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Pricing Municipal Water and Sewer Services in Minnesota

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INTRODUCTION

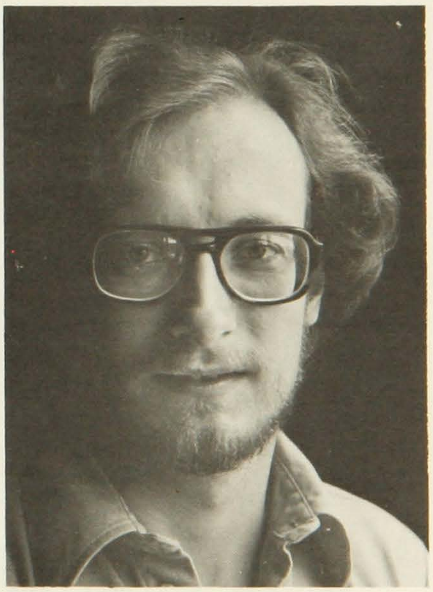
In recent years, several major events have revived interest in policies related to natural resources. The energy situation and worldwide shortages in food and feedgrains, both occurring in 1973, ushered in an era of increased awareness of our natural resources. The 1976 drought reinforced the possible consequences of short water supplies. Rationing of water in parts of California, some areas of the Upper Midwest, and other areas where ample water supplies have been taken for granted focused attention on national water problems.

Viewing natural resources, including water, in the context of scarcity is becoming more common. However, pricing systems for water which were designed decades ago have been modified little, if at all, to reflect the current situation.

PRICING OF WATER

Traditionally, municipal water rates have been designed to meet operating revenue and debt service rather than to encourage water conservation and allow for expansion of the system.

When water shortages occur, the usual response is to ration or regulate: curtailing lawn sprinkling for instance. This may be necessary and partially effective on a short term basis, but it provides no long term incentive for more rational use of resources.



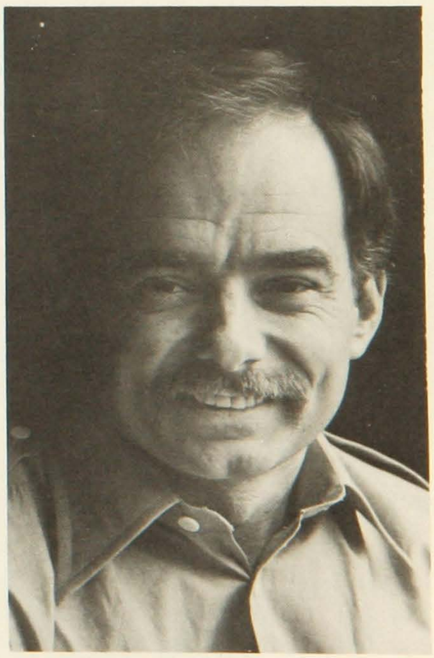
Richard L. Gardner

The conventional response for a longer term solution, whether of oil or water, is to expand supplies. If new supplies are found, consumers continue to enjoy high levels of consumption at continued low prices. To the extent that these supplies are found the strategy is successful. Realistically, however, these expanded supplies come only with increased costs. Long term policies are going to have to reflect scarcity. In most regions pricing water in the 1980's to reflect conditions of the 1920's will not be rational.

ALTERNATIVE RATE FORMS

As with any resource or product, price influences use. Municipal water and sewer rates can be classified in several forms. The rate form describes the manner in which price varies, such as by quantity used, location, time, persons in residence, or number of plumbing fixtures.

Common rate forms include:



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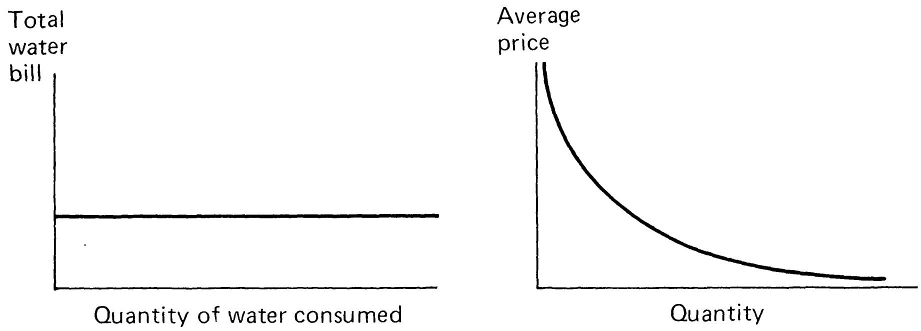
Flat Charge: Here, each customer pays one price for any amount of water consumed; there is no limit on the amount used. The total water bill does not vary with the amount used, and therefore the average price for water (or sewer) declines as more is consumed (figure 1). There is no incentive to conserve because the marginal cost of water to the consumer is zero.

Figure 1. How total water bill and average price of water vary with quantity consumed under flat charge



The water utility multiplies the average cost of producing water times the expected amount of use per customer to obtain the amount of the charge. This is the type of rate form which must be used when a city such as New York City, Denver, or many small Minnesota cities does not have residential water meters.

For several reasons, this is the least desirable rate form. It is inequitable because the size of the water bill has absolutely no relation to the amount of water used. Those with large houses, large families, or many water-using appliances are subsidized by people with more moderate consumption patterns.

Sometimes flat charges will be made to vary with the number of residents, the number of plumbing fixtures, and/or by the demand sector (figure 2). The first two install some measure of rate equity while the latter is by far the most common. The cost to the consumer of using additional water is zero under this rate form.

Single Block: Here, the price *per unit* of water is constant no matter how much water is consumed. Total cost to the customer increases with consumption so there is an economic incentive to conserve (figure 3). Since there is only one price, this incentive remains constant. If the single block is set to match the marginal cost of production,[1] this rate form can be both efficient and equitable. Varying costs for different consumer classes might mean a variety of single blocks. Of course, there must be some kind of metering system to measure the amount of water consumed.

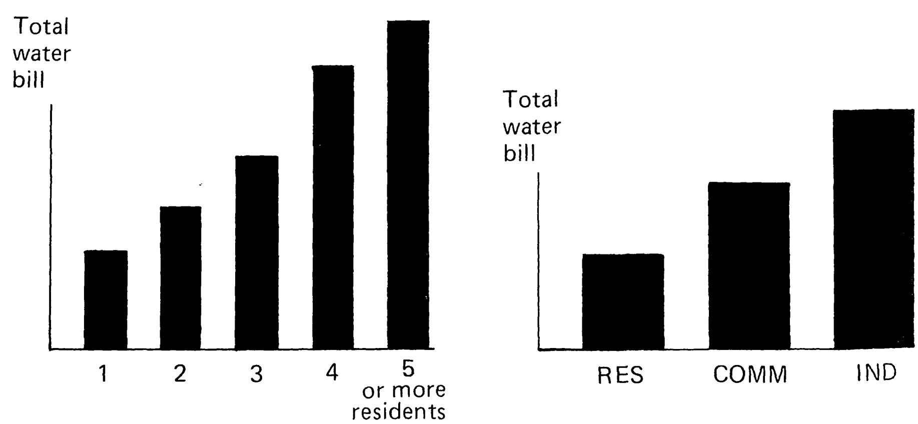
Declining Blocks: Here, the price per unit decreases by steps with the amount purchased (figure 4). The consumer pays one price, or rate level, for a certain quantity of water and a lower price for additional use. The total cost of water to the consumer increases, but at a decreasing rate. The incentive for conservation decreases as lower and lower rate levels are reached.

This is probably the most common rate form used by public utilities in the United States today. This is a promotional rate form originally used to encourage growth in demand to use the system to capacity. The current rationale for declining blocks is that larger customers deserve lower prices because of economies of scale in well and reservoir construction and because of lower distribution costs. With increasing scarcity of high quality water, the ramifications of this rate form need to be examined again.

Before any blanket judgments are made, remember that declining block rate structures can vary tremendously. The quantities at which different blocks begin are quite important. They may be placed so as to encourage water waste by residential users, or they may simply give a break to extremely large customers. An excessively large number of blocks can cause unnecessary confusion and difficulty in billing.

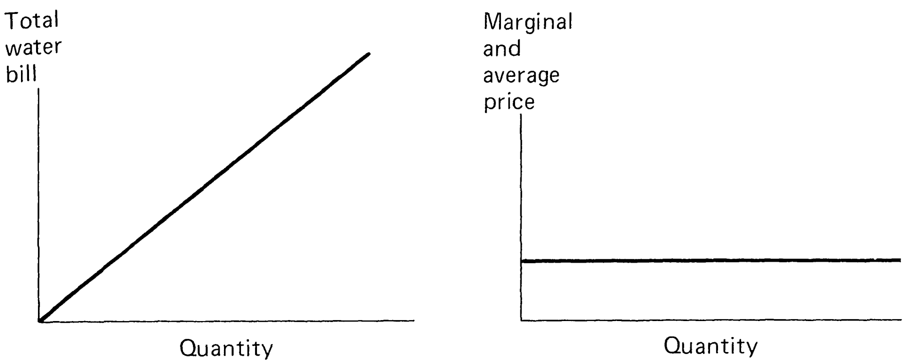
The ratio of highest to lowest rate levels also conveys information about the rate structure. Declining blocks range on a continuum from a very nearly single block rate form to blatant subsidization of large customers. If this ratio is to be justified on the economic grounds of marginal cost, then the costs of delivering

Figure 2. How total water bill may vary by residents per household and by demand sector



[1]Marginal cost is defined as the additional cost incurred from producing an additional unit of product: here, the cost to the utility of an additional gallon of water. Marginal price is the price of an additional unit of water to the consumer.

Figure 3. How total water bill and average price of water vary with quantity consumed under single block rate form



water should vary by this same ratio.

Increasing Blocks: This is the opposite of declining blocks—the price per unit increases by steps with the amount purchased (figure 5). The incentive to conserve increases as higher rate levels are reached. This rate form is rarely used by water utilities. With lower distribution costs for large customers, there seem to be serious inequities with this rate form. The proposed "lifeline" rates, which offer minimal amounts of water at a nominal cost, would come under this rate form.

ADDITIONAL CHARGES FOR UTILITY USE

Service Charge: This is a separate charge from the rate structure for the privilege of purchasing water from the municipality. The privilege is that each customer has an open-ended contract with the utility to purchase as much or as little water as desired. The utility must maintain excess capacity for those demand consumption peaks. This excess capacity costs money to build and maintain and is the rationale for the service charge. It could also be construed as a charge for fire protection and water hydrant use. In addition, there is a legitimate economic argument that all fixed costs should be included in the service charge, and that the commodity charge which is proportional to water use should include only variable costs (see discussion which follows).

Figure 4. How total water bill and water price vary with quantity consumed under declining block rate forms

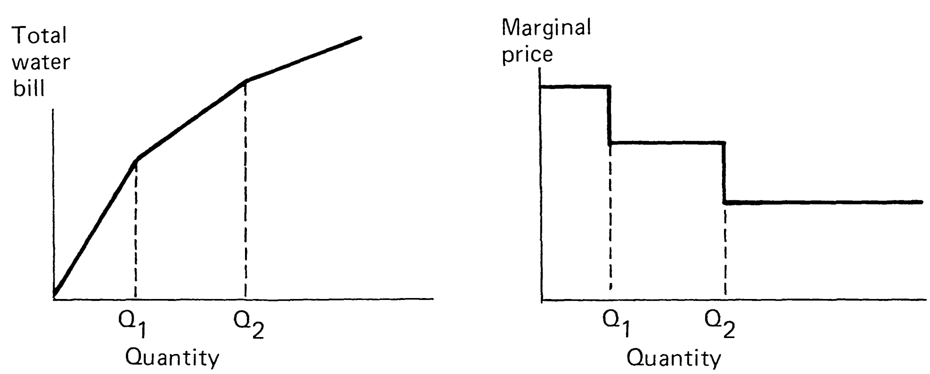
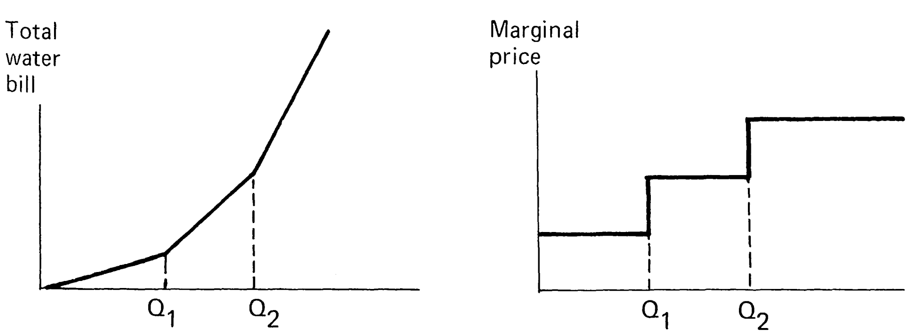


Figure 5. How total water bill and water price vary with quantity consumed under an increasing block rate form



The service charge is sometimes incorporated or disguised in the form of a minimum demand charge or minimum charge. Any of these can be added to the rate structure.

Minimum Demand Charge: This is a flat charge for the first quantity of water. The price per unit is usually much higher for this initial amount, and so the minimum demand charge may be thought to contain the service charge. The initial amount of water (or sewage if discussing sewage rates) included in this charge may be relatively small, such as 1,000 gallons; or larger, such as 10,000 gallons.

There is incentive to use this first amount since the customer will be charged for it anyway. The marginal price is zero up to the initial amount, so the minimum demand charge becomes more inequitable as the quantity of water it includes grows larger. The probability of altering consumer behavior grows in this manner also. A minimum demand charge is recommended by the American Water Works Association (AWWA) together with a declining block rate form.

Minimum Charge: This is nearly identical to the minimum demand charge, but the wording is different. A rate structure is given with the further stipulation that there is a minimum amount charged. One difference from the minimum demand charge is that a minimum charge need not come out to a whole number of units purchased, e.g., water costs 75 cents per thousand gallons with a minimum charge of $2.

RATE STRUCTURE IN MINNESOTA

Figures 6 and 7 compare the distributions of water and sewer rate forms in small, medium, and large size Minnesota cities.[2] In figure 6 the most common rate form is declining blocks. Note that small cities comprise most of the flat charges. This is not surprising since they often lack water meters. The proportion of single block forms increases with city size. Perhaps the bigger water systems get all the economies of scale from residential customers alone, and so do not have to cater to industrial demands.

The distribution of rate forms for sewer service is quite different. Figure 7 reveals a much heavier concentration of flat charges. Since all of the water used indoors goes into the sewer system, it makes more sense to make sewer charges dependent on water consumption. If these flat charges were removed in cities with water meters, there could be more efficient water and sewer use.

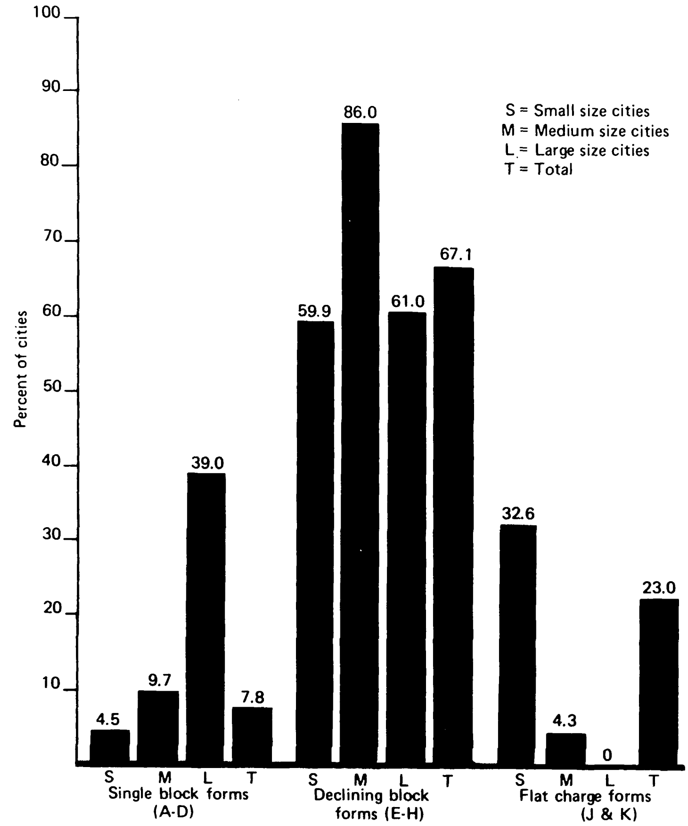
Monthly utility bills were calculated for each city for water and sewer. Consumption was held constant at 10,000 gallons per month to allow for comparisons. This level is about what an average family of four would consume. Of course, this use level is probably high for those cities with high prices. Table 1 summarizes resulting utility bills by rate form and city size.

Statewide, the average water bill at this level of consumption is $5.54, and the average monthly sewer bill is $3.79. The charges in large cities nearly match these figures. Small cities have lower utility bills, while medium size cities charge more than the state average. The range for extreme utility bills is largest in the small cities.

Comparing the average bill to the charges resulting from different rate forms, the bills from flat charges with $3.09 and $2.71 for water and sewer are obviously much lower. When the flat charges are removed, the average Minnesota bill rises from $5.54 to $6.27 a month for water and from $3.79 to $4.97 for sewer service. If the water bills from proportional rate forms reflect costs at all, then the flat charge rate structures may be inadequate from a revenue raising perspective. Single block forms tend to charge residential customers slightly less, especially for water, while declining blocks have larger bills for small users.

Figure 6. Frequency of rate forms (water)

Source: September 1976 survey by R.L. Gardner and J. J. Waelti, Department of Agricultural and Applied Economics, University of Minnesota.



PRICE ELASTICITY OF DEMAND

The price elasticity of demand measures the responsiveness of consumers' demand for water to price changes. It is a very important concept if price is going to be a tool to encourage water conservation. One phase of this study attempted to determine the price elasticity of demand and to establish which factors affect the demand for residential water.

Eleven variables were used in a multiple regression model to explain variations in daily per capita water consumption among 75 medium size Minnesota cities. Water price, the population served by the water system, the proportion of children in the city, and per capita income influenced water consumption.

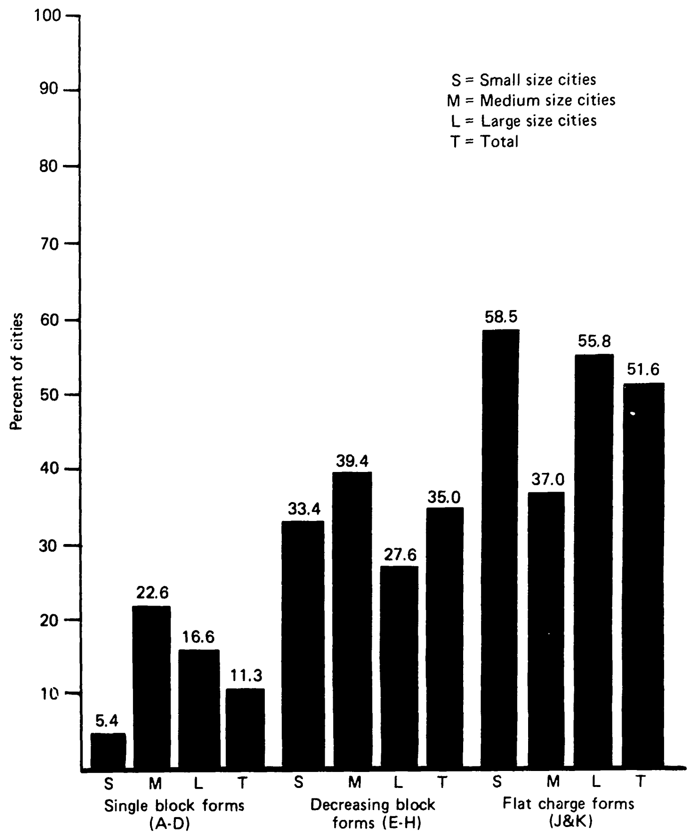
A 1 percent increase in per capita income would result in a .37 percent increase in water consumption. A 1 percent increase in the proportion of children would increase per capita water consumption by 2.2 gallons per day. A water system which serves 1,000 more people will have a 4.3 gallons per day lower per capita consumption level.

A 1 percent increase in price would decrease consumption by .24 percent; −.24 is the price elasticity of demand. A significant amount of conservation should result from a price increase. Note that price is the only factor affecting demand which water policymakers can change.

[2] Small cities less than 2,500 (1970 census); medium, 2,500 to 25,000; large, over 25,000.

Figure 7. Frequency of rate forms (sewer)

Source: September 1976 survey referred to in figure 6.



Consumers react to marginal price, that is the amount by which consumers could reduce their utility bill if one less unit of water were used. In cities charging for sewer service according to water usage, this marginal price includes the sewer charge for that unit of water.

A price elasticity of demand of −.24 is rather inelastic. An elasticity between 0 and −1 means that a price increase will generate more revenue for the utility than is lost to decreased consumption. Therefore, water utilities can raise price to avoid financial difficulties. By following a marginal cost rate structure, water systems should not need outside revenue to accommodate system expansions.

However, the price elasticity is significantly different from zero. There should be a noticeable effect of reduced consumption when the marginal price of water is increased. There are sound economic incentives to place this marginal price at the marginal cost to society of producing the water. As the price of water is increased to match marginal cost, the price elasticity would be

Table 1. Statewide comparison of utility bills by rate form (average cost of 10,000 gallons per month or 4 persons per residence)

Rate form	Water $	Sewer $
A	5.36	4.75
B	6.57	4.98
C	6.45	5.55
D	5.47	4.62
E	7.19	4.89
F	6.91	4.98
G	6.00	4.28
H	6.15	5.12
I	5.34	3.14
J	3.09	2.71
K	4.21	3.38
L	6.34	4.90
Average of all forms, statewide	5.54	3.79
Average of all forms, small cities	5.23	3.47
Average of all forms, medium cities	6.31	4.40
Average of all forms, large cities	5.45	3.93

Source: September 1976 survey, referred to in figure 6.

Key for rate forms:

A —Single block
B —Service charge plus a single block
C —Single block with a minimum charge
D —Minimum demand charge with a single block
E —Declining blocks
F —Service charge plus declining blocks
G —Declining blocks with a minimum charge
H —Minimum demand charge with declining blocks
I —Minimum demand charge with increasing blocks
J —Flat charge
K —Flat charge varying by number of residents
L —All other forms

expected to rise and produce even larger conservation effects.[3]

PRICING ISSUES

Marginal Cost Pricing

The crux of most pricing issues today is the pricing philosophy behind the advocated rate structure. Believers in marginal cost pricing are pushing for the change. Their philosophy is that a consumer who purchases a product should pay the full cost of producing that product. This idea is supported by economic theory asserting that marginal cost pricing will yield the most efficient allocation of resources.

Opposition comes from those who are content with the traditional average-cost pricing. The cost-of-service method of pricing advocated by the AWWA has some elements of rationality, but it still charges average costs for different user groups. In this way it fosters some social inequities.

The capital costs of a water distribution system is a major component of the cost of water. Additional funds are often spent to expand the water system to outlying regions. Yet all customers are charged the same average price for water. Those who live in the more densely populated city center subsidize the distribution costs of suburbanites.

The cost of water is therefore location-free. This is one small way of promoting the syndrome of expanding cities, decaying city centers, and decreasing agricultural land.

A similar subsidy occurs when water cost is averaged over the seasons. The demand for water is usually so much larger in the summer that extra capacity is needed. The marginal cost of water in the summer is higher than in the winter. The result of one year-round price is that inner city and apartment dwellers share the cost of lawn sprinkling, but may not enjoy the lawns of others.

Similar situations exist with water quality differences among wells, time of water use or the elevation above the water source. They stem from using average cost pricing policies instead of marginal cost. These inequities are techniques of price discrimination if expansion of the system is a goal. This was the rationale for the now unnecessary, but still common, promotional rate structures such as declining blocks.

Maximum economic efficiency only occurs when the price of water for each group of customers equals the marginal cost of getting water to them. If price exceeds marginal cost, then full economic use of the resource is prevented. Thus, artificially high prices to encourage water conservation would actually stop economically efficient use of additional water, barring any external costs.

If price is lower than marginal cost, as it appears to be in most instances, quantity demanded exceeds the optimum. Consumers are encouraged to use water for relatively low value uses. This leads to premature and overly large investments in water systems. Social benefits for dollars spent would be greater if used elsewhere.

PEAK LOAD PRICING

The demand for water is not constant. Each user class has its potential peak demands which are based on the number and size of connections to the system. These peaks are more or less predictable and may or may not coincide with the peak demands of other classes.

The water system must have extra capacity to accommodate these higher water demands. If marginal cost pricing were an ideal operation, higher cost consumption would be penalized by higher prices. The price of water would simply increase at the times of peak demands as marginal cost increased. Currently, it is not feasible to install the metering equipment necessary to monitor individual consumption rates for peak hourly and daily demands.

The next best alternative is to install a system of capacity or service charges.[4] This would be a fixed charge based on the cost of the amount of extra capacity that the system must provide for each class. It could be viewed as a charge for each customer's "option-to-buy," the open-ended contract to purchase any amount of water at any time. The collective residential demands for such uses as air conditioning and sprinkling are likely to outweigh industrial peaks, and so they would bear the majority of the capacity costs. Identifying those residents with these special uses and putting them in a separate class would provide even more equity. It should be noted that the cost of the peak demands often comes in the form of decreased quality of service, namely loss of water pressure.

SEASONAL PRICING

For sustained seasonal peaks that occur in the summer in most areas, the same theory applies, and a system of peak-load pricing is possible. The marginal cost of producing the extra water should be the peak price charged. This would have the desirable effect of reducing these peaks through the effect of price elasticity. One study found that seasonal pricing could delay water investments in Washington, D.C. for 10 years.[5]

A two-priced rate structure for each user group is generally recommended by the authors. A winter price and a higher peak season summer price could be implemented for cities with quarterly or monthly billing periods. A public education program with this system could further reduce peaks. The advantages of sprinkling lawns during off-peak hours should be stressed.

CHANGING MINNESOTA RATE STRUCTURES

The philosophy of marginal cost pricing has several implications for more efficient and equitable rate structures in Minnesota. Recommendations for individual cities will vary according to the rate structure

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[3]Higher elasticities at higher prices are due to technical characteristics of a typical demand curve.

[4]Hirshleifer, Jack, James C. DeHaven and Jerome Milliman, "Municipal Water Rates," **Water Supply: Economics Technology and Policy**, Rand Corp., Santa Monica, California, 1960, p. 105.

[5]Hanke, S. H., and R. K. Davis, "Demand Management Through Responsive Pricing," **Journal of American Water Works Association**, Vol. 63, No. 9, September 1971, pp. 555-560.

in effect and the cost curves for producing water from that system.

Those meter systems that have flat rate structures for water or sewer should change to a marginal cost pricing system. Flat rates produce a marginal price of zero; there is no incentive to conserve. Those flat rate systems without individual meters should strongly consider installing them. Since metering installation reduces consumption, this option would be less costly than expanding the water supply.

In general, declining block rates should not decline in price as much as many Minnesota rate structures presently do. This promotes a waste of scarce water at a net loss to the water utility. A price drop equal to the reduction in marginal cost from having a larger system can be justified. However, a single price (or two seasonal prices) for each user group is more equitable to large consumers than combining them all in a declining block rate structure. Also, those structures which contain many price blocks which change over small quantities should be simplified.

To adopt a marginal cost pricing system, a service charge should replace minimum demand charges and minimum charges. Minimum demand charges can encourage water consumption and disguise the true cost of purchasing additional water. In contrast the service charge does not affect conservation incentives.

It should be recognized that changing rate structures involve more practical considerations than simply recognizing a need for it. Once a rate structure is adopted, there is built-in resistance to change. Water users are sensitive to price increases and convey this to elected officials.

Peak summer users such as the single-family-residence lawn waterer, golf courses, nurseries, would not find summer surcharge rates attractive. Any proposal to change water rates for water and sewer service is likely to meet considerable resistance.

SUMMARY

Pricing of water and sewer services has been oriented toward meeting requirements for operating revenue and debt service. The various rate forms include flat charges, single blocks, declining blocks, and increasing blocks. These rate forms vary regarding economic efficiency and inducement for rational water use.

Declining blocks is a rate form commonly used in Minnesota. Its use should be questioned as it tends to subsidize large water users. There is a sound basis for greater use of the single block rate form. The flat charge is especially undesirable; switching from this rate form, however, requires meter installation.

There is sound basis for seasonal pricing of water in Minnesota. There is also sound economic basis for a service charge rather than a minimum demand charge.

As municipalities realize water shortages, there is considerable potential for greater reliance on water pricing as opposed to publicity campaigns, regulatory actions, and stopgap measures such as lawn watering on odd numbered days.

Proposed changes in pricing of water and sewer services may meet considerable resistance. However, as municipalities experience water shortages, changes in water pricing systems are inevitable. The question is whether change will occur before or after an individual municipality experiences water shortages and the accompanying need to reexamine rate structures.

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