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Base-extra capacity water rate design

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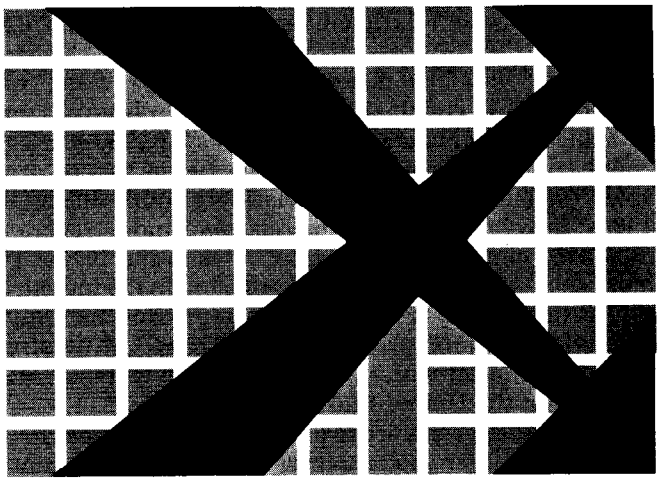

Increasing emphasis is being placed on developing water rates that reflect the costs of providing water service. The principles and philosophy of one cost-allocation method—the base-extra capacity method—are discussed.

Every water utility must receive sufficient revenue to assure proper operation and maintenance, development and perpetuation of the system, and maintenance of financial integrity. Consumer interest in utility rates and the impact of inflation have brought about increasing emphasis on developing rates that reflect the cost of providing service.

This article discusses the principles and philosophy of the base-extra capacity method of cost allocation and illustrates its effect on determining cost-of-service block rates.

The first step in developing water rates is to determine the total annual operating revenue requirements, or costs of service, for the period during which the rates will be effective. Costs of service are then allocated to functional cost components. The next step is to distribute the component costs to the various customer classes according to their requirements for service. The final step is the design of rate schedules that will recover from each customer class, within practical limits, the cost to serve that class. This discussion is limited to the last three of these steps, i.e., allocation of costs to functional cost components, distribution of those costs to customer classes, and design of rates.

Because the need for total volume of water supply and the peak rates of use vary among customers, the costs to the utility of providing service to meet the differing requirements of customers or classes of customers also vary.

In seeking equitable charges for different types of customers, the premise in establishing rate schedules is that the cost of providing water service should be reflected in rates. A sound analysis of the adequacy of charges requires allocation of costs among customers commensurate with their service requirements, recognizing differences in the costs of furnishing service to different types of customers. For example, a customer with a high peak-use rate compared with that customer's average-use rate would require the installation of larger-capacity pumps, mains, and other system facilities than would be required by another customer who uses an equal total volume of water but uses it at a uniform rate. Therefore, cost allocation procedures should recognize the individual service requirements of customers for total volume of water, peak rates of use, and other factors.

The allocation of water utility costs is accomplished by applying any of a variety of methods. In most cases, the costs are allocated, or assigned, in two steps: first, to appropriate cost components and, second, to customer classes. The cost components vary depending on the basis of allocation used. The two most widely used methods of cost allocation are the base-extra capacity method and the commodity-demand method. Each recognizes, in its way, the fact that costs of serving customers depend not only on total volume of water used but also on the rate of use, or peaking requirements. In general, the base-extra capacity method is judged by many to be the superior means of cost allocation for rate design, partly because it inherently identifies the lowest average cost at which water should be sold.

Base-extra capacity method

Allocation of the cost of service to functional components. Water supply and treatment systems are typically designed to meet both total annual water requirements and coincidental peak-day and peak-hour demands in excess of average annual demand. In the base-extra capacity method, the costs of service are usually separated into four functional cost components: base costs, extra capacity costs, customer costs, and direct fire protection costs.

Base costs tend to vary with the total quantity of water used and include operation and maintenance expenses as well as the capital costs of supply, treatment, pumping, storage, and distribution facilities, to the extent required for a constant, or average, annual rate of use. They do not include the cost elements incurred to meet peak demand. Impounding reservoirs are an example of facilities whose costs would usually be totally allocated to base costs.

Extra capacity costs are associated with meeting requirements in excess of average use and include operation and maintenance expenses and capital costs for system capacity beyond that required for average rate of use. These costs can be subdivided into the costs that are necessary to meet maximum-day extra demand,

maximum-hour extra demand, or other extra demand criteria that are appropriate for a particular utility. Costs related to water treatment plant and high-service pumping would be allocated to both base cost and maximum-day extra capacity cost functions because these facilities are designed to meet both average and maximum-day extra service requirements.

In the base-extra capacity method of cost allocation, care must be taken to separate the base costs from the extra capacity costs. The appropriate allocation factors between base costs and extra capacity costs vary among systems and should be determined by the operating history or design criteria for each system. For example, if a system has an annual average-day use to maximum-day use ratio of 1 to 1.54 and an annual average-day use to maximum-hour use ratio of 1 to 2.22, 65 percent (1/1.54) of the cost of facilities designed to meet maximum-day requirements can be allocated to base costs and 35 percent (0.54/1.54) to maximum-day extra capacity costs. Costs of facilities designed to meet maximum-hour requirements would be allocated 45 percent (1/2.22) to base costs and 55 percent (1.22/2.22) to maximum-hour extra capacity cost.

Customer costs are the costs associated with serving customers regardless of the amount or rate of water use. Customer costs include meter reading and billing, customer accounting and collecting expense, and maintenance and capital costs related to meters and services.

Direct fire protection costs are applicable solely to fire protection. Usually such costs are defined as the cost of public fire hydrants and branch mains. The costs allocated to direct fire protection are usually only a small part of the total cost of fire protection. A significant portion of extra capacity cost is also allocable to fire protection.

Proper allocation of costs under the base-extra capacity method identifies the costs of coincidental demands placed on the utility by system customers and is the preliminary step in distributing costs to customer classes served by the system.

Distribution of component costs to customer classes. Theoretically, the ideal solution to developing rates for water customers is to assign cost responsibility to each customer served and develop rates to derive that cost. It is not economically practical—or even possible—to determine the cost responsibility and applicable rates for each individual customer. However, the cost of providing service can be reasonably determined for groups or classes of customers who have similar water use characteristics and for special customers who have unusual water use or service requirements. The objective of ratemaking is to assign costs to classes of customers whose service requirements are similar, so that rates are nondiscriminatory and meet, as nearly as possible, the cost of providing service to such customer classes.

Units of service. Component costs can be distributed among customer classes in proportion to the responsibility each class bears for the total cost of serving all customer classes. This applies for each of the component costs of service. Responsibility for each component can be expressed in terms of the number of units of service required by each class. The sum of all component costs attributable to a given class is the total cost of service to be recovered from that class of customers.

The total cost allocated to each component, such as the total base cost, can be divided by the appropriate total requirements for units of service, thus expressing a unit cost for each component. The unit costs of each component serve as the basis for designing rates. To distribute component costs to customer classes, it is essential to establish the units of service attributable to each of the respective customer classes. This involves determining or estimating the total quantity of water that will be used by each class of customers during the test year and the peak-use rates of each class, usually for both maximum-day and maximum-hour rates of use. In addition, a determination of the number of equivalent meters and services serving each class and the number of bills rendered to each class must be made. Table 1 lists the units of service during a hypothetical test year for a water utility serving three customer classes and providing fire protection service. The base annual usage is the measure for distributing base costs to customer classes.

Maximum rates of use can be expressed in terms of the capacity factor, i.e., a percentage expression of each customer class's maximum rate of use to its average annual rate of use. Thus, if the residential customer class's maximum-day rate of use is 2.5 times its average rate, it has a maximum-day capacity factor of 250 percent. Maximum-day use in excess of average-day use is shown as extra capacity. Maximum-hour capacity factors and use are expressed in a similar manner. As shown in Table 1, demand patterns of various customer classes differ depending on peak-day and peak-hour rates of demand compared with average demands. For example, residential customers typically place high summertime lawn irrigation loads on the system and therefore account for a much higher extra capacity requirement compared with average demand than does the industrial class that typically requires water more uniformly throughout the year. Computation of extra capacity requirements is a mechanism for distributing extra capacity costs to customer classes. Fire service demands are based on the requirements of the Insurance Services Office for the system.

Customer-related costs for meters and services can be properly distributed among customer classes by recognizing the factors that are generally responsible for the costs incurred. For example, one method distributes meter reading and services costs to customer classes in proportion to the number of equivalent meters. Distributing billing and collecting costs to customer classes can be in proportion to the number of bills rendered.

Unit costs of service. Component costs can be distributed to customer classes in proportion to the service units applicable to each class. Unit costs of service are based on the total costs allocated previously to functional components and the total number of units of service expected to be used during the test year. The development of costs per unit of service is shown in Table 2.

Unit costs are simply determined by dividing the test year's functionally allocated operation and maintenance and capital costs by the total requirements for units of service in the test year. For example, under the base-extra capacity method of determining the cost of service, the base unit cost for operation and maintenance expense of $0.1928/1000 gal can be derived by dividing the allocated base expense for operation and maintenance of $514 100

by the total base units of service of 2 667 000 thousand gal. Similar computations are made to determine all other unit costs of operation and maintenance expense and depreciation expense.

The unit return is determined by first calculating the unit rate base. The total rate base is divided by the total units of service to yield the unit base rate. Subsequently, a unit return on the rate base is derived by applying the appropriate rate of return to the unit rate base. In this simplified example, a rate of return of 9 percent on the rate base is used.

Total unit costs of service consist of operation and maintenance expense, depreciation expense, and return on rate base. Unit costs of service are applicable to all customer classes. The costs of service directly allocated to fire protection service are also shown in Table 2.

The distribution of costs of service to customer classes is made by applying unit costs of service to customer classes. The total units of service and the unit costs of service for the test year derived from Tables 1 and 2 are summarized in Table 3.

As shown in Table 3, all residential customers are projected to use 928 000 thousand gal of water in the test year, commercial customers 590 000 thousand gal, and industrial customers 1 149 000 thousand gal. Applying the unit base cost of $0.3575/1000 gal to the units of service required by each customer class yields the distributed base cost of service. By definition, the unit base cost is the minimum rate at which water should be sold, if perfect load factors could be achieved (after customer costs are recovered).

Extra capacity costs for maximum-day and maximum-hour service are incurred in providing facilities to furnish water at varying rates above the average rates of use. The responsibility of customer classes for extra capacity costs is determined by applying the unit costs of service to customer class units of service in a manner similar to that used for determining customer class base costs.

Customer costs, which include meters and services and billing and collecting, are usually treated separately in rate studies. Customer costs associated with meters and services can be distributed to customer classes on the basis of equivalent meters and service factors. Billing and collecting costs are distributed to customer classes based on the number of bills estimated to be issued to each class during the test year.

Developing unit costs of service provides two advantages. First, unit costs are a useful tool in allocating total costs to customer classes as shown in Table 3. The unit cost approach demonstrates to all customer classes that the costs allocated to them are computed on the same cost basis. Second, unit costs provide a tool for use in designing rates.

Designing rate schedules

The final step in a cost-of-service rate study is to develop a schedule of rates that will recover, as nearly as possible, the allocated costs of service from customers. Since it is impractical to identify the cost responsibility of individual customers, rates are normally designed to fit average conditions for groups of customers who have similar service requirements.

Service charges. Customer costs, composed of meter and service costs and billing and collecting costs, can be recovered through a service charge. In addition, a portion of distribution main costs and a portion of demand-related costs are often included in service charges. In this example, however, only meter and service costs and billing and collecting costs are included in service charges. The base and extra capacity costs are recovered in the volume portion of the rate.

Table 4 shows how to develop a monthly service charge for retail customers. The unit billing and collecting cost of $2.2881 per bill is based on the projected total number of bills to be issued annually. In this example, it is assumed that billing and collecting costs do not vary substantially from smaller to larger customer accounts. All accounts are billed at a uniform rate of $2.2881 per bill per month.

Since the meter and service cost of $20.8404 is an annual cost, it is divided by 12 to derive the monthly unit cost of $1.7367. A 50-mm (2-in.) meter is assigned a 2.9 ratio factor, indicating the relative difference in cost incurred by the utility to buy, install, and service this meter compared with a smaller 17-mm (5/8-in.) meter. By applying the 2.9 ratio to the unit cost of $1.7367, a total cost of $5.04 is derived for the 50-mm (2-in.) meter. The billing and collecting cost of $2.29 is added to the meter and service cost to derive the total service charge for a 50-mm (2-in.) meter of $7.33, which is rounded to $7.35. Similar determinations are made for each meter size to determine the total service charge.

Once the service charge for each meter size is established, the charge is applied to the total number of customer class bills to determine the total service revenue that will be derived from each customer class.

Declining block rates. A declining block water rate schedule can be designed to recover the costs of serving different classes of customers and to maintain reasonable equity among customer classes. Declining block rates do not reflect quantity discounts but provide a mechanism for recovering costs from residential, commercial, and industrial users based on the differing water demand characteristics associated with providing service to each class of customers. Large-quantity users, as a class, characteristically show a lower peak- to average-demand factor, with correspondingly lower extra capacity requirements and related costs than do smaller-quantity users as a class. Accordingly, a properly designed declining block rate schedule of decreasing charges per unit of service will ordinarily recover revenue from each class commensurate with the cost of providing service to that class.

To design rate blocks and estimate revenues obtained through the designed rates, an analysis of the number of bills rendered to various customer classes at various use levels is necessary. The blocks used for rate design should reflect customer class water usage derived from billing records. Such information can be presented in the form of a bill tabulation showing levels of use for each customer class, the number of bills rendered for each customer class, the cumulative use, and the number of bills rendered at each level of use. This information can then be projected on graphs by means of curves showing the relative percent of total use by each customer class at various levels of use per month (Figure 1).

The curves shown in Figure 1 express the amount of

TABLE 1
Units of service requirements

Customer Class	Base Use		Maximum-Day Use			Maximum-Hour Use			Number of Equivalent Meters and Services	Number of Bills
	Total Annual Use—*1000 gal*	Average Daily Use—*1000 gal*	Capacity Factor *percent*	Total Capacity—*1000 gpd*	Extra Capacity—*1000 gpd*	Capacity Factor *percent*	Total Capacity—*1000 gpd*	Extra Capacity *1000 gpd*		
Residential	928 000	2542	250	6 355	3813	400	10 168	7 626	16 039	190 488
Commercial	590 000	1616	200	3 232	1616	325	5 252	3 636	1 951	12 528
Industrial	1 149 000	3148	150	4 722	1574	200	6 296	3 148	169	120
Fire service				960	960		5 760	5 760		
Total system	2 667 000	7306		15 269	7963		27 476	20 170	18 159	203 136

TABLE 2
Unit costs of service

	Total Cost—*dollars*	Base	Extra Capacity Costs		Customer Costs		Direct Fire Service
			Maximum Day	Maximum Hour	Meters and Services	Billing and Collecting	
Total number of system units of service—*thousand gal*		2 667 000	7 963	20 170	18 159*	203 136†	
Operation and maintenance expense							
Total—*dollars*	1 470 000	514 100	109 500	111 800	239 000	464 800	30 800
Unit cost—*dollars/unit*		0.1928	13.7511	5.5429	13.1615	2.2881	
Depreciation Expense							
Total—*dollars*	213 000	72 000	17 500	52 800	61 500		9 200
Unit cost—*dollars/unit*		0.0270	2.1977	2.6177	6.3868		
Rate base							
Total rate base—*dollars*	9 001 000	4 080 000	576 000	3 221 000	866 000		258 000
Unit rate base—*dollars/unit*		1.5298	72.3345	159.6926	47.6899		
Unit return on rate base‡—*dollars*		0.1377	6.5101	14.3723	4.2921		23 200
Total unit costs of service—*dollars*		0.3575	22.4589	22.5329	20.8404	2.2881	

*Equivalent meters
†Number of bills
‡9 percent

TABLE 3
Cost distribution to customer classes

	Base*	Extra Capacity Costs		Customer Costs		Direct Fire Service	Total Cost of Service
		Maximum Day*	Maximum Hour*	Meters and Services†	Billing and Collecting‡		
Unit costs of service—*dollars/unit*	0.3575	22.4589	22.5329	20.8404	2.2881		
Residential							
Units of service	928 000	3 813	7 626	16 039	190 488		
Allocated cost of service—*dollars*	331 800	85 600	171 800	334 200	435 800		1 359 200
Commercial							
Units of service	590 000	1 616	3 636	1 951	12 528		
Allocated cost of service—*dollars*	210 900	36 300	81 900	40 700	28 700		398 500
Industrial							
Units of service	1 149 000	1 574	3 148	169	120		
Allocated cost of service—*dollars*	410 800	35 300	70 900	3 500	300		520 800
Fire service							
Units of service		960	5 760				
Allocated cost of service—*dollars*		21 500	129 800			63 200	214 500
Total allocated cost of service—*dollars*	953 500	178 700	454 500	378 400	464 800	63 200	2 493 000

*Units of service are 1000 gpd
†Units of service are equivalent meters
‡Units of service are bills

TABLE 4
Test year design of monthly service charges for 17-mm (⅝-in.) and 50-mm (2-in.) meters

	Unit Cost *dollars*	Equivalent Meter and Service Ratio	Cost *dollars*
17-mm (⅝-in.) service charge			
Meters and service-related costs	1.7367 per meter*	1.0†	1.74
Billing and collecting-related costs	2.2881 per bill		2.29
Total			4.03
Rounded total			4.05
50-mm (2-in.) service charge			
Meters and service-related costs	1.7367 per meter*	2.9†	5.04
Billing and collecting-related costs	2.2881 per bill		2.29
Total			7.33
Rounded total			7.35

*$20.8404 annually per equivalent meter divided by 12 bills per year is $1.7367 per month per equivalent meter.
†Ratio of investment in this size meter and related service relative to investment in a ⅝-in. meter and related service

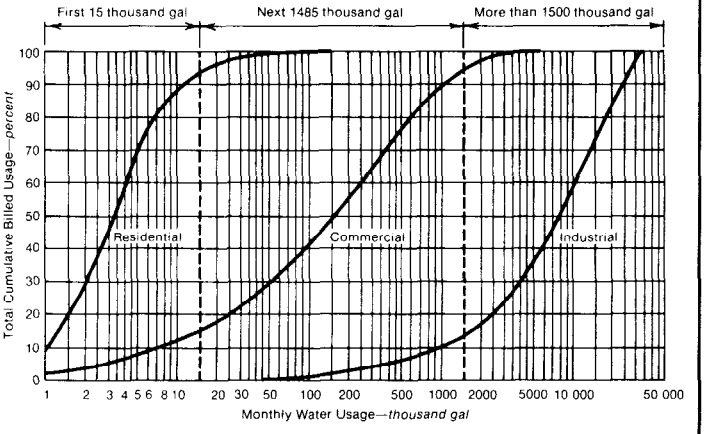

Figure 1. Example of monthly water usage for residential, commercial, and industrial customers

TABLE 5
Test year derivation of typical cost per 1000 gal by water use blocks*

Water Use Block—*1000 gal/month*	Unit Base Cost *dollars/1000 gal*	Maximum Day		Maximum Hour		Total Cost‡ *dollars/1000 gal*
		Extra-Capacity Factor in Excess of Average Day *percent*	Extra-Capacity Cost* *dollars/1000 gal*	Extra-Capacity Factor in Excess of Average Day *percent*	Extra-Capacity Cost† *dollars/1000 gal*	
First 15 units	0.3575	150	0.0923	300	0.1651	0.6349
Next 1485 units	0.3575	100	0.0615	225	0.1388	0.5578
More than 1500 units	0.3575	50	0.0308	100	0.0617	0.4500

*Based on maximum-day extra capacity unit cost of $22.4589/year/1000 gpd divided by 365 days/year (or $0.0615/1000 gal) applied to extra capacity factor
†Based on maximum-hour extra capacity unit cost of $22.5329/year/1000 gpd divided by 365 days/year (or $0.0617/1000 gal) applied to extra capacity factor
‡Total cost per 3785 L (1000 gal) is equal to sum of values shown in columns 2,4, and 6.

TABLE 6
Summary of customer water use by rate block and application of proposed rates

Customer Class	Monthly Usage Block	Use *percent*	Annual Water Use—*1000 gal*	Proposed Rates *dollars/1000 gal*	Revenue Under Proposed Rates *dollars*	Allocated Cost of Service *dollars*	Revenue as Percent of Cost of Service
Residential	Service charge				774 400		
	First 15 units	94	872 300	0.63	549 600		
	Next 1485 units	6	55 700	0.56	31 200		
	More than 1500 units			0.44			
	Total	100	928 000		1 355 200	1 359 200	99.7
Commercial	Service charge				69 400		
	First 15 units	15	88 500	0.63	55 800		
	Next 1485 units	79	466 100	0.56	261 000		
	More than 1500 units	6	35 400	0.44	15 600		
	Total	100	590 000		401 800	398 500	100.8
Industrial	Service charge				3 800		
	First 15 units	0.2	2 300	0.63	1 400		
	Next 1485 units	13.8	158 600	0.56	88 800		
	More than 1500 units	86.0	988 000	0.44	434 800		
	Total	100	1 149 000		528 800	520 800	101.5
Public fire protection annual service charge 1155 hydrants at $186/hydrant					214 800	214 500	100.2
Total					2 500 600	2 493 000	100.3

water used monthly by each class as a percent of the total water used monthly by that class. The cumulative percent of total water used by the class is shown on the vertical scale, and the monthly amount of water used per customer is shown horizontally. The residential customers' usage of 10 thousand gal/month intersects the curve at 88 percent. The 88 percent figure for residential customers represents all of the water used by those customers who use less than 10 thousand gal/month and the first 10 thousand gal/month used by residential customers with usage exceeding 10 thousand gal/month. Similarly, the curves indicate that only 12 percent of the commercial class usage and essentially no industrial usage occurs in the range of 0–10 thousand gal/month.

Such curves provide a basis for selecting usage blocks and estimating by customer class total annual revenues that would be derived from rate designs. The curves for all water systems are usually similar in configuration, often of an ogee type, but the slope and relative location of the curves for any particular utility depend on the type and mixture of customers served by the utility. For instance, the amount of lawn sprinkling that occurs affects the location and shape of the residential curve significantly. The commercial class curve for a large city would represent a composite usage pattern of numerous stores, office buildings, hotels, and other commercial establishments, whereas in the case of a smaller town, the pattern might be subject to the influence of one business or customer.

Comparison of the customer class curves shows the differences in use patterns among the classes of customers. These patterns provide a basis for the proper selection of usage blocks to design a rate structure under which revenues can be derived in accord with the cost responsibility of each class.

An example of rate block selection is indicated at the top of Figure 1. An initial block of 15 thousand gal includes a large portion of the residential water use but relatively little commercial or industrial water use. Accordingly, most residential costs of service, other than service charges, need to be recovered in this first block. Water use and demand cost characteristics of residential service would serve as the predominant basis for the design of rates for the initial block.

The next increment of 1485 thousand gal includes a major part of the commercial class use but only a small portion of industrial water use. The rate for this block should be adequate to recover a large part of the costs of providing commercial service. Water use and demand cost characteristics of commercial customer service are included in the design of the second block rate. The final block encompasses almost all industrial service and the use by commercial customers not covered in the first and second blocks. Therefore, rates for this block would be designed primarily to recover the industrial class costs of service.

The next step after selecting usage blocks is designing an appropriate schedule of rates for the blocks. The design of a water rate schedule, which requires each customer class to pay its full share of the cost of water

service, takes into account the unit costs applicable to the level of service rendered. Unit costs for each component of base cost and maximum-day and maximum-hour extra capacity costs are developed in Table 2. Recognition of the degree to which each component is involved in providing the level of service rendered provides the basis for the design of a schedule of rates.

Table 5 shows how typical costs per unit (1000 gal) are derived for various rate blocks, including base costs and maximum-day and maximum-hour extra capacity costs. The total cost for each block reflects the characteristics of the predominant class of water use that occurs within each block.

Base cost, by definition, is the cost for constant, uniform, or perfect load factors, and the unit cost is the same for all levels of use or classes of service. Accordingly, the variation in the total cost per unit between levels of usage reflects only the difference in extra capacity requirements for classes of service represented by the various levels of use.

The first block of usage consisting of 15 units (15 thousand gal/month) includes 94 percent of the residential class use, 15 percent of the total commercial class use, and almost no industrial use. The maximum-day and maximum-hour extra capacity factors in excess of average-day use selected for the design of the first block rate are representative of residential service.

The next block of 1485 thousand gal/month represents predominantly commercial usage. Therefore, the extra capacity factors used to develop the average cost for water use in this block reflect commercial service characteristics.

The last block, with usage exceeding 1500 thousand gal/month, is primarily industrial water use. Accordingly, the extra capacity factor used to derive the average costs for the last block of the rate schedule is characteristic of industrial water use.

The total cost per unit (1000 gal) is derived by adding the costs in columns 2, 4, and 6, providing an initial basis on which to select potential rates. The costs indicate that a monthly schedule of declining block rates of $0.63, $0.56, and $0.45 per unit of use might be proposed. However, the rates would be subjected to further testing to determine if revenues from each customer class would be sufficient to meet costs of service.

The total costs per unit of use (1000 gal) developed in Table 5 are based on a single set of water-use characteristics selected as representative of all customer use within each block. Actually, the amount and characteristics of use vary among customers within blocks. Detailed rate design studies involve examination of the costs for a range of amounts used and the characteristics of water use for various users within each block. Such variations might indicate that extra capacity factors should be selected to reflect a combination of factors derived from more than one class.

Actual rate designs also recognize that charges for the relatively high capacity factors associated with water use in the initial block may recover costs in excess of costs of service for those customers who have better load factors than residential users and whose use extends into subsequent blocks. The calculated charges for subsequent rate blocks might need to be adjusted downward to account for the costs recovered in lower-use blocks.

The calculated rates should be tested by applying them to customer class water usage to determine if revenues derived from each class will be in accord with the cost of service. At this point in developing the rate schedule, comparison of revenues derived from the designed rates with the cost of service by customer class might indicate that the designed rates would not recover costs of service from one or more customer classes. Selection of slightly different rate blocks or redesign of rates for selected blocks would be warranted. Normally, if designed rates recover the total system cost of service and the costs of service to each customer class within 2 to 3 percent, the rates are adequate.

Table 6 illustrates a test of a rate schedule developed for all classes of service. The final block rates are slightly different from those reflected in the initial schedule of rates developed in Table 5 in order to recover more closely customer class costs of service.

Columns 1, 2, and 3 show the development of total annual water use by rate blocks for each class of service. The percent use by rate blocks is derived from the customer class curves shown in Figure 1. Application of these percentages to the average annual use by each class results in the projected water use by block. The resulting revenues derived from the proposed rates for water usage in each block are shown in column 5. The costs of service by customer class developed in Table 3 are shown in column 6. The revenues expressed as a percent of costs are shown in column 7 and indicate that the proposed schedule of rates derives revenues from all customer classes that conform with the costs of providing service. Indicated deviations from allocated costs for all classes are less than 2 percent and are therefore well within practical allowances.

In actual practice, rates resulting in revenues that meet costs within the limits indicated may involve adjustments in the number of rate blocks, usage allowances in each block, and the block rates. Satisfactory results on the first try would be an oversimplification of the problems usually involved in developing an appropriate schedule of rates.

Summary

The base-extra capacity cost allocation method is a means of determining costs of service for classes of customers and provides a basis for developing rate schedules that recover those costs of service. When appropriate determination of water demand by customer class is made and costs are allocated properly, it is possible to design schedules of declining block rates that recover allocated costs of service from customer classes based on a single set of unit costs applicable to all customers.

Acknowledgment

This article is an adaptation of a paper presented at the 1982 annual conference of the National Association of Water Companies and includes material that was subsequently incorporated into the 1983 edition of AWWA Manual M1, *Water Rates*.

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