MUNICIPAL USES, PRACTICES, PROBLEMS

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Introduction

It has been said that the people of the semi-arid western United States appreciate the value of water more than any other group. Certainly to any observer in this area, the line which divides rich land from waste land is a water line and every citizen of this region is aware that water is the key to their present and future economy. Thus, in broad terms, the importance of water to our survival is self evident. The value and use of water, however, is obscured by a vast array of human attitudes and activities and therefore, the basis for its proper and economic evaluation is extremely elusive. Foremost among the usages of water are municipal uses to satisfy elementary human needs. Generally speaking, municipal use constitutes the consumption of water for domestic, industrial, and public purposes.

Factors Affecting Water Use

The relative abundance of water in most parts of the United States has been a basic factor in shaping our patterns of water use. Water has been traditionally free for the taking just as have many of our other natural resources. Only in the semi-arid regions have special practices evolved from a concept of scarcity. In addition to the abundance of freedom of capture, water is usually cheap to transport and handle. The consequence of these and other factors have led to patterns of water uses which are very generous and perhaps wasteful in most parts of the country. As water grows relatively scarce, changes will be required in our water use practices. Public welfare in many areas may require a more restrictive use of water for all purposes.

Effects Of Use On Quality

The quality of water is often affected by the use to which it has been put. This is particularly important from the consideration of its reuse. This phase of water supply is complicated and only a few generalities will be discussed. Domestic use of water generally results in increased amounts of dissolved chemicals and suspended organic materials. Organic pollution can be removed to a large degree by known methods of sewage treatment. The dissolved chemicals cannot readily be removed. The quality of waste water is thus downgraded from domestic use.

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The use of water for industrial enterprises causes a variety of qualitative effects. Cooling water is usually increased in temperature in proportions to the heat it absorbs but with no further harmful effects. Process water on the other hand, is affected by the solution and suspension of waste products of the particular industry involved. Removal of these contaminants can be accomplished in many cases by special industrial waste treatment processes.

Reuse Potential

A subject which is closely related to quality criteria is the general practice of using our streams as waste disposal systems. The widespread use of home garbage disposal units has tremendously increased the amount of waste reaching our streams. Although it is true that large streams can safely absorb some waste, the general practice is detrimental to the quality of our water resources. Probably more water is rendered useless by this practice than through other orthodox uses of water. It would seem that we shall be forced in the future to concern ourselves with this problem to a much greater extent than today. We shall, however, always use our streams to dispose of treated waste water since to do otherwise would mean to deny ourselves the opportunity for reuse of water. It is possible, therefore, to recapture and reuse our used water provided quality standards can be met. The reuse potential of our water resources is important in any analysis of the demand-supply situation. Depending upon the degree of degradation, the standards of quality of subsequent use, and the consumptive losses, we can anticipate varying degrees of reuse. Waters of initial high quality may be used for domestic purposes as much as four or more times. Similar use of industrial use is possible if no serious degradation of quality takes place during each use cycle. Reuse is normally the greatest in regions of relative water scarcity. This also points out that reuse may take place within a plant or may occur at some place far removed from the original use.

Domestic Use

Use of domestic water has grown steadily to record high rates today and will keep on growing with new innovations and technological advances. Although there are variations in use in different regions, these variations are not large because of the relatively uniform standards of living. Local variations can generally be explained by such particular needs as use for irrigation of lawns and shrubs. Price has little effect on use since costs are normally modest and have minor restraints on use. Per capita municipal use for cities in the United States varies from 50 to 500 gallons per day but

of this some is for industrial and commerical use. The 1960 figures indicated that the average use was of the magnitude of 130 gallons per capita per day.

Industrial Use

Use of water for industrial ventures varies in the extreme as between products and even between different plants producing identical products. The nature of the use is variable and the effects of the use on the waste water may vary likewise. A few industries such as soft-drink plants and breweries actually use water in their products, as well as in processing. The two major industrial uses are, however, for condenser water and in manufacturing processes. In the latter use, there is a wide range. For example, a canning plant may need only wash water, while paper mills require large amounts of water to suspend pulp fibers and steel mills may require large amounts of water to quench and descale the steel in rolling mill. Industrial use of water is therefore, a complex matter and cannot be easily defined. In the United States, it is customary to use water circulated per manufactured unit as a measure of industrial water use. It is important to recognize that these values are largely controlled by choice rather than necessity. Table I shows some typical industrial water uses.

TABLE I. Typical Industrial Use

Industry	Unit	Typical Use (Gallons)
Steel	Ton	65,000
Paper	Ton	38,000 to 184,000
Refined Petroleum	Barrel	770
Explosive	Ton	200,000
Alumina	Ton	2,200
Aluminum	Ton	32,000
Thermo-Electricity	1,000 kw. hr.	80,000
Synthetic Rubber	Ton	660,000
Hydrogen	Ton	660,000
Carbon Black	Ton	280 Contact Process
		140,000 Furnace Process
Coal Hydrogenation	100 Barrels	730,000
Glycerin	Ton	1,100
Oxygen	1,000 cu. ft.	2,000

Gross Use of Water In The United States And Time Phasing Of Water Requirement

Demands for different type of use such as domestic, industrial, and agricultural vary throughout the year. Agricultural uses

especially for irrigation are concentrated during the growing season and when precipitation is deficient. This concentration of demand has very serious effect on water use management. Domestic use increases by about 200 percent of the average in summer time and also shows pronounced changes during the day time. Many industrial uses are relatively uniform although some show seasonal variations such as food processing uses. Water demands may or may not have a fortitous phasing with dependable supplies. This phase of the problem requires detailed studies for each region before intelligent water resources development can be undertaken.

Gross use of water by areas in the United States is shown in Table II. The consumptive requirements have been estimated. These uses have been estimated on the basis of average efficiencies of irrigation in the various regions. Consumptive use of domestic and industrial water has been estimated to vary between 5 percent for humid areas to 10 percent for arid regions. Consumptive use estimates sometime are subject to considerable error.

TABLE II. Fresh Water Use In The United States
(All figures are in MGD)

Region	Gross Use: Domestic	Industrial	Agricultural	Total	Estimated Consumptive Use
New England	710	2,750	50	3,510	180
Delaware-Hudson	1,900	7,660	180	9,740	520
Chesapeake	500	2,610	130	3,240	180
Eastern Great Lakes-St. Lawrence	580	9,940	140	10,660	540
Western Great Lakes	770	13,750	210	14,730	750
Upper Mississippi	490	8,350	320	9,160	920
Southeast	1,020	9,990	840	11,850	890
Tennessee-Cumberland	190	4,690	100	4,980	260
Ohio River	1,140	22,350	280	23,770	1,190
Missouri-Hudson Bay	560	4,410	18,380	23,350	11,070
Lower Mississippi	410	3,550	1,090	5,050	710
Arkansas-White-Red	500	1,990	4,990	7,480	3,140
Western Gulf-Rio Grande	670	3,640	13,560	17,870	9,160
Colorado	170	300	16,430	16,900	10,730
Great Basin	200	270	8,540	9,010	5,800
Pacific Northwest	500	1,450	25,890	27,840	13,000
South Pacific	970	1,350	19,430	21,750	12,800
United States	11,280	99,050	110,560	220,890	71,840

Factors Affecting The Estimates For Future Use

Consideration for future uses of water involves many factors other than merely extrapolation of present demands. Among these factors are a relatively fixed water resource, changing use patterns particularly for industry and agriculture, competition for available cheap supplies of water, regional characteristics of water supply, threatened increased costs for supplimentary dependable supplies and legal problems.

Future Domestic Use

Future uses of water for domestic needs are in part directly related to future population. It is expected that per capita requirements will materially be increased. There is no reason to expect any revolutionary change in the consumption for domestic purposes but such things as more bathrooms per home and greater use of water in connection with air conditioning along with more generous use for established uses, causes a progressively higher per capita demand. By 1980, it is expected that domestic use per capita will be 160 percent of 1960 figures assuming that there is no unforeseen restraint on water supply.

Water being a regional resource, we must consider the probable trend in regional population and estimate where the greatest impact of these needs will develop. Data on increases show a marked increase in the growth of the Pacific Coast states and a continued trend to growth of the medium and large sized cities. Factors favoring trends toward urban and suburban living seem destined to continue. An accurate forecast region by region is beyond the scope of this discussion.

Future Industrial Water Use

In the realm of future industrial water use, we find uncertainty of changing economic factors to be a major effect on the future use patterns. The use of water in the future appears certain to increase at a greater rate than the level of industrial production. The manufacturing methods used and the net effects of such use on the supply situation is important and affects the use patterns. The pressures for the control of industrial pollution are growing and are expected to cause rather remarkable changes in industrial uses and on disposal of waste. Economic and administrative pressures are being generated which will force more conservative industrial water use practices. The net effect of these pressures is very hard to estimate aside from some relief of pollution.

Since one of the major uses of industrial water is for cooling in thermo-electric generation stations, it is important to anticipate trends in this segment of industry. Industrial activity generally correlates with overall power generation and therefore, the latter should indicate to us some index of water demands of industry. The experience of the electric-power industry shows an approximate doubling of power production in each decade. Assuming the same ratio of electric power generation by 1980 as is in present use, we arrive at an index of about 600 percent. By 1980, thermonuclear power stations will probably be commonplace and they will require large amounts of cooling water. Other industrial uses may not require as great an increase in water as that expected for cooling purposes. Taking into consideration the above factors, it is estimated that the industrial fresh water demand by 1980 will be about 400 percent of the present demand.

Gross Future Use--1980

Table III shows the gross estimated water use and corresponding estimates of consumptive use by 1980. These data are crude and have been extrapolated without major concern as to how demands might be met except for those areas which are presently approaching full scale development. In such a case, the limitation of gross supplies is a primary factor for future prediction.

Factors Affecting The Future Use Patterns By 1980

Potential and conflicting forces will affect future water use patterns. Some of these forces are relatively obvious as, for example, costs and availability of supply. On the other hand, legal action and administrative measures are far less apparent. Some of these factors are shown below.

For Greater Use	For Restrictive Use
Population growth	Decreasing quality
Greater per capita domestic use	Increasing cost
Agricultural need	Decreasing relative availability
Economic incentives	Legal restraints
Industrial activity	Administrative measures
Convenience	Trend towards highest use of priority
	Competition by class of use

TABLE III. Estimated Fresh Water Use In United States By 1980
(All figures are in MGD)

Region	Gross Use				Estimated Consumptive Use
	Domestic	Industrial	Agricultural	Total	
New England	1,570	11,000	500	13,070	880
Delaware-Hudson	5,080	19,100	700	24,880	1,560
Chesapeake	1,410	9,900	1,300	12,610	1,210
Eastern Great Lakes-St. Lawrence	1,820	34,800	600	37,220	2,130
Western Great Lakes	2,410	55,000	2,300	59,710	6,850
Upper Mississippi	1,380	33,400	10,000	44,780	8,450
Southeast	3,740	60,000	8,000	71,740	7,590
Tennessee-Cumberland	600	18,700	1,500	20,800	1,720
Ohio River	3,110	83,800	8,000	94,910	8,350
Missouri-Hudson Bay	1,450	13,200	28,000	42,650	18,200
Lower Mississippi	1,060	17,700	9,500	28,260	5,680
Arkansas-White-Red	1,080	8,000	10,000	19,080	6,890
Western Gulf-Rio Grande	2,420	14,600	12,000	29,020	9,440
Colorado River	780	1,200	14,000	15,980	9,310
Great Basin	630	1,100	7,000	8,730	4,710
Pacific Northwest	2,370	8,700	36,300	47,370	18,800
South Pacific	6,310	4,000	16,000	26,310	11,300
United States	37,220	394,200	165,700	597,120	123,070

We shall seldom find all of these factors dominating the situation at the same time. These forces are evolutionary and we shall experience progressive but constant readjustment in practices. Before restrictions on use become effective, the future demand must exceed the supply.

Industrial Growth And Its Relation To Water Use and Supply

Water is an essential constituent in many products and is a necessary adjunct to most manufacturing processes. Different products require it in different quantities. It is only one of the elements, however, in a long and complex chain to which we call our modern industrial process. It is also one of the items of cost for a particular plant. There must be real overall efficiency in each industrial plant if it is to compete successfully in its respective industry. Therefore, cost and availability of water is an important factor. There can be little question that availability and cost of water will be important to industrial growth and it

will have substantial effect in determining the location and manner of operation of new industrial plants.

Physical Problems As Related To Water Use

The extreme variations under which water occurs is a physical fact of great significance. Only through an adequate understanding of these conditions can we effectively meet the problems of use and developments of our water resources. Another physical problem is the effect of large concentration of demand. Where this happens there normally develops a problem of supply because of disproportionate demand over supply. Ideally, demand should be established where supply exists in order to minimize the transport of water from distant sources.

Political Problems As Related To Water Use

To every citizen of the Nation water is important, yet fixing the responsibility of safeguarding water is very difficult. It can be said that water is everybody's problem, and like most problems of this nature, it tends to become nobody's business. Of principle importance in this matter is the fixing of responsibility of several levels of government and private enterprises. In recent years, steps in this direction have been taken as shown by several case-studies. There is, however, a corollary to this problem and that is the education of the population to the true character of the water problems of the Nation. Without this latter enlightment, wise public policy towards conservation of water resources seems impossible. A consequent action stemming from governmental responsibilities is the development and functioning of administrative facilities to carry out public policy and law. There exists a serious lack in this field. No administrative unit of the federal government is now equipped or responsible for the co-ordination and direction of the total federal executive function in water resources, and except for a few western states, there is little counterpart organization at the state level. Lacking federal, state, and local level definition of responsibility, there is bound to be jurisdictional disputes over the conservation and development of our water resources. This is in part due to the lack of common agreement on relative importance of competing uses of water. It is, therefore, important that there be developed policies leading to the most beneficial use of water and that a demand - supply equilibrium be established.

Legal Problems As Related To Water Use

Part of the difficulty we face now and in the future is the confused state of water law and judicial interpretation. Except in a few western states, there does not exist a workable water law at the state level. Serious conflict exists between federal and state laws. Courts have, unfortunately, interpreted law and civil suits on a traditional basis without regard to natural laws affecting the situation. Here again, enlightment of the legal profession is desirable and necessary.

Economic Problems As Related To Water Use

Water is now considered essentially a free commodity to be captured by the most enterprising. It is not priced in relation to value but in relation to cost. It is one of the cheapest commodities in the market today, and we generally disregard its cost in our use habits. In the future, it appears that price will become more of a factor. Future development of water will be more expensive than water already developed because we habitually develop our cheapest resources first. Therefore, we may as well utilize a pricing structure to encourage restricted use of water rather than the contrary which is our practice today. In addition to extra cost for new supplies, we shall face also added costs for disposal and treatment. The net effect of increasing cost is beyond the scope of this discussion, but it is obvious that it will be a factor tending to restrict the use of water. Economic competition for water is partially defeated by legal and administrative measures. This competition is functional and geographic and in the future, we may experience more of it.

Conclusions

Water is used for many purposes, the foremost among which is the use for human needs. Industrial use varies between types of plants and even between plants of the same type. The major industrial use of water is for cooling. All users of water compete for the same basic source of supply. Therefore, when water is in short supply, there is a severe competition for each user to share. Many uses of water are not permanently harmful, and there is widespread opportunity for reuse. This reuse is totally dependent on the subsequent quality and diminution which occurs during each use. Under favorable circumstances several reuse cycles of domestic and industrial waste water can be accomplished. Water uses for industrial and domestic purposes have developed in an environment of relative abundance of water and uses have been very generous.

In the future, such uses will seem wasteful and we can anticipate more restrictive uses. So far, the water use patterns are not affected by price but in the future this might change. Water use is expected to rise in the future and in 1980 it is anticipated that 600 billion gallons per day will be used by our Nation. The major increase in use is expected to be industrial. There is a confused state of affairs in the matter of policy and governmental responsibility in water resources development. The confusion results from a lack of sound body of law and experience. The problems of water resources development have been emerging only in recent years and the citizens are not well informed in all phases of the problem. There is a lack of knowledge of the natural, economic, and political aspects of water resources and little is being accomplished to dispell this ignorance.

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