CHAPTER 16

THE FRAMEWORK FOR WATER SUPPLY DECISIONS

We have seen from the foregoing that through the application of formal economic analysis the problem of planning municipal water system expansion is amenable to solutions which minimize the total costs to the community. We hardly need point out, however, that the average municipal water system is not planned using a model including drought losses and taking account of the trade-off between these losses and capital costs of safe-yield expansion. The world of municipal water supply management is a world of pragmatists (political and otherwise) who tend to be seeking two goals: they wish to provide the community with safe, low-cost water; and they usually wish to retain or advance their personal positions. Because of the contrast between the "economic man" of sophisticated analytical abilities and the *homo realitus* of community government, we feel it will be useful to describe how planning is actually carried out, who the planners are, what sources of information they have, and how they make use of the information they receive from these sources. Hopefully we will be able to provide in conclusion some comments on the prospects for the inclusion of some tool such as our rules of thumb in the practical planning process.

MAJOR PARTICIPANTS IN THE WATER-MANAGEMENT SYSTEM

Although there are several forms of local government in Massachusetts, they differ only in detail. In these governmental situations, the water-management system itself is usually made up of three component parts, although there may be variations in organization. These parts are the elected community officials, the bureaucratic or departmental personnel, and the external advisors.

Elected Officials

The elected community officials, namely the mayor and the city councilors, are responsible for all functions that the government performs.[1] Final decision-making power on water supply matters rests in the hands of these elected officials. In Massachusetts the city government can authorize the issuance of bonds by the vote of the city council. Town governments, on the other hand, may issue bonds only with the consent of the voting public at town meeting.

Some communities have a board of water commissioners made up of three elected officials who are responsible, in an advisory capacity, for matters relating only to water supply. They have the power to act as agents for the city or town but do not have the power to raise funds.

The ultimate power regarding any large expenditure of funds by the water department rests with the elected officials. The information on the operation and expansion of the water supply system which the elected officials use in exercising this power generally comes from the city water department or from external specialists hired as consultants. Information on the performance of the water supply system (as distinct from its operation) comes to the elected officials from many other sources as well, including members of the general public.

In matters dealing with additions to water supply capacity the elected officials lean heavily on the advice of departmental personnel and consulting engineers. The goal of providing safe, efficient water supply which is built into the elected positions, and which becomes a part of the water manager role, is pursued subject to the constraint that the achievement of the personal goals of the individual officials, such as reelection, prestige, recognition, power, and so forth, is at least not jeopardized.

The mayor of a city (or the manager in the case of a city manager form of government) holds a critical position in terms of water supply, as he

[1] The entire area of the Commonwealth of Massachusetts is divided into municipal governmental units. Municipalities are either cities or towns. There are seven different types of city charter which may be adopted in the state. Space does not permit a discussion of their differences here; but see Commonwealth of Massachusetts, *General Laws*, Ch. 4, Sec. 7. There is only a single form of town government consisting of a board of selectmen carrying out executive functions, with legislative power in the hands of the general citizenry at town meeting. The finance committee of the town meeting is the body which actually allocates money to the selectmen so that town services may be provided. Under most of the *city* charters in Massachusetts this allocative function is performed by the city council. Although there are some towns in our sample, our discussion is simplified considerably by confining our descriptive passages to organization at the city level. In the further interest of simplicity the "typical" city government will be assumed to consist of a mayor or manager performing executive functions and a city council allocating funds.

does in other types of decision-making. It is the mayor who must request the city council to issue bonds or otherwise make funds available. The mayor must also balance the community's demand for water with its demands for all other city services. It is this elected official who most directly reaps the political gains and losses associated with choosing one service over another in the allocation of money.

The city council acts in a more passive way in water supply matters, although there are isolated examples of council members having an active interest in the development of the water system. Such examples generally arise because a councilor perceives some political advantage in using an active voice in water supply matters.[2]

The water supply system retains a unique position in that it is a source of revenue for the city and, at least theoretically, is capable of providing funds for its own development. Financial arrangements dictated by state law are permissive in this regard, and allow the water department to retain a portion of its revenues for future construction if the city government so desires. The fact that only half of the water departments in the 46 municipally operated systems we surveyed retained any control at all over their revenues testifies that the water departments generally must compete for development funds with other city departments.

In addition to the municipal officials, the state legislature also has a supervisory hand in local water management under two provisions of state law. First, it has established the ground rules under which the whole system operates, giving to the Department of Public Health its powers and occasionally creating new entities such as the Metropolitan District Commission. Secondly, it approves all increments of supply that involve crossing of municipal boundaries. In most cases its approval comes quickly as a matter of course. Occasionally, however, the state legislature may actually exercise very strong and direct control over the shape of the urban water supply system.[3] Thus while not a major decision-maker, the state legislature may operate as a constraint and a court of last resort in the provision of water supply.

[2] Two examples show how the councilor may be influential in specific decisions. In one community a councilor was reported to have a reputation for denigrating the recommendations of the water superintendent to the point that personal animosity existed between the two. In another case, a councilor's challenge to the recommendation of a consulting engineering firm resulted in the eventual rejection of expert advice.

[3] See, for example, the discussion of the legislature's role in the Brockton, Mass., water crisis in Roger Kasperson, "Environmental Stress and Municipal Political System: The Brockton Water Crisis of 1961–66," a paper presented at the 1968 Meetings of the Association of American Geographers.

Departmental Personnel

There is wide variance among communities in the structure of water departments themselves. In most places the water department is separate and headed by the water superintendent. In other places the water superintendent may be a member of the public works department.

The typical manager of an urban system in Massachusetts is not an engineer and often lacks any formal technical training. He is usually a municipal employee who began in the system in plant operation, water distribution, or even in meter reading. He rose through the civil service or its equivalent, and his present skills reflect primarily experience and on-the-job training. (See Table 46.) He knows best the distribution problems of the system, for these are his day-to-day concern. For most problems connected with the provision of supply capacity he relies heavily on his external advisers. Problems of projecting demand, choosing further increments of supply, or seeking out alternative sources, are almost universally referred to the consulting engineer in the first instance, and then, for approval, to the Massachusetts Department of Public Health.

TABLE 46. BACKGROUND OF INTERVIEWED WATER SUPERINTENDENTS

Background and training	Number	Percentage of total
City Water Department employee—no special training	23	48
City Water Department employee—with special training	8	17
Long-time employee with engineering degree	7	15
Managerial experience and training in another profession	5	10
Other than above	3	6
Not ascertained	2	4
Total	48	100

Nevertheless the water supply manager is the individual in the community whose role is most directly related to the system. As such he is frequently called upon to present his views as to system needs and expansion to the elected officials and the community at large, and he may prove to be quite influential. Managers do not have impressive knowledge of factors relevant to investment decisions about water supply, such as hydrology, economics of alternative supply, and projection of demand. But since they are deeply committed to the safety of the supply and they desire to satisfy all potential demand at the existing price, they are usually ardent advocates of system expansion and modernization.

External Advisers

On almost all questions that he cannot answer the manager turns to his consulting engineer for assistance. This assistance is provided in two ways: formal preparation of a report; or frequent, informal, personal consultation. In theory, consulting engineering firms prepare specific reports and analyses on the request of a water system. When a new increment of supply is authorized they then design the works and supervise their construction. But most firms also provide informal consultation for which they do not usually bill their clients, much as the family doctor is (or used to be) prepared to give minor advice or even prescriptions by telephone without fee.

The State Department of Public Health is required by law to approve all proposals and plans for public water supply before their implementation. It is responsible for approving the purity of the present supplies and the adequacy and safety of future supplies. Like the consultant engineer, the DPH serves informally, through its district engineers, as a source of advice and counsel in the day-to-day functioning of systems. The files of the department give ample testimony that managers turn to it for advice as well as consent on a variety of problems of supply, treatment, and distribution.

INTERACTION BETWEEN THE SYSTEM PARTS: THE FRAMEWORK FOR DECISIONS

A typical water supply management system is shown schematically in Figure 22. Here, the three key participants identified above interact with each other and with the system's customers. The initial impetus for discussion and decision of a system change may come from the elected officials, department personnel, or the water-users. Department personnel are interested in maintaining a relatively adequate system in terms of safety, aesthetic quality, and abundance. Their interest in price will depend on the pressures on them to be self-supporting and the extent to which they control the allocation of water revenues. They will probably be the source of proposals for expansion in times when the system is apparently performing well, for they have a real interest in insuring continued success and no particular responsibilities for other areas of the municipal budget. Such proposals must be "sold" to the elected officials and their public, and this may be a difficult task in the absence of clear "need." The department may seek out, on its own, the expert opinion of its consultants and use this to bolster its case.

The elected officials can hardly be against safe, clean, cheap, and abundant water, but they do have responsibilities in other areas. Faced with

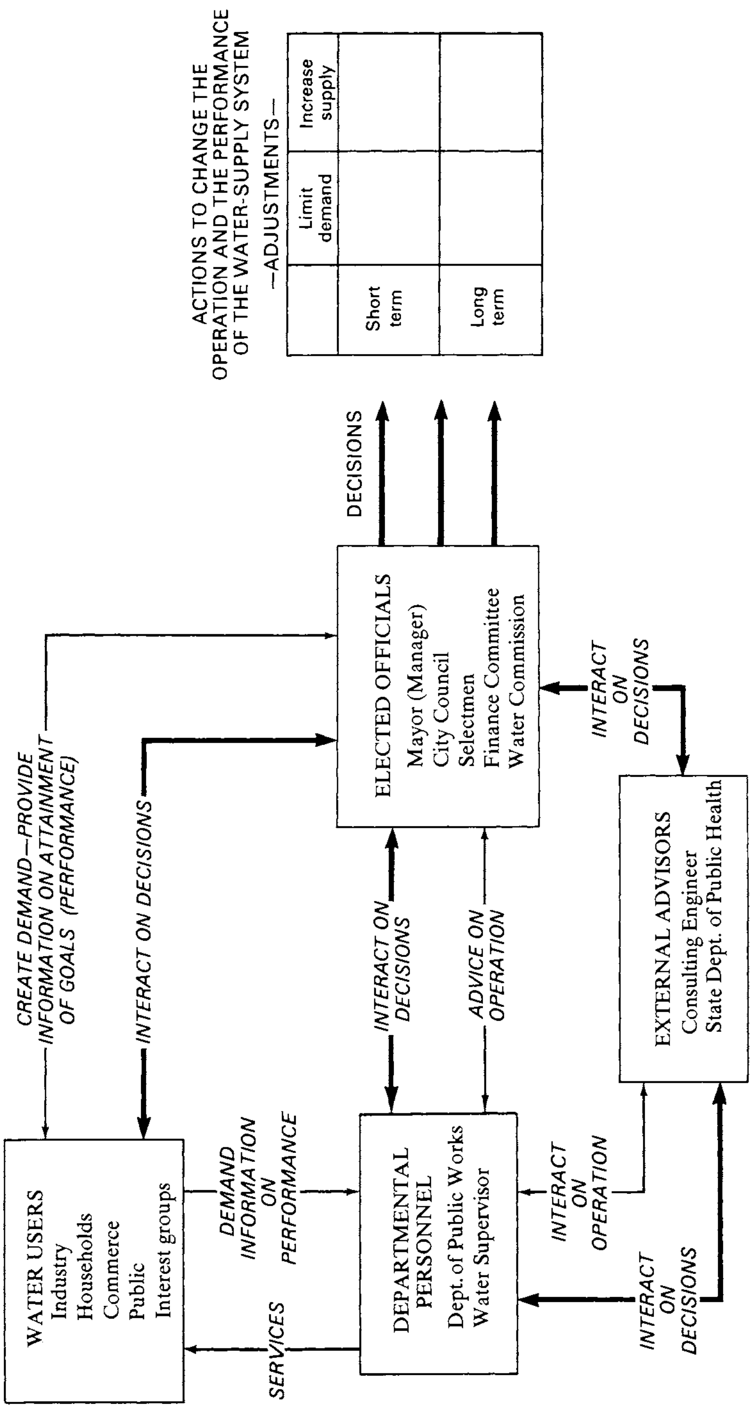

Figure 22. The municipal water-management system.

chronically insufficient local tax revenues, these officials must balance competing interests. They may agree publicly with a system expansion proposal, while maneuvering in private to delay or kill the measure. They may, on the other hand, attack the informational basis of the proposal; for example, by questioning demand projections.

The public, anxious for service, but equally anxious not to see increased debt or taxes may be reluctant to approve system expansion in normal times. If, however, a drought occurs or if distributional inadequacies are exposed, public concern may align itself with proposals for investment in new sources or transmission facilities. Indeed, a serious enough dry spell may find the public or its elected officials taking the lead in demanding system improvement. It seems often to be the case that drought serves in this respect as a determinant of increment timing, creating public acceptance of previously prepared plans. Moreover, as we showed in Chapter 8, it may spark the formulation of additional plans.

In the planning process, the scope of the debate is generally set by the consulting engineers. They define the alternatives, make the demand projections, and provide the cost information. They are, of course, constrained by existing attitudes of both officials and public; for example, it is generally true that all concerned are committed to obtaining "clean, upland sources" and the consultants tend to accept this, giving relatively short shrift to alternatives involving treatment of nearby but polluted sources. Within these constraints, they generally provide the town with a small set of alternatives, and these are generally discrete projects of set size.[4] Certain projects are generally recommended for stated reasons; these usually include some discussion of the implied safe yield of the total system and the projected level of demand. This discussion may give the impression that safe yield is really safe, and no discussion of the economic implications of choosing greater or lesser system adequacy is provided. This is entirely in keeping with the general antipathy among all concerned towards discussion of system failure (shortage) prior to its occurrence.

Now, it is certainly true that in the real world, our actors, even those in the water department, have concerns competing with long-run planning for their attention. We have stressed the planning role because of our interest in the application of better methods in this area. We have indicated, however, in Figure 22 that there are three other important decision categories involving our management system. We have discussed the matter of long-run efforts to limit demand, whether through metering, price changes, or permanent restrictions. We have specifically assumed away these im-

[4] We use "size" here to refer to estimated safe yield. This bit of information is peculiarly the province of the engineers, based as it is on technical methods.

portant areas in constructing our model, after having noted that they are not, in general, popular with managers.

The short-run decisions are typically those necessitated by supply shortage or distributional inadequacies. We have observed and commented on the kinds of short-run decisions made during the recent drought; we also noted that advance planning of such short-run measures as restrictions could have a great impact on long-run needs. But, again, our model takes account of the short run only as such decisions give rise to costs (as of emergency supplies), and we do not attempt to discuss optimal short-run actions.

SUMMARY: THE EXISTING SITUATION AND ECONOMIC OPTIMALITY

It is clear from the above discussion that there are serious obstacles in the way of attaining economic optimality in water system planning. This is true even if we agree to confine ourselves to seeking optimal capacity expansion paths.[5] There are any number of ways to categorize these obstacles, but we choose to divide them into those which are and those which are not in principle amenable to improved methodology.

There are two broad problem areas in the water supply planning process which are essentially immune to improvements in planning techniques. One of these areas is a problem for every management system in the local government structure such as the schools and police; indeed, to mention it is to risk stating a truism. That is, since the decision-making process is tied up with a democratic political process, the influences of personalities and pressure groups will contend with and often dominate considerations of efficiency.[6]

The other such problem area is perhaps unique to water supply, for it is here that public attitudes towards the service provided become quasi-mystical. Water is somehow special; that is the public feeling, and we are hardly the first to note it. This problem, however, is basically one of education, though changing this attitude may take a long and intensive campaign, since the traditions involved are old and the symbolism powerful.[7]

[5] We confine ourselves to efficiency considerations and do not become involved in a discussion of the importance of and method of dealing with other goals, such as the redistribution of income.

[6] This is not necessarily bad. Indeed, it is the essence of the process of making decisions about the provision of public goods. See Robert Dorfman, "General Equilibrium with Public Goods," Working Paper No. 95, Institute of Business and Economic Research, University of California, Berkeley, June 1966.

[7] See R. W. Kates, "Stimulus and Symbol: The View from the Bridge," *Journal of Social Issues*, XXII (1966), 21–28.

Several of the existing obstacles to planning are in principle subject to improvements in methodology. In practice, however, they promise to be with us for a considerable time. Among such long-term practical obstacles is the fact that water supply planning is hampered by the chronic lack of public funds at the local level. As things now stand, the preparation of elaborate optimal plans would seem, as often as not, to be a fruitless exercise for economists and engineers, for actual investment decisions would still be made after balancing competing demands at the political level. This pessimistic view ignores, however, the possibility of truly inclusive local planning. Were the costs and benefits in other areas of municipal concern quantified, one result could be the discovery of the shadow price for investment and/or operating funds within a limited city budget. The iterative process by which optimality might be attained has been described elsewhere.[8] We may confine ourselves to noting that the impact of overall planning on our sub-optimizing model could come through the assumed value of ρ, the discount rate. Instead of naively using the financial cost of capital funds, our planners could use the opportunity cost of funds withdrawn from the next most "productive" use.

Another obstacle which could, in principle, be dealt with is the preference of public and planners alike for clean upland supplies. Difficult as it might be, there is no reason why it should not be possible to measure the strength of people's desires in this regard. Perhaps all that would need be done would be to present alternatives on this issue explicitly—to say, "How much are you willing to pay for clean upland sources?"

A third set of problems which may be attacked via better methods are those surrounding the matter of uncertainty. We have not faced these problems squarely, having fallen back on expected values of losses and having treated only briefly the problems raised by uncertainty in demand projections. There has been and continues to be, however, a great amount of work in this area by professionals of several disciplines. It is conceivable that a practical way could be found to apply some of the more fruitful techniques to local planning problems. It seems most likely that such approaches would first be used in attacking the hydrologic sources of uncertainty, as a growing literature testifies is even now being done.[9] The problem of the uncertainty of demand projections is somewhat more

[8] See, for example, J. Kornai and T. Liptak, "Two-level Planning," *Econometrica*, 33 (1965), 141–69.

[9] For an approach to the evaluation of the relative importance of various sources of uncertainty in investment decisions, see Ivan James, Blair Bower, and Nicholas Matalas, "Relative Importance of Variables in Water Resources Planning," to be published in *Water Resources Research*.

difficult for two reasons: apparently it has a very great impact on the size of the cost incurred; and the probability distributions are particularly ill-defined.

The final problem area we discuss, and the one to which our suggested improvement is addressed, is that of the poor quality of information and the lack of *any* explicit economic considerations (except project cost) in the present planning process. Consulting firms provide population and per capita demand projections for the future. These are seldom of high quality, but, in any case, there is now no information given on the relative costs attached to building the recommended increment now or later or not at all. The lower system adequacy brought about by postponement is treated as a bad thing. Though there may be some discussion of the recurrence frequency of the event required to produce shortage under two different levels of capacity in relation to demand, there is no discussion of what this might mean in terms of losses.