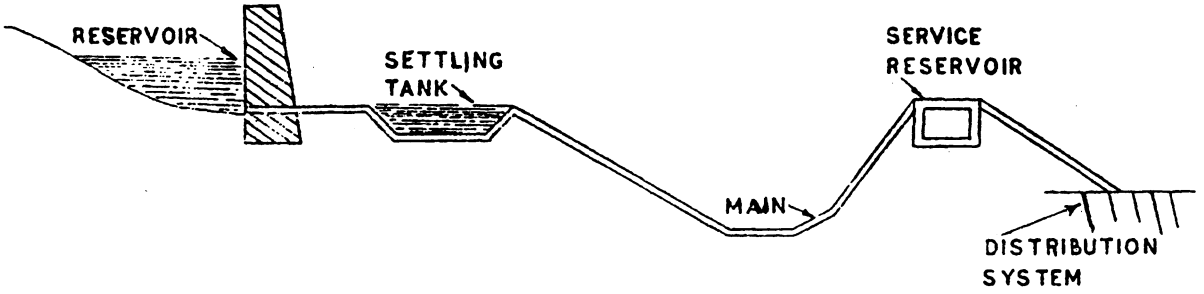

Figure 1.3: Arrangement of Water Supply.

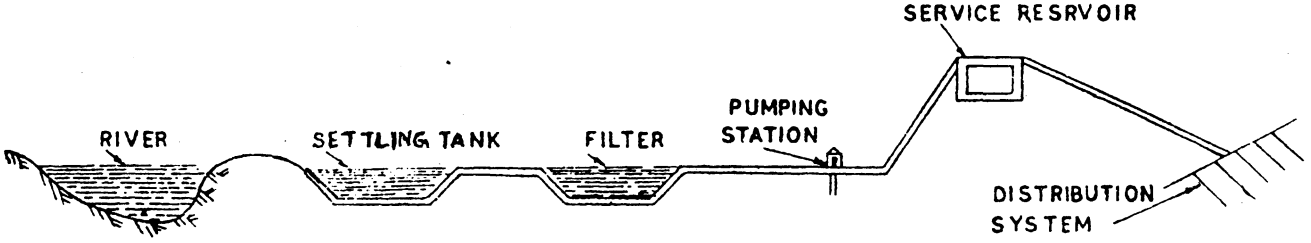

Figure 1.4: Arrangement of Water Supply.

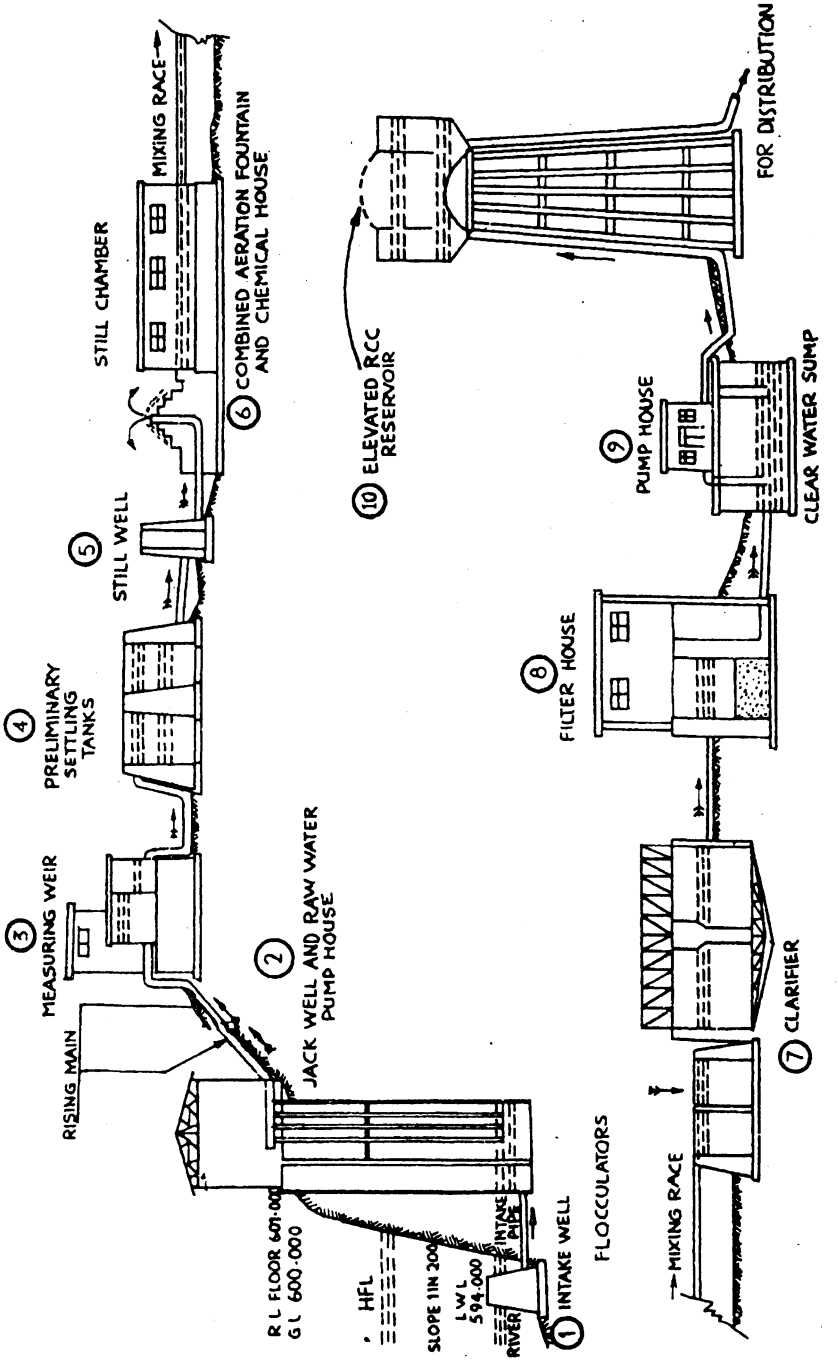

Figure 1.5: Complete General Layout of Water Works.

Appendix 1.1: Urban Water Supply and Sewarage Number of Towns Served and Expenditure under the Three Plans.

S.No	State	Urban population distributed in			Number of towns			Number of towns with		Expenditure on water supply and sewarage (Rs. in lakhs)		Number of schemes in progress			
												Water supply		Sewerage	
		Corporation	Municipality	Panchyat towns	Adequate water supply	Partial water supply	No water supply	Sewerage full or partial	No sewerage	In First Plan period	Proposed in Third Plan period	Improvements	New	Improvements	New
1	Andhra Pradesh	1	62	119	13	23	146	1	181	531.39	680.00	17	6	5	1
2	Assam	–	41	–	3	8	30	–	41	45.00	125.00	3	3	–	–
3	Bihar	1	76	–	21	–	56	4	73	532.48	400.00	9	12	3	3
4	Gujarat	1	101	101	38	102	52	8	165	93.54	607.07	19	24	–	3
5	Jammu and Kashmir	–	2	19	2	9	8	–	21	85.15	95.26	2	2	–	–
6	Kerala	1	29	165	–	7	187	1	194	388.06	450.00	4	3	–	1
7	Madhya Pradesh	3	135	–	32	21	85	11	127	425.44	510.00	12	16	–	–
8	Madras	1	66	151	–	35	167	6	212	926.01	950.00	21	27	4	1
9	Maharashtra	–	–	–	–	–	–	–	–	361.73	1150.00	–	–	–	–
10	Mysore	2	180	–	1	176	4	4	177	810.87	600.00	93	–	22	9
11	Orissa	–	64	–	9	24	31	2	62	170.99	150.00	6	5	–	1
12	Punjab	–	178	–	1	25	139	13	165	225.08	280.00	15	16	2	27
13	Rajasthan	–	138	52	18	5	151	3	187	275.59	500.00	13	33	–	–
14	Uttar Pradesh	5	135	299	73	–	–	15	–	694.55	1046.84	11	48	5	3
15	West Bengal	2	87	33	34	–	–	7	115	324.41	230.03	21	17	2	2
16	Delhi	1	–	–	–	–	–	–	–	887.00	959.12	–	–	–	–
17	Himachal Pradesh	–	–	–	–	–	–	–	–	–	30.00	–	–	–	–
18	Tripura and Manipur	–	–	–	–	–	–	–	–	4.83	83.64	–	–	–	–
19	Andaman and Nicobar Island	–	–	–	–	–	–	–	–	–	15.00	–	–	–	–

Appendix 1.2: Urban Water Supply percentage of 1961 Urban Population Served and Forecast of future workload Under this Phase.

S. No	State	Population (1961)	Percentage served by water supply system		Percentage not served by water supply system	Forecast of amount required to complete supply (Rs. in crores)	
			Adequately	Inadequately		As furnished by the State	As revised on a common basis
1	Andhra Pradesh	6261130	26	41	33	23.70	23.70
2	Assam	889080	9	24	67	1.26	4.80
3	Bihar	3915300	34	19	47	9.50	14.30
4	Gujarat	5280540	30	33	37	2.33	19.10
5	J & K	601958	43	14	43	0.15	2.00
6	Kerala	2535574	24	18	58	50.00	10.70
7	M.P.	4629276	33	14	33	3.16	17.50
8	Madras	8991318	–	54	46	82.00	46.60
9	Maharshtra	11028852	40	20	40	36.40	36.40
10	Mysore	5187105	25	62	13	16.70	18.20
11	Orissa	1111058	9	24	67	8.00	5.60
12	Punjab	4079100	32	25	13	17.00	17.00
13	Rajasthan	3233215	27	18	35	8.37	12.90
14	Uttar Pradesh	9476118	30	15	55	37.70	37.70
15	West Bengal	8095585	55	25	20	100.00	100.00
16	Delhi	2344051	90	10	–	28.00	28.00
17	Himachal	63811	–	–	–	–	–
18	Tri & Manipur	170359	–	32	68	1.40	1.40
19	Andaman & Nicobar Islands	4099	–	–	–	–	–
	Total	77907439				426.37	395.95
	Overall average		33.9	26.3	39.9		

Appendix 1.3: Progress of Rural Water Supply Achievements so far under the Plans in regard to Rural Water Supply and the Approximate Future Workload in this Field.

S. No.	State	Population (1961)	Progress under Community Development Programme (October 1952-March 1961)			Progress under National Water Supply & Sanitation Programme	Number of wells constructed or renovated so far		Expenditure during first and second Plan periods (Rs. in Lakhs)			
			Wells constructed	Wells renovated	Total number of wells		Progress under Local Development Works	Progress under Tribal Welfare Programme	National Water Supply and Sanitation Programme	Community Development Programme	Local Development Works	Tribal Welfare Programme
1	Andhra Pradesh	29716989	17900	65000	82900	780	–	–	77.90	–	–	–
2	Assam	10970979	10100	15900	26000	1947	–	–	39.19	–	–	–
3	Bihar	42541742	21700	28200	49000	588	–	–	73.95	–	–	–
4	Bombay	15340833 28475442	8700	12300	21000	858	–	–	132.49	–	–	–
5	Jammu and Kashmir	2981627	1100	1300	2400	7	–	–	25.34	–	–	–
6	Kerala	14339625	2900	1600	4500	31	–	–	34.20	–	–	–
7	Madhya Pradesh	27765099	15700	10200	25900	671	–	–	71.79	–	–	–
8	Madras	24659599	12300	13900	26200	518	132000	20000	61.96	1600	2025	300
9	Mysore	18359976	7600	13600	21200	183	–	–	62.96	–	–	–
10	Orissa	16454587	13200	10500	23700	1141	–	–	60.06	–	–	–
11	Rajasthan	16912958	8200	9300	17500	4597	–	–	92.64	–	–	–
12	Punjab	16219051	18000	13300	31300	346	–	–	71.32	–	–	–
13	Uttar Pradesh	64276796	63000	92700	155700	1563	–	–	148.88	–	–	–
14	West Bengal	26872049	11200	9500	20700	1357	–	–	115.38	–	–	–
15	Union Territories	3408076	4900	14500	19400	130	–	–	58.53	–	–	–
	Total	359895308	216500	311800	528300	14713	132000	200000	1122.70	1600	2025	300

Appendix 1.4: Recommendations of the WHO Expert Committee on 'Community Water Supply'

A WHO Expert Committee on 'Community Water Supply' met in Geneva from October 29 to November 4, 1968. This was the first Expert Committee to be convened by WHO specifically to consider problems of community water supply. Its composition reflected the wide variety of disciplines and experience needed for the creation and successful operation of a water supply programme. After examining the reasons for the failure to make more rapid progress, the Committee made a number of specific recommendations as given below for national and international action to achieve a significant improvement in community water supply programmes.

A community water supply should provide to all consumers a flow of water, available at all times, adequate for all purposes, conveniently accessible, and of a safe and acceptable quality.

The aim of a water supply project should be to deliver water to every consumer in his house or on his premises. Any measures less than this, for examples, the provision of public stand pipes, should be regarded as an interim expedient, to be improved as early as possible.

A community water supply can be of great benefit to the health and well-being of the people whom it serves; it can, on the other hand, be a mechanism for the rapid transmission of water-borne disease if the delivered water becomes contaminated. For this reason, close and continuous surveillance by the public health authority is necessary in order to ensure the constant high quality of water received by each consumer. Precautions must be taken against contamination through leaking mains, cross connections and back syphonage. Intermittent supplies should be replaced by continuous ones at an early stage, since the former represent a distinct health hazard.

In formulating policies and procedures for control of water-borne diseases greater recognition should be given to the fact that the provision of public water supplies and other environmental health activities are essentially preventive measures. Economic considerations should never be allowed to obstruct measures designed to save lives. The prevention of disability, morbidity, and mortality from water-borne disease is sufficient justification in itself for the provision of safe water supplies, aside from any economic arguments.

In designing water supply works, a balance should be struck between the individual requirements of each project and the economies that can be effected by standardization and prefabrication. The publication of guidelines are recommended criteria would materially assist government staffs and consulting engineers in adopting conventional design standards to the particular circumstances of each country.

Maximum use should be made of locally available materials, techniques, and skills in the design, construction and operation of water supplies. International assistance, in the form of research, specialist advice, and publications, would greatly assist governments to achieve this objective.

As an essential basis for surveillance and quality control by the health authorities, the formulation of national quality standards should be encouraged. As far as possible, these should be based on the international standards for drinking water published by WHO, but these should be regularly reviewed and kept up to date. Further research is also needed into the basis of the toxicological levels of some contaminants so that more accurate standards can be specified.

Preventive maintenance is of vital importance at the water source, the treatment plant, in the distribution system, and in house installations. It is a concept that must receive adequate consideration in the design, construction, operation, training, and management of water supplies.

Sound national organizational structures adapted to the conditions of the countries concerned, are essential if any appreciable progress is to be made in meeting the existing demands for improved water supplies. The most appropriate pattern can be determined only by making a thorough study of national problems. International assistance in the form of administrative, economic, and legal advice is useful to governments in setting up such organizations.

Maximum use should be made of financial assistance from international, regional, bilateral and other sources for waterworks planning and construction. Advice and assistance is available from WHO and other agencies in the preparation of 'bankable' projects aimed at attracting such assistance.

Possibilities of external assistance are not unlimited, and a greater effort should be made to tap financial sources within the country. In many countries, the possibilities of raising capital for water supply

construction from private investors, banks, insurance companies and other sources are not fully appreciated; the Committee recommends that methods of local financing, appropriate to each country, should be more fully explored. Some form of governmental or municipal guarantee of repayment would assist in creating the necessary confidence in this form of investment.

Some water supply projects, particularly those in rural areas and for small communities, cannot hope in the immediate future to be financially self-supporting in view of the limited capacity of the consumers to pay the whole cost of operation and capital amortization. Economic planners should take into account the total value of such projects in terms of improved health, increased agricultural output and similar benefits, these may amply justify their country's development plans.

Every endeavour should be made, by the improvement of tax structures and accounting methods, to place the finances of water supplies on a sound, business like basis. Not only will this make for efficiency in operation and use of the funds available, but it will also help to attract finances for the construction of similar undertaking elsewhere in the country.

Governments could benefit from the professional advice of engineers, at a policy-making level, in all matters relating to water supply. The formation of national professional groups and waterworks associations should be encouraged, as it is believed that these groups can materially assist in raising the standard of water supplies, and in improving their efficiency, to the advantage of the country as a whole. The status of the engineering profession within the Ministry of Health should be improved in many countries so that engineers engaged in the solution of problems related to water supplies can work in equal partnership with their colleagues in the medical and other professions.

One obstacle to the efficient planning and design of water supply projects is the lack of data on similar projects in the same and in other countries. These data can be furnished only by those responsible for the planning and operation of existing water supplies, and governments are urged to initiate the recording of information not only for their own use but also for the future use of other countries and of international agencies concerned with the development of community water supply programmes. The publication of annual reports by governments is one convenient means of placing essential facts on record. It is recommended that international guidance should be given on the form and content of such reports.

The construction management, operation, and surveillance of water supplies demands the services of trained and experienced personnel, professional and sub-professional, if the large investments made in these facilities are to be protected. International assistance has been, and should continue to be, of value to governments in the training of these men. In view of the large numbers of personnel and diversity of disciplines required, however, and to ensure effectiveness, the bulk of training should be carried out within the country concerned.

So that the investment in training activities is not wasted by the loss of qualified men to other employment, governments should be urged to introduce such measures as minimum salary scales, promotion by merit, and certification of ability, in order to retain their existing staffs, and to encourage the recruitment of able personnel of all grades.

There would be undoubted advantages if research institutions and universities interested themselves in the water supply problems of their respective countries. A close liaison between such institutions and the operative departments responsible for water supplies would be mutually valuable and should be encouraged.

The interchange of information by seminars, publications and other means on all aspects of community water supplies, as carried out in the past by international organizations such as WHO, is a valuable service that, it is hoped, will be continued and extended in the future.

The Committee would urge governments everywhere to accord the highest possible priority to the provision of ample supplies of safe water to all their people, having in mind that here is no measures that can have such a far-reaching and beneficial effect upon the health and well-being of every individual.