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INTEGRATED RESOURCE PLANNING FOR WATER UTILITIES

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EXECUTIVE SUMMARY

Is integrated resource planning as applied to electricity and natural gas utilities transferable to the case of water? The answer is a resounding "yes," with few caveats. Integrated planning can be considered a generic regulatory approach to the extent that water utilities are comparable to other utilities in terms of applicable performance standards and regulatory principles. If anything, applying planning to water is made easier by the relative straightforward measurement of water (a gallon is a gallon). The structure of the water industry presents a limitation to planning in terms of small systems, but even small utilities can benefit from the planning framework. As planning becomes a higher priority for water utilities and regulators, the interest in planning approaches will grow.

Integrated resource planning is a somewhat more encompassing term than least-cost utility planning, although the two are consistent and can be used interchangeably for most analytical purposes. Least-cost planning emphasizes the least-cost principle, the concurrent consideration of supply and demand options, and a more open and participatory process. Integrated planning subsumes these goals and places additional emphasis on integrating the many institutions involved in water resource policy and planning and the many public policy issues they address. Particularly important is an understanding of the relationship of water utility planning to the activities of various government agencies whose policies may constrain utility planning choices. Nevertheless, the distinction between least-cost planning and integrated resource planning should not be overstated.

In the multijurisdictional realm of water supply where so many government agencies are involved in making water policy, there remains a consensus that the states should maintain primacy. This holds both for matters of water quantity (under the jurisdiction of state water resource agencies) as well as water quality (under the jurisdiction of state drinking water regulators). However, the fragmentation of government roles in water policy and planning remains the greatest obstacle to a fully integrated approach. Unfortunately, the state public utility commissions are not necessarily well integrated within the state water resource policy infrastructure. Even though commission jurisdiction in water is sometimes limited, the potential role of the commissions in planning is not insignificant. At the very least, commissions can help ensure that jurisdictional utility plans are consistent with state water resource plans and policies. At best, commission expertise on issues of price and the least-cost utility planning framework can be of substantial value in other water resource planning processes.

For water utilities, integration of planning activities has both internal and external implications. The least-cost planning literature emphasizes internal coordination of utility management functions (forecasting, financial analysis, engineering, supply management and demand management, and so on). At least as important is the integration of water utility planning externally, such as with other water resource planning processes conducted by state agencies and neighboring utilities. Integrated resource planning also brings with it additional responsibilities for water utilities in such areas as supply conservation, load management, drought planning and management, conservation pricing, and conservation programs.

The success of integrated planning depends on the continued development of analytical tools, especially modeling applications and forecasting techniques designed to address issues specific to the water sector. An integrated planning approach calls for interdisciplinary methods of analysis. Fortunately, the evaluation methods developed for integrated energy resource planning are largely transferable to the water sector. The available methods include criteria for evaluating planning decision instruments, incremental least-cost analysis, program evaluation methods, social acceptability tests, and methods for incorporating externalities and environmental impacts. Public utilities and their regulators need not reinvent the wheel in considering integrated water resource planning but can borrow heavily from existing expertise in this area.

In sum, integrated resource planning is not a panacea for the many problems confronting water supply utilities. Integrated planning does not constitute a blanket approval of utility programs nor does it preclude the assessment of management prudence. A comprehensive, integrated planning approach should enhance other regulatory determinations, but it is not a substitute for them. Planning does require state commissions to adopt a more forward-looking perspective than has been associated with traditional rate base regulation. Admittedly, this orientation means that regulators must contend with substantial uncertainty in regulatory decisions. The difficulties associated with the reliance on incomplete and imperfect information should not become the rationale for delaying consideration of a planning strategy. Instead, these difficulties could become the rationale for cooperation among commissions, utility managements, and other stakeholders to engage in the continual improvement of the integrated water resource planning process.

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FOREWORD

The progression of interest in integrated resource planning for electricity and natural gas public utilities, including research by the NRRI, leads naturally to the analysis of applications to water supply. Growing concerns about the cost of water and its availability also have stimulated interest in planning by water utilities and the agencies that regulate them, including but not limited to state public utility commissions. This report explores least-cost and other approaches to planning that are emerging in the multijurisdictional realm of water.

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Increased attention should be paid to the integrated planning of water management. Integrated policies and legislative and administrative guidelines are needed so as to ensure a good adaptation of resources to needs and reduce, if necessary, the risk of serious supply shortages and ecological damage, to ensure public acceptance of planned water schemes and to ensure their financing. Particular consideration should be given not only to the cost-effectiveness of planned water schemes, but also to ensuring optimal social benefits of water resources use, as well as to the protection of human health and the environment as a whole. Attention should also be paid to the shift from single-purpose to multipurpose water resource development as the degree of development of water resources and water use in river basins increases, with a view, *inter alia,* to optimizing the investments for planned water-use schemes. In particular, the construction of new works should be preceded by detailed study of the agricultural, industrial, municipal and hydropower needs of the area concerned. Water-management plans may be prepared using systems analysis techniques and developed on the basis of already adopted indicators and criteria. This analysis would take into account the economic and social evolution of the basin and be as comprehensive as possible; it could include such elements as time horizon, and territorial extent, and take into account interactions between the national economy and regional development, and linkages between different decision making levels. National policies must provide for the modernization of existing systems to meet the requirements of the present day.

Report of the United Nations Water Conference, 1977

CHAPTER 1

PERSPECTIVES ON WATER RESOURCE PLANNING

On the "blue planet," water is generally regarded as an abundant and renewable resource. Three-hundred twenty-six million cubic miles of water on Earth move through the hydrologic cycle but only 0.3169 percent of this water is freshwater accessible for human use.[1] The *Global 2000 Report to the President of the U.S.* describes water as ubiquitous, heterogeneous, renewable, and as something often treated as common property, used in vast quantities, and inexpensive relative to other commodities.[2] Of water's many interesting characteristics, one that stands out is that water is fugitive in both space and time.[3] Put another way, water is not always where it is needed, when it is needed despite its natural global abundance and renewability. Moreover, water resources are not renewable to the extent they become artificially contaminated or drawn down beyond the capacity of nature to replenish them, and because water resource development consumes nonrenewable resources, namely energy.

Today, the water resource debate is an issue of global significance.[4] Some say that a "water crisis" may be at hand.[5] Though the availability of water resources may vary, the need to set priorities and resolve intersectoral conflicts over water

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[1] Andrew A. Dzurik, *Water Resources Planning* (Savage, MD: Rowman and Littlefield Publishers, Inc., 1990), 11. On hydrology, see C. W. Fetter, *Applied Hydrogeology* (Columbus, OH: Merrill Publishing, 1988); and Brian J. Skinner, *Earth Resources* (Englewood Cliffs, NJ: Prentice-Hall, 1986).

[2] As cited in David H. Speidel, Lon C. Ruedisilli, and Allen F. Agnew, eds., *Perspectives on Water: Uses and Abuses* (New York: Oxford University Press, 1988), 4-5.

[3] Kenneth D. Frederick, "Water Policies and Institutions," in Speidel, et al., eds., *Perspectives on Water,* 335.

[4] United Nations, *Water Resources Planning to Meet Long-term Demand: Guidelines for Developing Countries* (New York: United Nations, Natural Resources/ Water Series No. 21, 1988); and Sandra Postel, "The Consequences of Mismanagement," in Speidel, et al., eds., *Perspectives on Water,* 307-25.

[5] For a discussion, see Frank Welsh, *How to Create a Water Crisis* (Boulder, CO: Johnson Books, 1985); and Terry L. Anderson, *Water Crisis: Ending the Policy Drought* (Washington, DC: CATO Institute, 1983).

use can be found in most corners of the world. At an abstract level, water resource planning is directed at these issues.

A variety of perspectives on resource planning, applicable to public utilities in general and water utilities in particular, is available. This chapter introduces various aspects of water resource planning. Traditional water supply planning is contrasted with least-cost and integrated resource planning. The chapter concludes with a discussion of some of the unique issues associated with applying integrated resource planning to water utilities.

The Purpose of Planning

Planning is a general decisional process for choosing a course of action based on its estimated future impact. Government agencies are known for planning but private organizations plan as well. Both entities are involved, to one degree or another, in water supply planning.[6] A schematic of the formal or rational planning process appears in figure 1-1. The basic steps involved in planning are:

- Problem identification.
- Design of alternative solutions.
- Comparison and evaluation of alternatives according to specified criteria.
- Development of a plan to implement the selected project or solution.
- Monitoring and evaluation of the project such that planning is an ongoing process.

In reality, planning is not always so systematic and rational. The complexities of public policy issues and political environment in which they are defined influence the planning process. Planning assumes a rational decisionmaking paradigm and the limitations of that paradigm are well documented.[7] It is not realistic, however, to

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[6] This report is organized according to federal and state roles in water resource planning (chapter 2), the state public utility commission role (chapter 3), and the public utility role (chapter 4).

[7] For a discussion, see Paul J. Culhane, H. Paul Friesema, and Janice A. Beecher, *Forecasts and Environmental Decisionmaking: The Content and Predictive Accuracy of Environmental Impact Statements* (Boulder, CO: Westview Press, 1987).

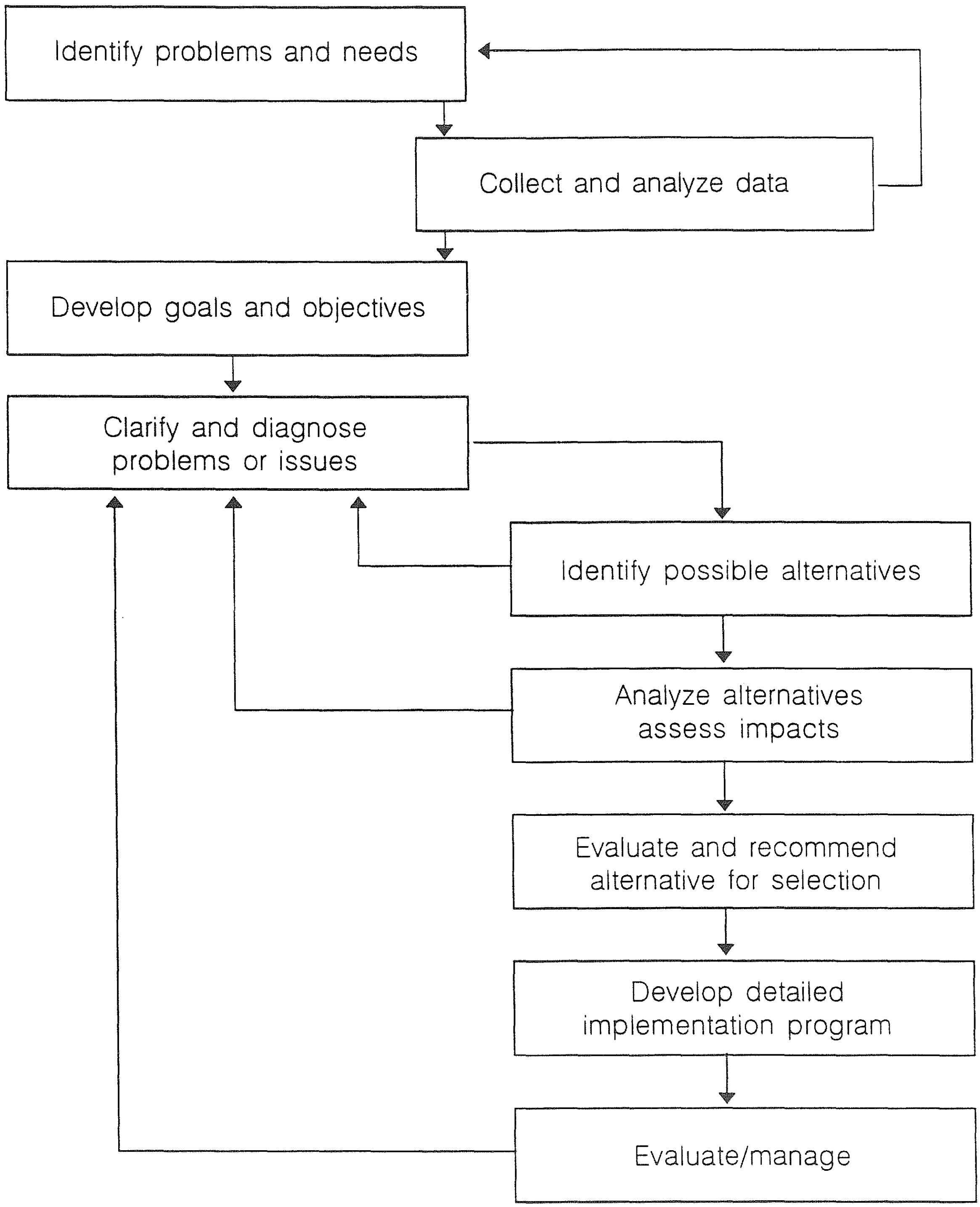

Fig. 1-1. The planning process as depicted in American Society of Civil Engineers, Urban Planning Guide (New York: American Society of Civil Engineers, 1986), 9.

suggest that planning must be perfectly rational or scientific. It also is a strawman to suggest that planning is inappropriate because it is not always done very well. The issue is not whether planning is without imperfection, but rather whether decisionmaking is better off with planning than without it.[8] Part of "the water problem" is knowing what the problem is:

> Diagnosis of the nation's water supply systems is difficult. The systems are decentralized. Climatic, geophysical and socioeconomic conditions vary widely even within small geographic regions making problems site specific and hard to generalize. A review of the nation's municipal and industrial (M&I) water supply problems and issues by the General Accounting Office in 1979 concluded that the Federal Government does not know how bad the problems are: 'We can only guess.'[9]

The impetus for planning is in part a desire to replace guesswork with some level of analysis. Advocates of planning are generally willing to accept a certain degree of imperfection in order to get the improvement that planning brings, especially in the identification of alternative courses of action. Different disciplines might take different approaches in defining the goals of planning and the alternatives appropriate for consideration. For this reason, one way to optimize planning results is to take an interdisciplinary approach to analyzing a range of alternatives. According to the United Nations:

> Planning aims at the optional use of available resources. Water resources development planning involves examination of short-term and long-term needs and ways to meet these needs. It involves the comparative evaluation of alternative solutions with respect to their technical, economic, and social merits. Planning means looking into the future and looking from a broad spectrum of disciplines.[10]

The product of planning varies with the time frame and scope of analysis. A short-term plan for a small geographic area will probably be more focused than a

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[8] Ibid. The environmental impact statement process is a useful analogy. While these statements are not instruments of perfect rationality, they do enhance the quality of decisionmaking.

[9] U.S. Army Corps of Engineers, *The State of the States in Water Supply/ Conservation Planning and Management Programs* (Fort Belvoir, VA: Institute for Water Resources, U.S. Army Corps of Engineers, 1983), B-1.

[10] As quoted in Neil S. Grigg, *Water Resources Planning* (New York: McGraw-Hill, 1985), 20.

long-term plan for a large area. The more focused plan is likely to address specific resource management issues. By contrast, resource plans for states or regions tend to be less specific. However, they can be used to set out general policy principles that more specific plans can follow. Thus a plan may be a detailed document or a broad statement of policy. The existence of a plan does not ensure institutional support for implementation and enforcement; some of the best laid plans may lie unnoticed. Many plans, however, have a substantial impact on the plan subject.

Applying a natural resource perspective, Andrew Dzurik distinguishes between comprehensive planning and single-purpose or functional planning.[11] Comprehensive planning is usually administratively centralized and broad in scope, covering overall priorities for the planning agency's entire jurisdiction (federal, state, or local). By contrast, functional planning is directed at topics or resources of primary interest, such as water resources. Similarly, the United Nations defines three general types of planning on the basis of scope: multisectoral national planning, which involves coordinated planning across all sectors of the economy; sectoral planning, which entails integrated planning within a sector; and functional planning, which is designed to meet a specific need within a sector.[12]

For water resources in particular, variations in planning scope can be used to categorize the many different types of planning activities within this sector. In a 1972 report, the National Water Commission described four key stages of planning, examples of which appear in table 1-1:[13]

> **Policy planning:** definition of overall goals and program objectives, policy development, overall budget and priority analysis, dissemination of program guides, and evaluation of results.
>
> **Framework planning:** identification of general problems and needs, outlining a range of possible alternatives futures, inventory of available resources and general opportunities, assessment of overall adequacy of resources, determination of need for further specific investigations.
>
> **General appraisal planning:** broad evaluation of alternative measures for meeting hypothesized goals and objectives, with recommendations for action plans and programs by specific agencies or entities.

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[11] Dzurik, *Water Resources Planning,* 83.

[12] United Nations, 23.

[13] As reported in Grigg, *Water Resources Planning,* 38.

TABLE 1-1
WATER RESOURCE PLANNING ACTIVITIES BY SCOPE

Policy planning
- Assess broad national needs
- Hypothesize national goals and objectives
- Identify problems and opportunities in achieving goals
- Identify costs and benefits in achieving goals
- Recommend goals and objectives
- Recommend policy choices
- Coordinate national priorities
- Review programs for achievement of goals

Framework planning (regional basis)
- Inventory and evaluate available data
- Assess present and future water use and environmental needs
- Assess available water and related land resources
- Evaluate general regulation potential and identify water quality management approaches
- Inventory present status of development
- Inventory general means available to satisfy needs
- Assess general alternatives to meet different goals
- Identify problem areas that need priority attention
- Recommend actions that can be taken at present and those that require further study

General appraisal planning (local and regional projects, measures, or areas)
- Estimate present and future water use and environmental needs
- Estimate available water and related land resources
- Make preliminary evaluations of alternative water quality management approaches
- Make preliminary estimates of costs, benefits and consequences of specific alternative projects and measures
- Compare alternative projects and measures
- Devise alternative early action and future programs
- Recommend specific early action and alternative future programs, including selection of projects or measures for implementation study

Implementation planning (specific projects or measures)
- Evaluate specific water use and environmental needs
- Evaluate available water and related land resources
- Evaluate regulation potential for different degrees of storage
- Evaluate degree of water quality control with different types of facility
- Prepare conceptual designs and cost estimates
- Make economic analyses of benefits and consequences
- Make financial analyses to demonstrate payout
- Compare alternatives on basis of costs, benefits and payout
- Recommend an alternative to be selected
- Recommend concerning authorization

Source: Adapted from National Water Commission (1972) as reported in Neil S. Grigg, *Water Resources Planning* (New York: McGraw-Hill, 1985), 39.

> **Implementation planning:** investigations of a specific structural or nonstructural measure, or system of measures, in sufficient detail to determine whether it will serve intended purposes in a manner consistent with established goals, objectives, and criteria and, if so, whether it is physically possible to implement it within estimated costs and within limits of financial feasibility.

The type of planning that public water utilities can perform is generally of the implementation variety. That is, the planning purpose is specific and such issues as costs and benefits are the focus. It takes the form of either traditional supply planning or integrated planning. However, all of the more general planning activities occurring in the water sector may have implications for planning by utilities. At times, these implications may constrain utility options.

Water resource planning can serve a variety of purposes, not the least of which is political. Neil Grigg explains:

> Water planning is needed at different levels and for different purposes of water management. Planning is needed to site a new water supply reservoir or a wastewater treatment plant. Planning is also needed to develop integrated, multipurpose development plans for a river basin. And planning is needed to develop the best policies for the regulation of contaminants that are discharged into waterways. All of these purposes, and more, are part of the general water planning picture. They interact, and planning for water resources must take into account the integration of different purposes and interests if it is to be effective. John Kennedy is said to have said, 'Anybody who can solve the problems of water will be worthy of two Nobel Prizes--one for peace and one for science.'[14]

Grigg identifies six encompassing water issue areas: toxic pollutants in the water, water shortages, safe drinking water, high cost of water, wastewater handling, and water politics.[15] It is easy to see many intersections among these issues. Water shortages, for example, can result from water pollution as well as drought and are associated with higher costs. Pollution of water sources and contamination at the tap are companion issues.

Perhaps most encompassing is the issue of water politics, which historically and today pervades virtually every aspect of decisionmaking in the water policy arena. Politics involves allocation decisions and conflict over those decisions,

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[14] Grigg, *Water Resources Planning,* 3.

[15] Ibid., 56.

which makes water an ideal subject for political study.[16] Public water suppliers know, for example, that as costs and prices escalate, so do water politics. The pressing and sometimes emotional nature of the many issues associated with water serve to fuel the political nature of water. Water management and planning is in part a method for mitigating the more contentious side of water politics.

Political issues tend to attract participants having a stake in the outcome of policy decisions. In water resource planning, the potential participants in water resource planning are numerous. Table 1-2 lists the parties with a vested interest in this area, categorized as producers, ancillary industries, consumers, and regulators. The presence of many participants adds to the complexity of planning and increases the potential for conflict. Water involves many competing beneficial uses.[17] It is easy to find uses for water, but often harder to define priorities for water use that will satisfy all of the parties involved. One purpose of planning, then, is to respond to the competition for water.[18]

Because the uses for water are multidimensional, so is water planning and management. Different water sectors are associated with different planning issues, decisions, and goals. Grigg identifies several water management areas in which planning is used for both capital investment and operational decisions.[19] Each planning area tends to be dominated by federal, state, local, or private concerns, or some combination, as seen in table 1-3 Water resource planning orientations are not always the same. While cost effectiveness is a decision criterion for both water supply and wastewater treatment, preservation and enhancement of species is the goal of fish and wildlife planning. Also, the potential for competition between uses (such as water supply and recreation) means that a coordinated, integrated approach may be hard to achieve.

Institutional support for water resource planning is mixed. Despite the long history of federal, state, and local involvement in water resources, planning has not

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[16] The long-standing definition of politics comes from the title of Harold D. Lasswell's, *Politics: Who Gets What, When and How* (New York: McGraw-Hill, 1938).

[17] Robert Clark, *Water and Water Rights* (Indianapolis, IN: The Allen Smith Company, 1978).

[18] For example, Kenneth D. Frederick and Allen V. Kneese, *Competition for Water* (Berkeley, CA: University of California Press, 1984).

[19] Grigg, *Water Resources Planning,* 50.

TABLE 1-2

PARTIES AFFECTED BY WATER RESOURCE PLANNING

Producers	Privately owned water utilities Publicly owned water utilities Privately owned wastewater utilities Publicly owned wastewater utilities Self-suppliers (water and wastewater) Bottled water/sparkling water providers
Ancillary Industries	Engineering, economic, and legal consultants Construction industry and well drillers Equipment and supply manufacturers and distributors Agricultural and domestic irrigation system providers Metering and other instrumentation providers Point-of-use filtration/purification providers Professional, technical, and educational associations Banking and insurance industries University research organizations
Consumers	Residential and commercial water users Industrial and mining users (processing and cooling) Agricultural users Hydroelectric power producers Navigation users Recreational users Fish and wildlife
Regulators	United States Environmental Protection Agency Other federal agencies State drinking water regulators State economic development/commerce agencies State environmental protection agencies State natural resource departments State public utility commissions State transportation departments State water supply planning and management agencies State governors Other state agencies Interstate and river basin agencies Intrastate and regional agencies Local government agencies

Source: Authors' construct.

TABLE 1-3

WATER RESOURCE PLANNING BY MANAGEMENT AREAS

Water Management Areas (Primary responsibility*)	Capital Investment Plans	Operating Plans
Municipal water supply (L)	Cost effectiveness	Contingencies, best use of facilities
Irrigation (F,S,L,P)	Best construction of systems	Best use of water and money
Industrial water supply (P)	Cost effectiveness	Contingencies, best use of facilities
Energy cooling water (P)	Development of supplies	Best use of facilities, meeting standards
Hydropower (F,P)	Development of economic power	Maximization of energy production
Wastewater treatment (L)	Cost effectiveness	Meeting standards, reducing costs
Navigation (F)	National economic efficiency	Operation of facilities
Flood damage reduction (F,S,L)	Optimum facilities	Optimum operation
Urban drainage (L)	Plans for economical systems	Maintenance, warning, etc.
Agricultural drainage (L)	Plans for systems	Operation of systems
Watershed management (L)	Best plans	Maintenance and operation
Recreation (F,S,L)	Development of facilities	Effective operation
Fish and wildlife (F,S)	Preservation and enhancement of species	Effective operation
Ecological and unique systems (F,S)	Preservation of systems	Not applicable

Source: Adapted from Neil S. Grigg, *Water Resources Planning* (New York: McGraw-Hill, 1985), 50. * F = federal; S = state; L = local; P = private.

always been a priority. The demise of the National Water Resources Council is clearly associated with the slippage of water from the national agenda. Today, national water policy exists only in the form of broad environmental principles and agency-specific and program-specific measures. There is no national water policy, at least not some document for researchers and attorneys to consult when issues arise. Of greater practical importance is planning at the state level by water resource and development agencies and, potentially, planning by regulatory agencies. This is not to say that state drinking water regulators (vested with water quality jurisdiction) or state public utility commissions (vested with economic regulatory powers) will become water planning agencies; today, in general, they are not regarded as prominent participants in existing state planning processes. However, these agencies constitute essential parts of the water sector, as do the public utilities they regulate. A more broadly defined state water planning process would ensure the participation both of utilities and their regulators, which in turn would enhance the effectiveness of the outcome.

Water Planning Philosophies

Planning of all types raises philosophical issues that have a direct bearing on public policy choices, and water resource planning is certainly no exception. David Prasifka contrasts two competing water supply philosophies.[20] The first is based on traditional criteria for evaluating new projects (economics and operational feasibility) and conservative assumptions about future conditions affecting water demand. This philosophy favors the investment in utility-owned facilities that will assure an uninterrupted level of supply under all conditions. Although the approach may result in excess capacity, if construction costs are not tremendously high and the customer base is sufficient, the rate impact may not be substantial. Areas experiencing demand growth may eventually need the capacity and thus enjoy the economies of scale that the facilities offer. In the developing world, this philosophy (sometimes known as a "hardware bias") has at times resulted in

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[20] David W. Prasifka, *Current Trends in Water-Supply Planning* (New York: Van Nostrand Reinhold, 1988), 22.

overbuilding national water supply infrastructures to the perceived detriment of other needed programs and national economies as a whole.[21]

The second philosophy takes other factors into account, including the impact of construction on rates. Relying on risk management, facilities are designed and built to provide less than a continuous level of supply. For the periodic shortfall in supply as occurs during a severe drought, consumers are called upon to conserve water. In return for sacrifices in lifestyle and convenience, ratepayers do not pay for peak capacity that would only be used under the driest conditions. The method assumes that consumer attitudes and behavior can be "predicted" and incorporated into the planning model. Water supply managers inclined to embrace this philosophy are more inclined to share facilities with other water suppliers and promote water efficiency and conservation.

Philosophical differences also are apparent in the conception of "safe yield," a guiding principle in water resource development. Historically, the term was used to refer to the amount of water that could be pumped "regularly and permanently without dangerous depletion of the storage reserve."[22] C. W. Fetter provides a composite definition of safe yield that has contemporary relevance because it considers additional constraints. In his terms, safe yield is "the amount of naturally occurring ground water that can be withdrawn from an aquifer on a sustained basis, economically and legally, without impairing the native groundwater quality or creating an undesirable effect such as environmental damage."[23]

Competing philosophies can be reconciled. One such attempt was advanced with the concept of "sustainable development," which was advanced by the United Nations in 1980.[24] Those ascribing to the philosophy support economic development to the extent it takes long-term environmental consequences into account; it is a limited form of development. Growth is replaced by sustainability as the goal.

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[21] United Nations, *Water Resources Planning,* 26.

[22] Fetter, *Applied Hydrogeology,* 450.

[23] Ibid. The term "safe yield" is comparable to terms that apply in other natural resource areas, such as "maximum safe yield" in timber production.

[24] D. M. Tate, *Water Demand Management in Canada: A State-of-the-Art Review* (Ottawa, Canada: Water Planning and Management Branch, Inland Waters Directorate, 1990), 4.

Resource replenishment and demand management, including conservation, are essential parts of the emphasis on sustainability.

The problem many water planners continue to face is the tension between source development for water supplies and conservation. According to a survey of state water plans published by the U.S. Army Corps of Engineers, water planners "fear environmentalists are using water conservation as a ploy to divert energies away from future water supply development" and "sometimes fail to realize that new source development and consideration of conservation go hand in hand."[25]

As noted in the Corps study, the consideration of water conservation measures on an equal basis with water supply planning means that the full assessment of future water needs will address:[26]

- Demand reduction and waste elimination practices.
- More efficient use of existing supplies.
- New supply development including both surface and groundwater for drought as well as periods of normal water availability.

Duane Baumann and colleagues defined conservation as "the socially beneficial reduction of water use or water loss."[27] This definition extends the consideration of conservation and demand management to the consideration of social welfare. Water planners are beginning to recognize that water conservation is not simply a short-term drought management tool, but one that can be compared with supply options and integrated into long-term planning. Also, planners are expanding their attention to encompass municipal and industrial water purveyance in addition to agricultural use in recognition of the substantial impact of urban water use on water resources, particularly during periods of drought.

The result of one Corps of Engineers workshop was the assertion by participants that "The integration of supply and demand management alternatives

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[25] U.S. Army Corps of Engineers, *The State of the States,* B-10.

[26] Ibid., "Preface," iii.

[27] D. D. Baumann, J. J. Boland, and J. H. Sims (1980) as cited in Tate, *Water Demand Management in Canada,* 4.

must be balanced for effective water conservation programming."[28] Moreover, it was observed that:

> While water conservation should first be more clearly aligned with water supply planning activities, opportunities for the integration of conservation strategies within wastewater planning and management activities must not be overlooked. In view of escalating costs for constructing wastewater treatment facilities, coupled with an increased local share of these costs, conservation opportunities and flow reduction potential should be carefully scrutinized prior to investing tremendous amounts of money in wastewater collection and treatment facilities. Federal, state and local cost sharing arrangements and incentives need to be examined for consistent treatment of both demand and supply management measures including wastewater treatment considerations.[29]

Conservation continues to be a source of philosophical and public policy controversy, and a sore subject for those who put great faith in water's natural abundance and equate conservation with the unjustified curtailment of water use. However, the emergence of a conservation or wise-use paradigm in the water sector is partially responsible for the reexamination of traditional water utility planning. This evaluation parallels, but lags behind, a comparable analysis of traditional planning by electricity and natural gas utilities.

Approaches to Planning

Most public utilities are quick to point out that they have always "planned." Replacements, improvements, and additions to capacity do not happen automatically or casually, but through planning. Today, utility planning can generally be organized into three types: traditional supply planning, least-cost planning, and integrated resource planning. Each approach is described below.

Traditional Supply Planning

Traditional planning for water utilities is not that different from traditional planning by electricity utilities, which can be characterized by its focus on utility ownership of all resources (including central-station power plants), its reliance on

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[28] U.S. Army Corps of Engineers, *The State of the States,* 9.

[29] Ibid., "Preface," iii.

system and financial planning processes internal to the utility, and its emphasis on the goals of minimized electricity prices and maintaining system reliability.[30]

There are two principal complaints about the traditional approach. The first has to do with the treatment of demand management options. According to a planning handbook of the National Association of Regulatory Utility Commissioners:

> With traditional utility planning, the planner takes into consideration the demand to be met, the reliability to be achieved, and the applicable state and federal regulations regarding safety and the environment to be complied with. Then he or she selects the types of fuels, power plants, distribution systems and patterns, and power purchases that will meet these objectives with the minimum revenue requirement. Two aspects of this type of planning should be noted. Demand is taken as a 'given' as opposed to a variable that can be altered. And options are selected only from the supply side (as opposed to the consumption or 'demand' side) of the electricity system. Traditional utility planning makes no attempt to integrate supply and demand-side options.[31]

The second principal complaint about traditional planning is that the public at large, outside experts, and government regulators (public utility commissions in particular) generally have little or no involvement in traditional utility planning. The forecast of demand and analysis of alternatives takes place within the utility; only the final product is presented to the commission for approval. Depending on its jurisdiction, commission review may occur through a certification hearing for a new facility, or it may be removed further in states where the rate case is the first and only opportunity for oversight and approval. In the latter case, the plan essentially has been implemented with few decisions left to make. Moreover, traditional water supply planning also tends to be utility specific. That is, development and evaluation of supply alternatives are made for individual utilities in isolation. The decisionmaking process serves to exclude parties who not only have a vested interest but who may provide important input.

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30 Eric Hirst, Charles Goldman, and Mary Ellen Hopkins, "Integrated Resource Planning for Electric and Gas Utilities," a paper presented at the conference on Energy Efficiency in Buildings sponsored by the American Council for an Energy-Efficient Economy (August 1990), 2.

31 National Association of Regulatory Utility Commissioners, *Least-Cost Utility Planning Handbook for Public Utility Commissioners, Volume 1* (Washington, DC: National Association of Regulatory Utility Commissioners, 1988), 9.

In sum, there is a tendency for traditional planning to be narrowly focused and exclusionary:

> [The] traditional electrical power planning process has several shortcomings. First, traditional electric utility planning is supply-side-dominated in that the utility is not required to give equal consideration to supply-side and demand-side options. Second, the traditional planning process limits the criteria for project evaluation; generally it focuses on traditional financial and economic considerations. This occurs because the utility's selection criteria reflect private interests rather than social interests and because regulators consider only the utility's specific proposal rather than pursuing a comprehensive plan for meeting energy needs over time. A final shortcoming is the restriction the traditional process places on the range of participating parties. Intervenors who may be concerned about regional energy needs, environmental quality, or social issues find it difficult to become involved, particularly in the early stages of planning.[32]

Not unlike other types of public utilities, the planning processes undertaken by water utilities have, throughout the years, been controlled internally and dominated by supply considerations. The result has been an emphasis on maintaining dependable water supplies and, accordingly, the engineering of facilities for source development, treatment and storage, and transmission and distribution of water. Water supply planning generally takes the form of forecasting future demand and developing and analyzing supply options to meet the projected demand level. The result is a disaggregated planning approach that considers only new supply alternatives, while initiatives in the areas of demand management and conservation are consigned to separate programs.

Engineering considerations have always been central to water utility planning, at times to the exclusion of other perspectives.[33] The emphasis on supply options can result in additions to capacity that outpace growth in demand, which is a problem familiar to the electricity industry. Water's natural abundance may explain why the central water supply issue is that of engineering water delivery (getting water to where it is needed), rather than the management of water demand. In fact, an historical presumption is that there always would be enough water to go

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[32] Mark Hanson, Stephen Kidwell, Dennis Ray, and Rodney Stevenson, "Electric Utility Least-Cost Planning," *Journal of the American Planning Association* 57, no. 1, Winter 1991 (Chicago, IL: American Planning Association, Winter 1991): 35.

[33] Engineering does, however, take into account the benefits and costs of supply projects.

around and that water would generally be so inexpensive that investments in demand-management would not be cost effective. A cultural element also favors the supply side, as Thomas Stack explains:

> [I]n the past, only supply-side cost was considered. It was the virtually universally accepted standard that the public was entitled to use all the water they wanted, provided they were willing to pay for the water used. The only exception was during water shortages and even then the utility was expected to either construct additional facilities or find an additional supply so that the public could again use all the water it wanted.
>
> That attitude is beginning to change. . . .[34]

The shortcomings of traditional planning gave rise to the current interest in least-cost or integrated resource planning.[35] The changes that may be underway in the water sector follow the path of least-cost energy planning.

Least-Cost Planning

Frustration with the rising costs associated with capacity additions, as well as concern for environmental externalities and other considerations played a role in the emergence of least-cost planning in the 1980s as an essential tool of economic regulation of the electricity, and, to a lesser extent, natural gas utilities. In many jurisdictions, the concept of least cost can now be counted among the fundamental regulatory standards.[36] In fact, the emergence of least-cost planning may be changing the face of regulation altogether. According to its proponents, planning allows regulators to be more "proactive," that is, to actively affect utility decisions rather than simply react after decisions have taken place.

The National Association of Regulatory Utility Commissioners (NARUC) *Least-Cost Utility Planning Handbook* provides the following definition:

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[34] Thomas R. Stack, "Least-Cost Planning for Water Utilities from the View of a State Regulatory Staff Member," *NAWC Water* 30 no. 3 (Fall 1989): 20.

[35] Hanson, Kidwell, Ray, and Stevenson, "Electric Utility Least-Cost Planning," 35.

[36] Just and reasonable, used and useful, and investment prudence are examples of other standards applied frequently in modern regulation.

> Least-cost planning is a way of analyzing the growth and operation of utilities that considers a wide variety of both supply and demand factors so the optimal way of providing electric service to the public can be determined. A path is chosen that will ensure reliable service for the customers, economic stability and a reasonable return on investment for the utility, environmental protection, equity among ratepayers, and the lowest costs to the utility and the consumer. A least-cost plan balances three interests (reliability, profitability, and affordability) while keeping a sharp eye on the risks and uncertainties associated with each component of the plan.[37]

Soon after its introduction, a wave of research focused on the meaning of the concept of "least cost," including a protracted controversy about the issue of the term's hyphenation. Although least cost can be translated into cost or technical efficiency (attempts at cost minimization), in practice, there are multiple and sometimes competing definitions of the least-cost concept.[38] Different definitions emphasize the minimization of rates, customer bills, utility revenue requirements, and production (both capacity and operating) costs.

Definitions are not trivial matters, particularly when they shape fundamental public policy choices and political debates. Regulators and utility managers, for example, do not necessarily have identical views about the meaning of least-cost planning. According to one survey, "regulators tend to view least cost planning with an emphasis on conservation whereas utilities tend to regard least cost planning as an integrated supply and demand analysis."[39] Eric Hirst has addressed the issue of "what's in a name":

> The name 'least-cost' planning is, in my view, an unfortunate choice. It implies the existence of a single, optimal solution. Identification of this optimal mix of demand and supply resources will, according to the LCUP paradigm, yield least cost. This implicit notion that the single best solution can be identified and implemented ignores the fundamental problem of uncertainty. The lack of knowledge about future load growth,

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[37] National Association of Regulatory Utility Commissioners, *Least-Cost Utility Planning Handbook, Volume 1,* 1.

[38] Cynthia K. Mitchell, "Application and Utilization of Cost-Benefit Analysis in the Evaluation of Competing Resources," *Proceedings of the Fifth Biennial Regulatory Information Conference, Volume 3* (Columbus, OH: The National Regulatory Research Institute, 1986), 2043-54.

[39] Hayes and Sheer (1987) as reported in Arizona Corporation Commission, *Regulatory Institutions for Least Cost Energy Planning* (Phoenix, AZ: Utilities Division, Arizona Corporation Commission, 1987), 5.

> construction costs, environmental regulations, and inflation rates (to mention only a few of the important uncertainties) suggests that utilities carefully consider resources that can be purchased in small amounts and that can be constructed quickly. Neither leadtime nor unit size are encompassed by the notion of least cost.
>
> It is unclear whether least cost implies minimization of utility revenue requirements, electricity prices, electricity-service costs, or energy-service costs. . . .
>
> Similarly, it is unclear for whom least costs are to be provided: existing customers, future customers, utility shareholders, or society at large. . . .[40]

Least-cost planning has come to be understood as the comprehensive evaluation of all supply and demand alternatives with the end result, in an attempt to minimize costs, of creating a flexible plan allowing for uncertainty and a changing economic environment.[41] Cost minimization, diversity, and flexibility are the hallmarks of least-cost planning.

It follows that least-cost planning can facilitate the regulatory approval of capacity expansion projects prior to construction and the improvement of commission review of the various supply and demand factors salient to rate cases and other proceedings. Other purposes are to enhance commission recognition of the critical issues in utility supply decisions and to induce the utility to aggressively engage in long-term planning.[42] Least-cost planning can focus on a particular utility or take the form of a statewide assessment of all utilities in a given utility sector, the latter of which is typically performed by a state government agency.[43]

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40 Eric Hirst, "Integrated Resource Planning Issues," *Least-cost Energy Planning in the Midwest: A Symposium* (Palo Alto, CA: Electric Power Research Institute, 1988), 13-7.

41 National Association of Regulatory Utility Commissioners, *Least-Cost Utility Planning Handbook, Volumes 1 and 2.*

42 David Berry, "Least-Cost Planning and Utility Regulation," *Public Utilities Fortnightly* 121 (March 17, 1988): 9-15.

43 In Illinois, for example, the Department of Energy and Natural Resources prepares statewide plans for electricity and natural gas and develops guidelines for utility planning; individual utilities submit least-cost plans to the Illinois Commerce Commission that can be reviewed for consistency with the statewide plans.

In least-cost planning, in contrast to traditional supply planning, much weight is given to the distinction between demand-side and supply-side options or activities.[44] The demand side involves any strategy to eliminate or defer the need for an investment in new capacity by the utility, including load management, conservation, and pricing strategies. The supply side involves determining the most efficient method of meeting growing demand, including the investment in new capacity or reliance on external capacity. All demand-side activities decreasing the demand for utility services tend to affect supply since existing system capacity is released for other customers and other uses.[45] That is, the freed or redirected utility capacity is similar to that provided by more traditional means.

Traditional supply planning and least-cost planning for utilities are compared in table 1-4. In sum, least-cost planning is characterized by a diversity of resources (including conservation, load-management, and pricing), planning that spans several departments within the utility and outside participants as well, and multiple resource selection goals, including those that address prices, costs, revenue requirements, utility financial condition, risk reduction, technological diversity, environmental quality, and economic development.

Not everyone agrees on the appropriateness of applying planning--least-cost planning in particular--to public utilities. According to another National Regulatory Research Institute (NRRI) analyst, there are several common misconceptions about least-cost utility planning:[46]

- A planning problem with clearly defined objectives can always be specified as an optimum-seeking problem to be solved.

- The optimum solution to a well-defined planning problem can always be characterized or identified.

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[44] Ross C. Hemphill and David W. South, "Least-Cost Planning: How Alternatives Dictate the Approach," *Proceedings of the Fifth Biennial Regulatory Information Conference, Volume 3* (Columbus, OH: The National Regulatory Research Institute, 1986), 2055-63.

[45] Linda G. Baldwin, "Evaluating Utility Options: Integrating Supply-Side and Demand-Side Resource Planning," *Adjusting to Regulatory, Pricing, and Marketing Realities*. Harry M. Trebing, ed. (East Lansing, MI: The Institute of Public Utilities, Michigan State University, 1983), 250-86.

[46] Daniel J. Duann, "Alternative Searching and Maximum Benefit in Electric Least-cost Planning," *Public Utilities Fortnightly* 124 (December 21, 1989): 19-22.

TABLE 1-4

COMPARISON OF TRADITIONAL SUPPLY PLANNING AND LEAST-COST PLANNING

Criterion	Traditional Supply Planning	Least-Cost Planning
Resource options	Supply options	Demand and supply options
Resource diversity	Utility-owned and centralized	Diversity of resources, including demand-side management
Resource ownership	All resources owned by the utility	Some resources owned by other utilities, other producers
Resource selection criteria	Minimize prices and maintain system reliability	Diverse criteria, including risk reduction, technological diversity, environmental quality, economic development
Focus of economic cost analysis	Ratepayers	Multiple groups (society, program participants, ratepayers, individuals, etc.)
Conduct of planning	Internal to the utility, mainly system planning and financial planning	Several utility departments as well as outside experts, commissions staff, public
Role of public groups	Intervenors	Participants
Judgment	Implicit	Explicit
Preferences	Implicit	Explicit
Objectives	Single	Multiple
Reliability	Constraint	Decision variable
Environmental quality	Constraint	Objective

Source: Adapted from Mark Hanson, Stephen Kidwell, Dennis Ray, and Rodney Stevenson, "Electric Utility Least-Cost Planning," *Journal of the American Planning Association* 57, no. 1, Winter 1991 (Chicago, IL: American Planning Association, Winter 1991): 36; and Eric Hirst, Charles Goldman, and Mary Ellen Hopkins, "Integrated Resource Planning for Electric and Gas Utilities," a paper presented at the conference on Energy Efficiency in Buildings sponsored by the American Council for an Energy-Efficient Economy (August 1990).

- The tasks of identifying all feasible alternatives, finding optimal solutions, and verifying them can be accomplished within a reasonable time and at a reasonable cost.

- No local optimum (defined as a optimal plan valid only within a limited range of alternatives) exists in addition to an overall optimum.

Least-cost planning is further complicated by the difficulties associated with the consideration of demand-side management options, the required coordination with nearby utilities, the use of broad definitions of costs (such as those associated with externalities), and the inclusion of goals (such as pollution abatement) not directly attributable to the utility.[47]

While highly pertinent to the debate, these misconceptions and complexities can be overcome, in theory as well as in the practice of least-cost utility planning. For example, planning analysts need not make assumptions about optimization. Indeed, one can argue that it is the analyst's job to educate decisionmakers about alternative means of optimization, the potential for optimal local solutions to conflict with optimal solutions at large, and the problem of the unknowable optimum. The issue that probably merits the most careful attention is the issue of cost. Certainly the benefit of planning should outweigh the cost. This calculation itself poses a rational decisionmaking problem. The benefits of increased awareness and understanding, and reduced ignorance and uncertainty, can be substantial but are not easily quantified.

Nonetheless, the practice of planning requires attention to potential barriers to success. One cannot necessarily presume that regulators and utility managers will engage in integrated water resource planning with enthusiasm.[48] One authority identifies three broad areas of concern: (1) access to tools and adequate information, (2) the level of commitment of utilities and regulators to considering and pursuing new options, and (3) the consistency of approaches and methods within the real-world context of existing regulatory practices.[49] If these issues still apply to least-cost planning for energy utilities, they are as much or more applicable to the case of water. As planning emerges as a regulatory tool for water, attention

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[47] Ibid., 21.

[48] Richard A. Rosen, "Practical Problems in Least-Cost Planning," *Proceedings of the Sixth Biennial Regulatory Information Conference, Volume 1* (Columbus, OH: The National Regulatory Research Institute, 1988), 493-99.

[49] Ibid.

should be paid to the design and implementation of planning strategies that minimize, for example, the problem of inadequate information.

Integrated Resource Planning

Integrated resource planning is a somewhat more encompassing term than least-cost utility planning, although the two are consistent and can be used interchangeably for most analytical purposes. Least-cost planning emphasizes the least-cost principle, the concurrent consideration of supply and demand options, and a more open and participatory process. Integrated planning subsumes these goals and places additional emphasis on integrating the many institutions involved in water resource policy and planning and the many public policy issues they address. Particularly important is an understanding of the relationship of water utility planning to the activities of various government agencies whose policies may constrain utility planning choices.

At a more practical level, the concept of integrated planning evolved in part to address the potential misconceptions and complexities arising from use of the term "least cost." Although it is hard to generalize, the utility industries seem to prefer the term "integrated planning" because of the close association of least-cost with demand-side options. Integrated planning, in their view, does not deny the possibility of considering supply options along with demand options and thus is more realistic. Still, the distinction between least-cost planning and integrated resource planning should not be overstated.

Integrated planning from an analytical perspective is illustrated in figure 1-2, where environmental engineering, social, financial, and economic considerations all feed into the planning process. Recently, the concept of integration has been applied to the strategy of fuel switching between natural gas and electricity to achieve least-cost provision of energy services. Another recent application is the idea of integrating environmental externalities in the planning process.[50] Increasing attention also is being paid to institutional integration (as in the coordination of

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[50] Jennifer Fagan and Rodney Stevenson, "Incorporation of Environmental Externalities into Integrated Resource Planning," a paper presented at the NARUC Third National Conference on Integrated Resource Planning, April 8-10, 1991, Santa Fe, New Mexico.

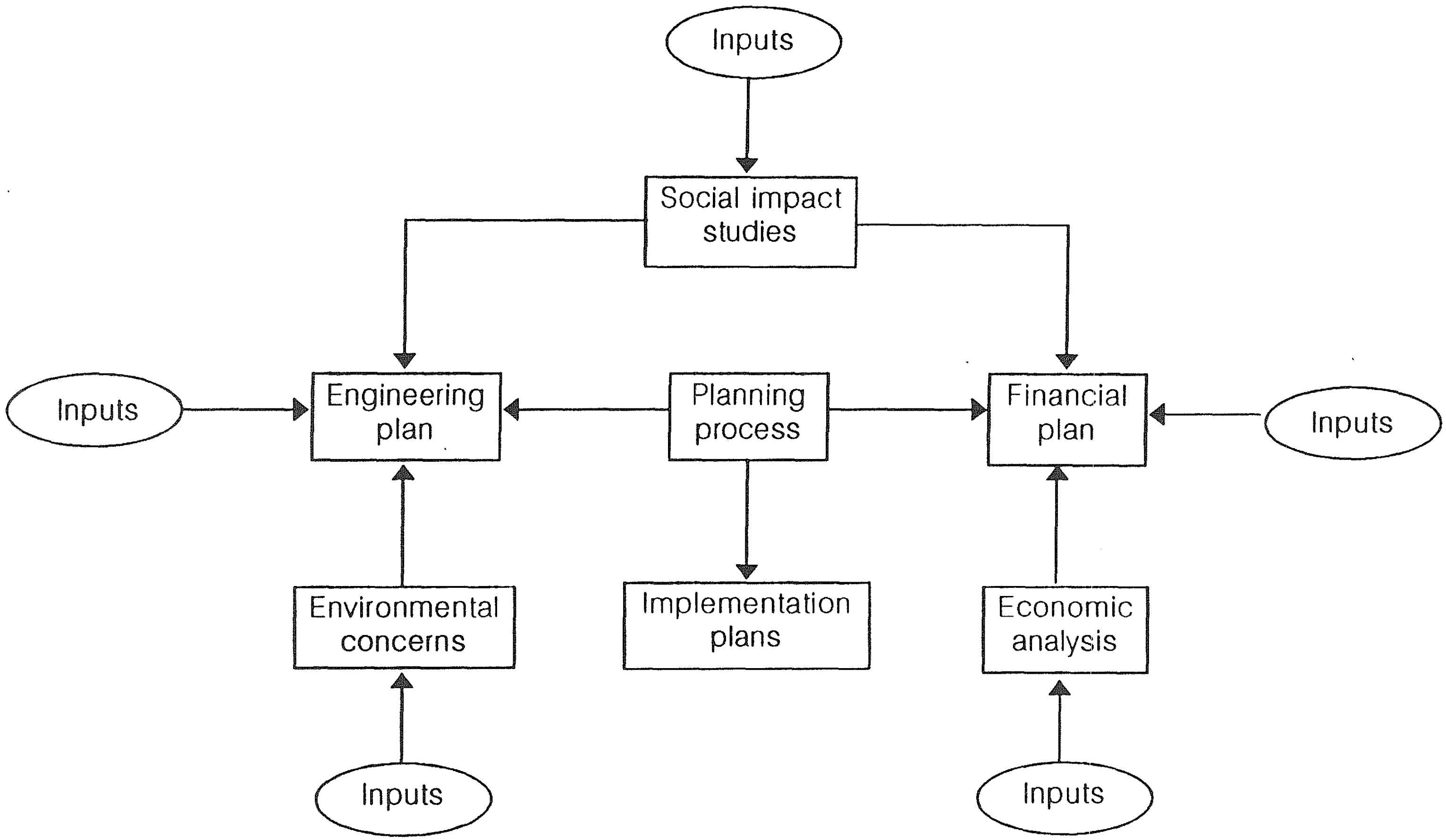

Fig. 1-2. Activity flows of the planning process as depicted in Neil S. Grigg, Water Resources Planning (New York, McGraw-Hill, 1985), 23.

governmental planning processes), which is especially important in water resource planning.

Based on their experience in Nevada, Jon Wellinghoff and Cynthia K. Mitchell emphasize implementation issues in their framework for statewide integrated resource planning, which consists of: planning process integration, sufficient methodological specification, required implementation, utility responsibility for plan creation, and plan enforcement.[51] Eric Hirst also recognized the multidimensional nature of integration in identifying key elements of integrated resource planning: integration of all resources (supply, transmission and distribution, and demand), integration of utility departments and people (such as financial planners, supply engineers, and demand forecasters), explicit treatment of uncertainty, and public involvement in the planning process.[52]

Integrated water resource planning has the potential to be a useful concept. This is mainly because water is a natural resource and subject to forces of nature, the water industry (and ancillary industries) is highly fragmented, many disciplines are involved in the study of water, and many institutions are involved in water resource policy. The following integrated water resource planning framework was introduced in an earlier NRRI report:[53]

- **Temporal.** Integration of short-term planning, including drought contingency plans, with long-term planning; integration of forecast of water supply with forecasts of water demand; integration of crisis management with risk management.

- **Spatial.** Integration of planning needs for all the suppliers within a water resource region and across regions, with particular attention to the quantity and quality of the region's water resources and such issues as water rights.

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51 Jon B. Wellinghoff and Cynthia K. Mitchell, "A Model for Statewide Integrated Utility Resource Planning," *Public Utilities Fortnightly* 116 (August 8, 1985): 223-35.

52 Hirst, "Integrated Resource Planning Issues," 13-4.

53 Janice A. Beecher and Ann P. Laubach, *Compendium on Water Supply, Drought, and Conservation* (Columbus, OH: The National Regulatory Research Institute, 1989), 275.

- **Interdisciplinary.** Integration of engineering, economic, legal, social, health, safety and other relevant perspectives in developing, implementing, and evaluating water resource plans; integration of supply management and planning with demand management and planning.

- **Institutional.** Integration of jurisdictional water utility planning with statewide water resource planning, including planning for nonjurisdictional water, wastewater, and energy utilities; integration of water resource planning with land-use and other resource planning efforts; integration of public policy alternatives in the areas of water supply and demand.

- **Participatory.** Integration of the priorities of water suppliers with those of government policymakers, representatives of water users, and the public at large; integration of federal, state, and local water resource policymaking through mutual coordination and participation.

Planning can facilitate integration of activities both internal and external to water utilities. As illustrated in figure 1-3, in an integrated approach planning data and information are linked internally to the other management activities of the water utility (physical facilities management, financial management, environmental management, research and development, and economic development). Illustrated in figure 1-4 is the integration of water utility planning with external planning processes (planning by other water suppliers, local and regional planning, river basin planning, and statewide, interstate, and federal water planning and policy). Some of these relationships are formal (as in permit processes involving state water resource or drinking water regulators), while others are less so (as in the use of regional water planning data by the utility in developing forecasts).

In reality, this level of institutional integration in water resource planning is a long way off. However, there are signs that least-cost planning and other models are making their way into the water sector. This study contributes to that effort.

Planning Applied to Water Utilities

As in the case of planning for electricity and natural gas utilities, integrated planning for water utilities requires a balanced evaluation of both demand-side and supply-side options for meeting future demands at minimum costs given reliability, quality of service, and environmental constraints. Water utility executives have already begun to feel the impact of the least-cost-planning mandate in some

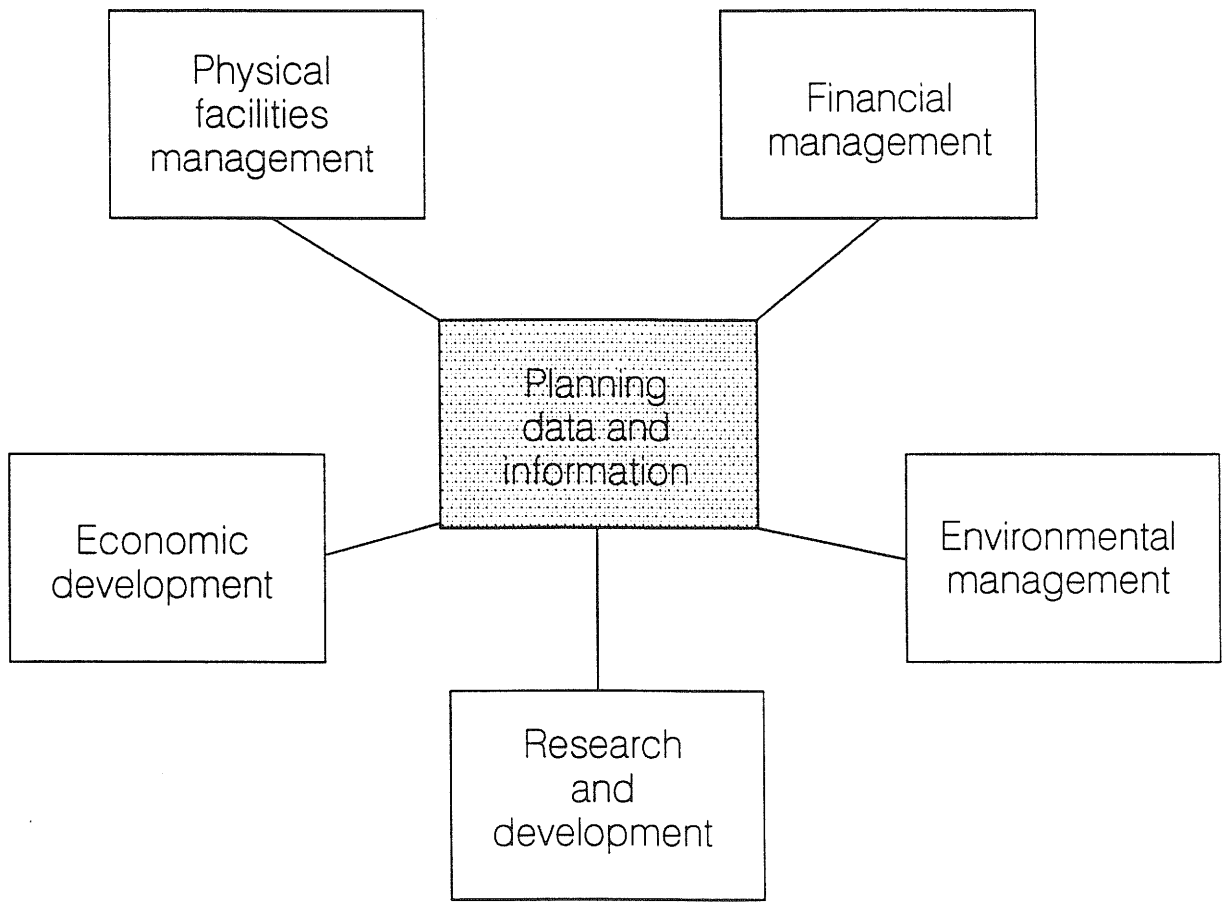

Fig. 1-3. Relationship of planning information to water utility management activities as depicted in Neil S. Grigg, Water Resources Planning (New York: McGraw-Hill, 1985), 21.

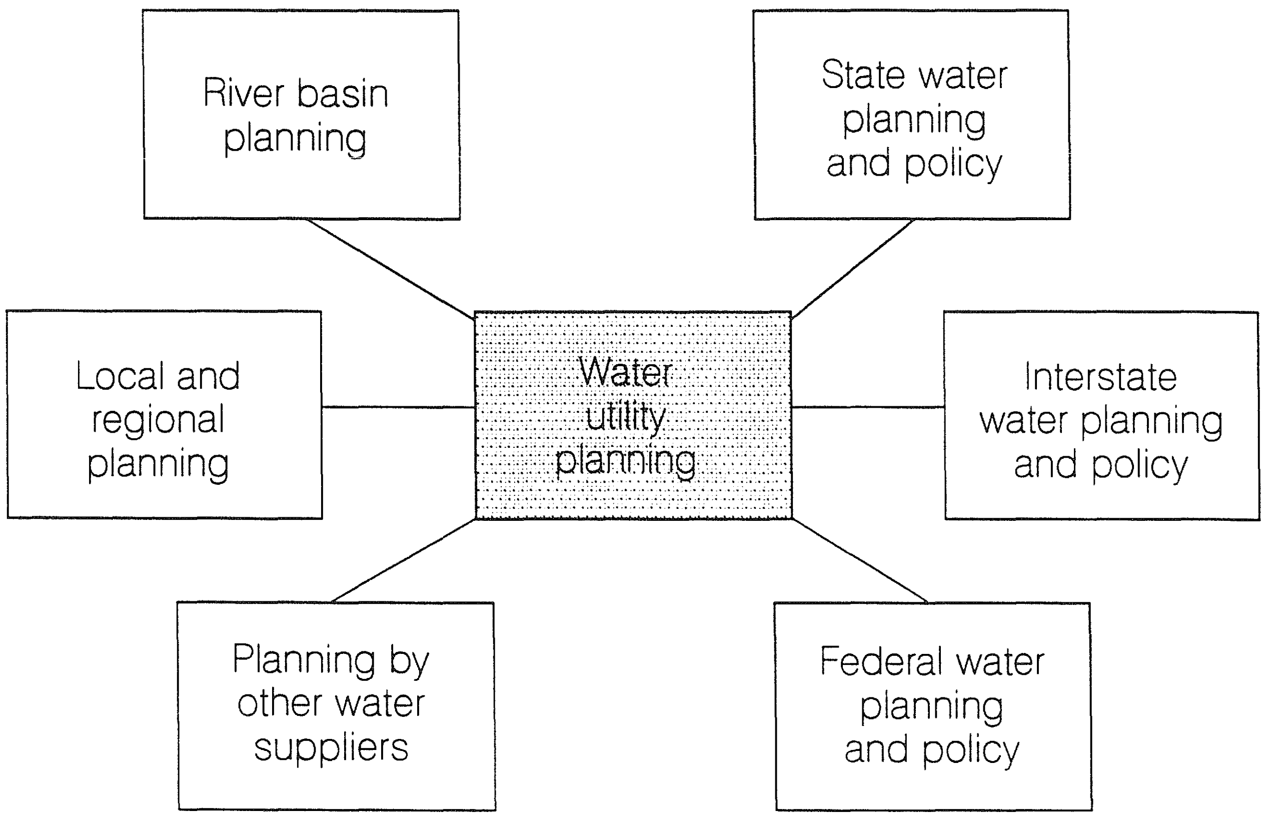

Fig. 1-4. Relationship of water utility planning to other planning and policy processes (authors' construct).

jurisdictions, where traditional methods of utility planning and the exclusion of demand-side options are being reevaluated:

> Although water utilities have considered the least-cost approach in their planning process, they have not historically taken what commissions define as a least-cost planning approach to determining whether or not to build additional facilities. The focus of water utility executives has been on engineering considerations--i.e.: additional plant and more source of supply with adequate reserve to ensure maximum day demands can be met.
>
> The fact is, the engineering approach ensures that quality, quantity, fire protection and public health are not at risk. . . .
>
> However, in the environment in which we operate today, there are those who are challenging the engineering approach as not being totally prudent, suggesting that demand-side options ought to be considered as part of the planning process.[54]

Integrating engineering and economic considerations is essential to this emerging planning process in the water sector.[55] The tools and methods of least-cost planning can assist utilities and regulators in making a variety of decisions, including the decision to retire aging or obsolete capacity, construct new capacity, use purchased water to meet demand, upgrade the distribution systems, invest in leak detection and repair, implement a conservation program, practice load management, and modify the rate structure.

With water, an important potential use for integrated planning--perhaps its most important application--is in preparing utilities for meeting the requirements of the Safe Drinking Water Act (SDWA). Planning for water *quality* is as essential as planning for water *quantity*. This is a distinguishing feature of planning in the water utility sector. Along with the SDWA, many water utilities are under pressure from demand growth and/or an aging water delivery infrastructure. Finally, the recurrence of drought and the potential for other natural and manmade disasters to threaten water supplies are increasingly apparent. An integrated planning approach to these issues would seem highly appropriate.

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[54] Edward W. Limbach, "Least Cost Planning for Water Utilities: A Balancing Act," a paper presented at the regional meetings of the National Association of Regulatory Utility Commissioners (NARUC), June and July, 1989, 2-3.

[55] Steve H. Hanke, "A Method for Integrating Engineering and Economic Planning," *Energy and Water Use Forecasting* (Denver, CO: American Water Works Association, 1980), 76-80.

Thomas Stack points out that large utilities experiencing growth have much to gain from least-cost planning:

> With increasing rates, the availability of new technology and a general public awareness of the importance of water it is very possible that customers can realize overall savings from the inclusion of demand side planning. Such planning could also benefit a utility by avoiding a costly error associated with overbuilding a facility. It could also prevent considerable backlash against the utility and the Commission by the public. The prudent course of action in today's environment is to perform a thorough study of both supply and demand considerations.[56]

Even in slow-growth or no-growth areas, the ultimate need for replacing facilities and reducing wastewater treatment needs can be addressed through an integrated resource planning framework.[57] Also, integrated planning principles can be adapted to the needs of small water systems. While small water utilities do not have the resources to conduct a full-blown planning process on their own (many do not even use a basic business plan), a truly integrated approach at the state level will encompass their interests as well.

While experience with planning for other public utilities is largely transferable to the water sector, some aspects of water supply are dramatically different from energy supply, particularly electrical energy. The most important difference is that water is a natural and renewable resource, although one that is also highly vulnerable. Natural and artificial constraints can limit the quality and quantity of water available. Any form of planning for water supply must take this into account. Further, it should be acknowledged that the development and use of water supplies affects the ability of others to develop and use those supplies. Even though manmade water systems may not be physically interconnected, many natural water sources are common to more than one user. In other words, upstream use affects downstream use, diversions for one use can affect another, and contamination can render a water supply source useless altogether. More so than in energy planning, a natural resource perspective is essential to integrated water resource planning.

Adapting some aspects of integrated energy resource planning to the water sector may be problematic. For example, because of quality, reliability, and safe

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56 Stack, "Least-Cost Planning for Water Utilities," 20.

57 Ibid., 21.

yield concerns, it would seem that engineering considerations could continue to dominate water supply, with or without integrated planning. Furthermore, since water utilities are usually not physically interconnected (as in the case of electricity), it may be difficult for utilities to meet unanticipated demand on short notice. In other words, when demand management programs perform poorly, supply options may be limited. The relatively low price of water in many areas may prove to be a disincentive for consumers to invest in demand management measures. If consumers do conserve, water utilities may find it difficult under current rate structures to meet overall revenue requirements and cover fixed costs. There may be a reluctance on the part of jurisdictional water utilities to cooperate given regulatory disincentives and the uncertain impact of demand management on earnings. State public utility commissions may find it especially difficult to integrate planning between jurisdictional utilities (usually small and privately owned) and nonjurisdictional utilities (usually large and publicly owned).

Finally, there is a unique cultural bias affecting water. Some say that the water supply industry provides a uniquely essential service: one can live without telephone or electricity service, but not without water. In reality, water itself is essential, but water service must be held to the same standards of performance as any other public utility service. For their part, consumers typically want, and in many cases are accustomed to, water prices that vastly undervalue the water commodity. Conservation or demand management might be confused with curtailment of use (as is sometimes necessary during periods of drought), and therefore viewed as a threat to green lawns as well as everyday conveniences. Some regulators (particularly those in water-rich regions) may have reservations about adapting planning to water utilities, especially given the commitment of regulatory resources required. In the long run, however, water utilities, ratepayers, and regulators may recognize that certain elements of integrated planning (such as improved intergovernmental coordination and sharing of commission expertise with other state regulatory agencies) can be beneficial even to states that today do not perceive a water crisis.

Integrated resource planning is not a panacea for water or any other utility sector. To judge it accordingly would be misleading and unfair. However, it does offer an improved way of addressing a very complex area of public policy. These are not trivial matters, as Warren Viessman articulates:

> In the final analysis, the severity of water and other crises we may face as a nation will depend heavily upon our ability to be 'society wise' as well as 'technology wise.' If we can do this, our creativity, imagination, and sound technical underpinning will find a way to unlock the constraining mechanisms that force us to operate at a level of efficiency far beneath than for which we are capable. This is perhaps the only hope we have for unraveling the years of tradition, laws, regulations, and other institutions which must be tampered with to permit us to use the great pool of knowledge that has been accumulated. This is the challenge, and if it is not accepted, the frequently referred to 'water crisis' will become a reality.[58]

In meeting this challenge, an examination of institutional roles and methods of analysis is in order and is the purpose of the remainder of this report. While the result is not a "how to" book, it does lay a foundation for the application of integrated water resource planning.

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58 Warren Viessman, Jr., "Water Crisis: A Physical Reality or an Institutional Specter," a paper presented at the 1982 meeting of the New England Interstate Water Pollution Control Commission in Merrimack, New Hampshire, June 10, 1982, 4.

CHAPTER 2

FEDERAL AND STATE ROLES IN WATER RESOURCE PLANNING

Governments can, and do, affect water resources in many ways. Governments promote water resource development, finance or subsidize water projects, enact water laws, enforce water rights, control water transfers, establish water markets, issue permits for water withdrawals, regulate water pollution and drinking water quality, set efficiency standards for water fixtures, manage droughts and other water crises, allow or restrict water use, influence or sanction water pricing, collect data on water resources and water use, empower water authorities, and plan for meeting future water needs.[1] Water policy is as ubiquitous as water itself.

It is fair to say that while there is much government *activity* in the water sector, an encompassing government *policy* is not necessarily the result. As Charles Foster and Peter Rogers noted, the term "national water policy" has a nice ring to it, but in reality it is only "the sum total of a number of individual federal, state and regional policies."[2] Indeed, water resource policy may be one of the best examples of the pluralistic nature of intergovernmental politics and policymaking. Water is attended to by so many governmental players and policies that it appears more "disintegrated" than "integrated." Above all else, the prospect for successful integrated water resource planning in the long term depends on improvements in how the nation's governments deal with the water issue.

This chapter addresses federal and state roles in water resource planning, with the exception of the role of the state public utility commissions, which is addressed in the following chapter.

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[1] For a normative view of what governments *should* do, see United Nations, *Water Resources Planning to Meet Long-Term Demand: Guidelines for Developing Countries* (New York: United Nations, Natural Resources/Water Series No. 21, 1988), 86-8.

[2] Charles H. W. Foster and Peter P. Rogers, *Federal Water Policy: Toward An Agenda for Action* (Cambridge, MA: Energy and Environmental Policy Center, John F. Kennedy School of Government, Harvard University, 1988), 7.

Federal Water Resource Policy[3]

The history of federal involvement in water resources is a subject worthy of volumes.[4] It is a history of politics, emotion, and controversy spanning decades. Drawing principally on its constitutional authority to regulate interstate commerce, of which navigable waters are an integral part, Congress has enacted numerous statutes affecting the nation's water resources, many of which appear in table 2-1.[5] Dozens of federal agencies are involved in water resource policymaking. Table 2-2 identifies some of these agencies based on their significance in water resource planning. Appendix A of this report provides a description of the background and programs of each of these federal agencies as adapted from Section 16 of the *Utah State Water Plan.*

The hallmark of the federal role in water was in development projects, such as projects for storage, flood control, navigation, hydroelectric power production, and other purposes. It is no secret that in the past many federal water projects were undertaken for political reasons, authorized by Congress in "pork-barrel" dealmaking.[6] Some say that excessive federal involvement, namely subsidization, has contributed to the inefficient allocation and use of the nation's water resources.[7] Congress continues to authorize federal water projects, as in the Water Resources Development Act of 1986, but increasing importance is placed on cost-sharing with nonfederal sponsors (states, localities, and private interests).[8] In the interest of

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3 Adapted in part from Janice A. Beecher and Ann P. Laubach, *Compendium on Water Supply, Drought, and Conservation* (Columbus, OH: The National Regulatory Research Institute, 1989), chapter 9.

4 A provocative analysis is provided by Mark Reisner, *Cadillac Desert: The American West and Its Disappearing Water* (New York: Viking, 1986).

5 For a review, see Andrew A. Dzurik, *Water Resources Planning* (Savage, MD: Rowman and Littlefield Publishers, Inc., 1990), 49-81; and Warren Viessman, Jr., " A Framework for Reshaping Water Management," *Environment* 32 (May 1990): 10-15 and 33-35.

6 Kenneth D. Frederick, "Water Politics and Institutions," in David H. Speidel, Lon C. Ruedisili, and Allen F. Agnew, eds., *Perspectives on Water: Uses and Abuses* (New York: Oxford University Press, 1988), 337; and Reisner, *Cadillac Desert.*

7 Ibid.

8 Foster and Rogers, *Federal Water Policy,* 34.

TABLE 2-1

CHRONOLOGY OF FEDERAL LEGISLATION SUBSTANTIALLY AFFECTING WATER RESOURCE POLICY

- The Refuse Act of 1899
- Reclamation Act of 1902
- Oil Pollution Act of 1924
- Soil Conservation Act of 1935
- Flood Control Act of 1944, 1962
- Water Pollution Control (Clean Water) Act of 1948, 1956, 1972, 1977, and 1981
- Water Supply Act of 1958
- Watershed Protection and Flood Prevention Act of 1964
- Water Resources Research Act of 1964
- Water Resources Planning Act of 1965 and 1974
- Water Quality Act of 1965 and 1987
- Clean Rivers Restoration Act of 1966
- National Environmental Policy Act of 1969
- Environmental Quality Act of 1970
- Coastal Zone Management Act of 1972
- Federal Insecticide, Fungicide and Rodenticide Act of 1972
- Marine Mammal Protection Act of 1972
- Marine Protection, Research and Sanctuaries Act of 1972
- Weather Modification Reporting Act of 1972
- Offshore Shrimp Fisheries Act of 1973
- Safe Drinking Water Act of 1974, 1977, and 1986
- Fishery Conservation and Management Act of 1976
- Resource Conservation and Recovery Act of 1976
- Toxic Substances Control Act of 1976
- Water Resources Development Act of 1976
- Soil and Water Resources Conservation Act of 1977
- Surface and Mining Control and Reclamation Act of 1977
- Agricultural Credit Act of 1978
- Uranium Mill Tailings Radiation and Control Act of 1978
- Comprehensive Environmental Response, Compensation and Liability Act of 1980 (Superfund)
- Pacific Northwest Electric Power Planning and Conservation Act of 1980
- Food Security Act of 1985
- Superfund Amendments and Reauthorization Act of 1986
- Water Resources Development Act of 1986
- Water Quality Act of 1987

Source: Authors' construct.

TABLE 2-2

SELECTED FEDERAL OFFICES ENGAGED IN WATER RESOURCE PLANNING

Department of Agriculture

- Agriculture Stabilization and Conservation Service
- Forest Service
- Soil Conservation Service

Department of the Army

- U.S. Army Corps of Engineers

Department of the Interior

- Bureau of Indian Affairs
- Bureau of Land Management
- Bureau of Reclamation
- Fish and Wildlife Service
- Geological Survey

Environmental Protection Agency

Federal Emergency Management Agency

Other Federal Agencies

- Economic Development Administration
- Farmers Home Administration
- Federal Energy Regulatory Commission
- Department of Housing and Urban Development
- National Oceanic and Atmospheric Administration
- National Weather Service

Source: Utah Department of Natural Resources, *Utah State Water Plan* (Salt Lake City: Division of Water Resources, Utah Department of Natural Resources, January 1990), section 16. See also *The United States Government Manual* (Washington, DC: U.S. Government Printing Office, annual). The backgrounds and programs of these agencies are discussed in appendix A.

shifting costs and other responsibilities, federal legislation places an increasing emphasis on state primacy. A key example is the delegation of the enforcement of federal drinking water standards to the states.

Despite a pervasive role in water development, water planning has not necessarily been a federal government priority. Today, however, such issues as environmental protection, conservation, and resource planning appear to be increasing in importance, as the chronology in table 2-3 sets forth. According to Warren Viessman, water management policies today no longer focus exclusively on development, such as dam and canal construction; in fact, "Nonstructural measures, such as land-use modifications and regulations, to solve water problems are favored."[9] Viessman attributes this shift in emphasis, at least in part, to changing values, perceptions, and attitudes of the public toward the nation's water resources and the public policies designed to address them.

In the past two decades, more and more federal legislation has been concerned with issues of water quality, specifically pollution control, wastewater treatment, and drinking water. Some key pieces of water quality legislation feature planning and management requirements. The Federal Water Pollution Control Act Amendments of 1972 "provided for regional basin-wide planning in many areas throughout the country and included provisions for planning the control of nonpoint source pollution of surface water systems."[10] Pollution of water sources from hazardous waste was addressed later in the Resource Conservation and Recovery Act of 1976. The Clean Water Act of 1977 included several sections pertinent to water planning.[11] Different sections of the Act provided for annual state reports on water quality (which serves as a basis for long-range management and planning), basin plans, areawide plans, and wastewater treatment facility plans. Although the Safe Drinking Water Act did not provide for planning, its provisions made better planning by water suppliers a necessity to mitigate cost and regulatory impacts.

Several points about water quality planning can be made. First, compliance with provisions of the Clean Water Act ultimately affect compliance with the Safe Drinking Water Act because water resource protection helps prevent drinking water

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9 Viessman, "A Framework for Reshaping Water Management," 12.

10 Dzurik, *Water Resources Planning*, 184-5.

11 Ibid.

TABLE 2-3

RECENT CHRONOLOGY OF FEDERAL WATER RESOURCE POLICY

- In 1961, the Senate Selected Committee on Water Resources released a report that led to passage of the Water Resources Research Act of 1964 and the Water Resources Planning Act of 1965.
- The planning act set up the U.S. Water Resource Council; encouraged a comprehensive, coordinate federal attitude toward water-resources management; and served as the foundation for states' efforts to begin or expand water-resources planning.
- The research act established a Federal Office of Water Resources and Technology and a water-resources research institute in each state to address water management issues.
- The National Environmental Policy Act of 1969 and the Federal Water Pollution Control Act Amendments (Clean Water Act) of 1972 profoundly changed the emphasis of federal funding and effort from traditional water-resources development to environmental protection and restoration.
- In 1973, the National Water Commission, created by Congress in 1968 to review national water-resources problems, released the landmark report "Water Policies for the Future," which further emphasized the need for clean water and environmental protection rather than just water supply.
- President Carter's 1978 water policy initiatives called for improvements in water-resources planning and management, construction of only cost-efficient water projects, increased attention to water conservation, improved cooperation between federal and state agencies, and greater focus on environmental quality.
- The Reagan administration supported transferring responsibility for many water programs to the states, sought to increase nonfederal cost sharing, encouraged full recovery of expenditures, and terminated the Water Resources Council, signaling then end of the only umbrella water-resources planning effort in the federal government.
- The Water Resources Development Act of 1986 culminated years of effort by the Carter and Reagan administrations to require greater levels of nonfederal cost sharing for water projects and programs.

Source: Warren Viessman, Jr., "A Framework for Reshaping Water Management," *Environment* 32 (May 1990): 10-15 and 33-35.

contamination therefore reducing treatment complications. Second, water quality planning may provide essential data to the supply planning process, particularly on areawide and basinwide issues. Third, water supply planners may be able to draw upon the data sources and technical expertise developed for water quality planning. Finally, water supply planning should be integrated with water quality planning if conflict is to be avoided and mutual policy goals are to be achieved.

Conservation, of course, is not an entirely new concept to federal water policy as apparent in the goals of the Water Resource Planning Act of 1965:

> [To] encourage the conservation, development, and utilization of water and related land resources of the United States on a comprehensive and coordinated basis by the Federal Government, States, localities, and private enterprise with the cooperation of all affected Federal agencies, States, local governments, individuals, corporations, business enterprises, and others concerned.[12]

Authorization and appropriation legislation for many federal agencies includes conservation provisions. Recently, legislation has been proposed to establish national water efficiency standards for bathroom and kitchen fixtures.[13] The interest in conservation is related to the recurrence of drought conditions in the late 1980s and early 1990s and in part stems from a realization that most federal drought policy is reactive, emphasizing drought relief rather than drought planning and management. Concerns about drought and long-term supply reliability led to the proposed Municipal and Industrial Water Conservation Act of 1989.[14] The bill emphasizes the wise and efficient use of the nation's water resources, better coordination of federal water resource policymaking, and a strong institutional commitment to water conservation. Recent proposals to amend the Clean Water Act have focused on conservation and least-cost planning provisions for both water and

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12 As cited in Foster and Rogers, *Federal Water Policy,* 3.

13 "The National Plumbing Products Efficiency Act of 1989," House Resolution 1185 (S. 583), *Congressional Record* 135, no. 20 (March 1, 1989). State plumbing efficiency legislation is discussed below.

14 "The Municipal and Industrial Conservation Act of 1989," Senate Bill 1422 (H.R. 3099), *Congressional Record* 135, no. 20 (July 27, 1989). Related legislation was the proposed National Water Conservation Act of 1988 (S. 2904/H.R. 5496).

sewer utilities.[15] Such proposals have far-reaching implications for the future of water resource planning at all levels of government, particularly with respect to conservation issues.

Interstate Water Resource Policy[16]

Sandwiched between the federal and state levels of government are oversight bodies organized according to the nation's major river basins. Title II of the Water Resources Planning Act of 1962 provided for the establishment of the six interstate river basin commissions: New England, Great Lakes, Ohio, Upper Mississippi, Missouri, and Pacific Northwest.[17] The commissions were created to perform water resource planning and management functions in cooperation with federal agencies. Basin plans were intended to be comprehensive and coordinate planning with regard to all water and water-related problems in basin regions. Federal funding, however, fell far short of what was needed to meet the mandate of the 1962 legislation. Moreover, the Act envisioned federal participation and coordination through the now-dormant U.S. Water Resources Council. Thus, the commissions have become neither an effective "nationwide network" nor an "integral part of the national water policy machinery."[18]

Nevertheless, the interstate commissions have provided pragmatic and focused analyses of issues affecting the nation's river basins. Some are clearly becoming more active in regional water policy. The Delaware River Basin Commission, for example, has recently considered amendments to its Comprehensive Plan and Water Code in relation to the use of retail water pricing to encourage conservation.[19] The proposed rule would require water purveyors seeking a new or expanded withdrawal permit to demonstrate that they have adopted, or plan to adopt, or plan

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15 Correspondence of the National Wildlife Federal dated July 23, 1991 to "Persons Interested in Water Conservation."

16 Adapted from Beecher and Laubach, *Compendium* chapter 9.

17 Leonard U. Wilson, "Intergovernmental Coordination of Water Resource Planning," in Wilson, *State Water Policy Issues,* appendix E.

18 Ibid., 63.

19 *Federal Register* 56 no. 110 (June 7, 1991): 26397-8.

to study the feasibility of adopting, a water conservation pricing structure. Such a policy would directly and significantly affect water utilities and their regulation.

Today, fifteen major water agencies have been established by interstate compacts through which states agreed to allocate and manage a common water resource. As identified with their state members in table 2-4, these agencies may serve either in an advisory or an enforcement capacity. Forty-one states and the District of Columbia belong to one or more of these interstate commissions. The federal government is a signatory party in some of the compacts, such as those for the Delaware and Susquehanna river basins. Interstate compacts, which require the approval of Congress under the consent provision of the Constitution, are of four types:[20]

- Water allocation compacts (such as the Colorado River compact).
- Pollution control compacts (such as the Klamath River compact).
- Planning flood control compacts (such as the Red River of the North compact).
- Comprehensive regulatory and project development compacts (such as the Susquehanna River compact).

There are opposing positions on the issue of whether or not water management and planning should be centralized on an interbasin or interstate basis. Emergencies, such as severe drought, may call for more centralized approaches. Such coordination, however, requires cooperation. Although the states have shown little enthusiasm for cooperative efforts, planning actually may reduce the amount of local power that must be relinquished in a crisis and may help minimize cost impacts.[21] Crises aside, regional water management at some level may be necessary. Many long-term water supply solutions involve diversions from the major river basins to water-poor regions. Their successful implementation, however, depends on whether interstate and interbasin conflicts can be resolved. A high degree of conflict may stimulate interest in other options, including conservation.

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[20] Peter E. Black, *Conservation of Water and Related Land Resources* (New York: Praeger Publishers, 1982), 28-33.

[21] Anne M. Blackburn, "Management Strategies: Dealing with Drought," in American Water Works Association, *Water Conservation Strategies* (Denver, CO: American Water Works Association, 1980), 24.

TABLE 2-4

INTERSTATE WATER RESOURCE AGENCIES

Agency (Year Established)	Member States
Advisory Agencies	
New England Governors' Conference, Inc. (1936)	CT, ME, MA, NH, NY, RI, VT
Interstate Commission on the Potomac River Basin (1940)	DC, MD, PA, VA, WV
Great Lakes Commission (1955)	IL, IN, MI, MN, NY, OH, PA, WI
Klamath River Compact Commission (1957)	CA, OR
Western States Water Council (1965)	AK, AR, CA, CO, MT, NV, NM, ND(a), OR, SD(a), TX, UT, WA, WY
Missouri Basin States Administration (1981)	CO, IA, KS, MO, MT, NE, ND, SD WI, WY
Ohio River Basin Commission (1981)	IL, IN, KY, MD, NC, OH, PA, VI, WV
Upper Mississippi River Basin (1981)	IL, IA, MN, MO, WI
Agencies with Enforcement Powers	
Interstate Sanitation Commission (1936)	CT, NJ, NY
New England Interstate Water Pollution Control Commission (1947) (b)	CT, ME, MA, NH, NY(c), RI, VT
Ohio River Valley Sanitation Commission (1948)	IL, IN, KY, OH, PA, VA, WV
Upper Colorado River Commission (1948)(d)	CO, NM, UT
Delaware River Basin Commission (1961)	DE, NJ, NY, PA
Tahoe Regional Planning Agency (1969)	CA, NV
Susquehanna River Basin Commission (1971)	MD, NY, PA

Source: The Council of State Governments, *Book of the States, 1988-89 Edition* (Lexington, KY: The Council of State Governments, 1988), 412-13.

(a) Associate member.
(b) Primarily advisory; has the power to enforce water quality regulations on interstate rivers.
(c) Not a formal member; cooperates on water issues through the New England/New York Water Council, which is part of this conference.
(d) Allocates water from the Colorado River.

Absent clear federal signals, the national role of interstate policy is uncertain. However, because the states share water resources, the need for coordination in planning and resource development is obvious. Water flows freely across state boundaries and many water resource problems--and their solutions--tend to be regional in nature. Thus, the potential exists for interstate agencies to play a prominent role in water resource policy.

State Water Resource Policy

A paradox of water resource policy is that while the federal role is pervasive and at times preemptive, primacy belongs to the states.[22] Like the federal government, however, state policymaking for water resources sometimes can appear fragmented and pluralistic. The states have asserted primacy in many facets of water policy, including planning, management, and regulation.[23] State water law, a complex configuration of constitutional, statutory, administrative, and common-law components, serves to reinforce the rights of states in governing water resources.[24] For example, water law has a constitutional basis in New Mexico, as Article XVI of the state charter sets forth:

> The unappropriated water of every natural stream, perennial or torrential, belongs to the public and is subject to appropriation according to the laws of the state. Beneficial use shall be the basis, the measure, and the limit of the right to the use of water, and priority in time of appropriation shall give the better right.[25]

The year 1978 was a watershed for the national water policy debate, particularly with respect to the role of the states. President Jimmy Carter issued a

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22 Adapted in part from Beecher and Laubach, *Compendium,* chapter 9.

23 Wilson, *State Water Policy Issues.*

24 See Frederick, "Water Policies and Institutions," in Speidel, Ruedisili, and Agnew, eds., *Perspectives on Water*; and Bonnie Colby Saliba and David B. Bush, *Water Markets in Theory and Practice* (Boulder, CO: Westview Press, 1987).

25 As quoted in Philip B. Mutz, "Water Resources Planning in New Mexico," *State Water Plans: Water Management Symposium* (proceedings of a conference sponsored by the Western States Water Council and held in Reno, Nevada, September 7-8, 1989). In New Mexico, virtually every drop of water is appropriated and accounted for by the state.

message to Congress announcing his national water policy initiatives, declaring that his proposals were designed "to enhance the role of the states, where the primary responsibilities for water must lie."[26] Also in 1978, the National Governors' Association published a policy paper asserting eleven policy principles, which appear in table 2-5.[27] According to Council of State Governments analyst Leonard Wilson:

> The central thesis of the [NGA] policy is that states should be recognized as the key managers of water as well as all other natural resources. States should have the primary planning, management, and regulatory roles. Federal programs should recognize and reinforce state capacities and legal structures, and provide incentives for reform, as needed. The states seek a state-federal partnership in policy development and planning, and a delegation to the states of management responsibilities. Inherent in the state approach is recognition of the need for far greater integration of activities among all levels of government, among federal agencies, and among the states. The states argue for far greater flexibility in federal programs to encourage integration of: water quality and supply programs, surface and groundwater management, and water with other resource planning. A basic tenet is that problem definition and solution design should be sensitive to the need to differentiate among regionally disparate needs and conditions.[28]

The statement by the governors' association stands as the states' strongest assertion of primacy in water resource planning and management. As noted above, recent presidential administrations have been willing accomplices in establishing state primacy, particularly since it is consistent with reduced federal funding for water projects and programs. Among the NGA policy principles especially worth noting are the ideas that water management should be approached in a more comprehensive and coordinated manner at all levels of government, and that water conservation should be a fundamental consideration.

Recent state legislation addresses such issues as planning, conservation, and water resource development. An example of comprehensive legislation comes from Wyoming, whose development goals are the focus of legislation enacted in 1975:

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[26] Leonard U. Wilson, *State Water Policy Issues* (Lexington, KY: The Council of State Governments, 1978), 4.

[27] These views were later reiterated by the National Conference of State Legislatures.

[28] Ibid., 6-7.

TABLE 2-5

NATIONAL GOVERNORS' ASSOCIATION POSITION ON NATIONAL WATER POLICY

Principle 1:	The states have the primary authority and responsibility for water management.
Principle 2:	The proper role of the federal government is threefold: (1) to establish a framework for national objectives and criteria developed in consultation with the states; (2) to provide assistance to the states in the development of programs to meet state needs within such a framework; and (3) to be consistent with such state programs to the maximum extent possible when undertaking direct federal actions pursuant to national interests.
Principle 3:	Water management must be approached in a more comprehensive and coordinated manner at the federal, state, local, and interstate levels.
Principle 4:	Federal actions must be consistent with adopted state and interstate water and related resources plans and programs.
Principle 5:	There must be continuity in federal support for water management programs.
Principle 6:	There must be greater flexibility in the entire federal support system for water management.
Principle 7:	Criteria for planning and evaluating federal and federally assisted water projects and programs must be refined and applied uniformly.
Principle 8:	Federal project financing, cost-sharing, and cost recovery policies should be reviewed and simplified to eliminate inequities and inherent biases toward specific solutions to water problems and promote equal consideration of structure and nonstructural solutions.
Principle 9:	Water conservation must be the fundamental consideration in water management programs.
Principle 10:	Federally supported water research should be expanded, coordinated, and tied closely to the planning and management concerns of the state.
Principle 11:	Any claims to federal reserved water rights, including those for Indians, must be initially addressed within the framework of established state systems.

Source: Leonard U. Wilson, *State Water Policy Issues* (Lexington, KY: The Council of State Governments, 1978), appendix C. Adopted February 1978.

> The Wyoming water development program is established to foster, promote and encourage the optimal development of the state's human, industrial, mineral, agricultural, water and recreational resources. The program shall provide, through the [Wyoming Water Development] commission, procedures and policies for the planning, selection, financing, construction, acquisition and operation of projects and facilities for the conservation, storage, distribution and use of water, necessary in the public interest to develop and preserve Wyoming's water and related land resources. The program shall encourage development of water facilities. . . and shall help make available the waters of this state for all beneficial uses, including but not limited to municipal, domestic, agricultural, industrial, instream flows, hydroelectric power and recreational purposes, conservation of land resources and protection of the health, safety and general welfare of the people of the state of Wyoming.[29]

Of particular importance to the western states is drought response capability. A survey of twenty western states by the Western States Water Council is reported in table 2-6. Like most federal policy in this area, state drought management has taken the form of reactive policymaking. The survey indicates this may be changing. Many western states have taken steps to prepare for drought both through institutional and programmatic measures. However, few of the states surveyed had developed action plans, even in the area of public water supplies. Fewer still had established priorities for water use in case of drought.

One of the most important functions of state drought planning and management is identifying water-use priorities. The idea of priority water use is an important element of water law and becomes a focal point when water resources are impaired. Setting priorities makes a policy statement that water allocation is not to be left to market forces, namely price. A detailed priority scheme comes from Wisconsin's water resource plan, reported in table 2-7. A proposed drought management strategy for the state emphasizes the distinction among three water-use classes:[30]

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[29] As cited by Mike Purcell, "Wyoming Water Development Program," *State Water Plans: Water Management Symposium* (proceedings of a conference sponsored by the Western States Water Council and held in Reno, Nevada, September 7-8, 1989).

[30] Dale J. Patterson, Jeffrey J. Prey, and Allen K. Shea, *Drought Emergency Water Allocation Strategy* (Madison, WI: Wisconsin Department of Natural Resources, 5.1 Draft, June 1990), 15-16.

TABLE 2-6
WESTERN STATES DROUGHT-RESPONSE CAPABILITY SURVEY

Capability	Number of States
State Authority	
General emergency response	20
Water use permits required	20
Standing drought response plan	9
Other drought response authority	6
State water conservation program	12
State water development program	15
Require local contingency plan	8
Governors' Emergency Powers	
Declare emergency	20
Suspend procedural state law	20
Issue E.O.s with force of law	20
Reallocate state resources	20
Governor's emergency funds	17
State Water Law	
Surface water use controlled	20
Groundwater use controlled	18
Public interest review required	18
Redefine beneficial use/duties	5
Statutory water use preferences	11
State basinwide adjudications	17
Expedite permits and transfers	10
Waive notices and hearings	6
Encourages transfers/marketing	6
State water banks	3
Temporary water use permits	18
Temporary water transfers	16
Enforces waste prohibition	19
Special water management areas	14
Water masters regulate use	13
Suspend junior uses	20
Municipal eminent domain powers	20
State Drought-Response Capacity	
Drought defined	7
Triggers for state action	7
Early warning system	19
Drought coordinator named	11
Lead state agency designated	16
State Drought-Response Capacity (cont.)	
Drought response center	13
Agency responsibilities clear	12
State resources inventoried	2
Water needs prioritized	3
Impact task force(s) organized	9
Action plans developed for	
Agriculture	5
Bus./commerce/economics/energy	2
Fish and wildlife	3
Public water supplies	5
Recreation	3
Tourism	2
Water quality	3
Wildfire	6
Public info./education program	14
Local coordination mechanism	13
Federal cooperation program	13
State emergency funds	16
Problem Areas Identified	
Critical water supply areas	3
Vulnerable communities	13
Inadequate delivery systems	8
Shallow water intakes	6
Shallow wells	8
Inadequate groundwater	9
Critical stream reaches	4
Reduced effluent dilution	6
Special State Concerns	
Agriculture	19
Effluent dilution	6
Federal water/regulation claims	5
Hydropower	7
Instream flows/fish and wildlife	11
Other states' actions	8
Tourism/recreation	11
Salt water intrusion	4
Navigation	4
Wildfire	1

Source: Adapted from Tony Willardson, "State Drought Response Capability: A Regional Perspective," a paper provided by the Western States Water Council (June 1990). Twenty western states were surveyed.

TABLE 2-7

EXAMPLE EMERGENCY WATER ALLOCATION PRIORITY LIST

Priority Ranking	Water Use
1st	Water supplies (public and private) used for human consumption and sanitation.
2nd	Maintenance of the seven-day, ten-year low stream flow, $7Q_{10}$.
3rd	Water for livestock production.
4th	Maintenance of the seven-day, two-year low stream flow, $7Q_2$.
5th	Electrical power generation (other than hydroelectric).
6th	Hydroelectric power generation.
7th	Withdrawals for manufacturing or other industrial or commercial processes of less than one million gallons per day.
8th	Withdrawals for manufacturing or other industrial or commercial processes of greater than one million gallons per day.
9th	Water withdrawals for irrigation.
10th	Water used primarily for recreation and aesthetic purposes (such as lawns, golf courses, water rides).

Source: Jeffrey Prey and Terry Lohr, *The Wisconsin Water Quality Resources Management Plan, Report No. 9, Summary* (Madison, WI: Bureau of Water Resources Management, Department of Natural Resources, 1988), 19-20.

- **Class 1.** Essential consumptive water uses and all nonconsumptive uses (for example, human consumption).
- **Class 2.** Socially or economically important water uses that have a significant consumptive use, in terms of either total volume consumed or rate of consumption (for example, agricultural irrigation); and
- **Class 3.** Nonessential consumptive water uses (for example, golf courses).

A comprehensive state policy not only identifies priorities but addresses how to implement use restrictions when enforcement becomes necessary. Presumably, however, better water resource planning in general may help mitigate drought impacts in the first place, so that restrictions are infrequently needed. In sum, drought management planning, as well as emergency planning (needed in the case of chemical contamination or other crises) are areas ripe for improved integration with overall state water resource policy.

Many states have water resource policies promoting conservation in broad strokes. This often translates into protection and preservation of water resources in their natural state. In addition, some states on both coasts (and a few in between) are addressing long-term end-use conservation pragmatically by enacting water-efficient plumbing standards, as summarized in table 2-8. Where refrigerators typically account for a significant portion of household electricity use, the culprit in indoor water use is the toilet. As with efficiency standards for electric appliances, plumbing standards have the potential to reduce consumption substantially without necessarily impairing consumer lifestyles. Plumbing fixture efficiency can be expected to figure prominently in water utility conservation and demand management programs. This and other conservation strategies also may figure prominently in an integrated state planning approach.

State Water Resource Planning

Even with primacy, much of water planning at the state level can be linked to federal initiatives. The federal Water Supply Act of 1958 delegated responsibility for developing water supplies to the states and localities. State water planning was promoted in 1965 with the passage of the Water Resources Planning Act, the purpose of which was to encourage state involvement in water development

TABLE 2-8
STATE ENACTMENT OF WATER-EFFICIENT PLUMBING STANDARDS

State	Effective Date	Toilets (a)	Urinals (a)	Shower Heads (b)	Bathroom Faucets (b)	Kitchen Faucets (b)
California	01-01-92	1.6	1.0	2.5@80 psi	2.2@60 psi	2.2@60 psi
Colorado	01-01-90	3.5	-	3.0@80 psi	2.5@80 psi	2.5@80 psi
Connecticut	10-01-90	-	1.0	2.5	2.5	2.5
	01-01-92	1.6	-	-	-	-
Delaware	07-01-91	1.6	1.5	3.0@80 psi	3.0@80 psi	3.0@80 psi
Georgia						
Residential	04-01-92	1.6	1.0	2.5@60 psi	2.0	2.5
Commercial	07-01-92	1.6	1.0	2.5@60 psi	2.0	2.5
Massachusetts	03-02-89	1.6(c)	1.5	-	-	-
	01-01-88	-	-	3.0	-	-
	09-01-91	1.6(d)	-	-	-	-
New Jersey	07-01-91	1.6	1.5	3.0	3.0	3.0
New York	1980	-	-	3.0	-	-
	01-26-88	-	1.0	-	-	-
	01-01-91	-	-	-	2.0	-
	01-01-92	1.6	-	-	-	-
Oregon	07-01-93	1.6	1.0	2.5	2.5	2.5
Rhode Island	09-01-90	1.6(c)	-	2.5@80 psi	2.0@80 psi	2.0@80 psi
	03-01-91	1.6(d)	1.0	-	-	-
Texas	01-01-92	1.6(e)	1.0	2.75@80psi	2.2@60 psi	2.2@60 psi
Washington	07-01-93	1.6	1.0	2.5@80 psi	2.5@80 psi	2.5@80 psi

Source: Judith L. Ranton, City of Portland, Oregon, Bureau of Water Works as reported in *Small Flows* 5 no. 3 (July 1991), 3. *Small Flows* is a publication of the National Small Flows Clearinghouse located at West Virginia University.

(a) In gallons per flush.
(b) In gallons per minute, where psi = pounds per square inch.
(c) Two-piece fixtures.
(d) all others (besides two-piece fixtures).
(e) Two gallons or flow rate for ANSI ultra-low flush toilets, whichever is lowest for wall mounted with flushometers

decisionmaking. The result was substantial federal pressure on the states to prepare statewide water resource plans.[31] Federal grants pursuant to this legislation made it possible for many states to launch their planning efforts. The Water Resources Development Act of 1974 authorized the Corps of Engineers to cooperate with the states in preparing plans for the development, use, and conservation of water and related resources.

In recent years, many states have established their own statutory basis for water resource planning. Usually, planning is mentioned within the larger scope of a state water management strategy and administrative agency discretion is high. A selected sample of state water resource planning statutes appears in appendix B of this report. (Represented are the states of Arkansas, Hawaii, Indiana, Kentucky, New Hampshire, New Jersey, New York, and Pennsylvania.) Each statute reveals the distinct institutional character of individual state planning processes.

In some states, considerable controversy remains over the meaning and purpose of water supply planning. Conflict can become particularly acute when planning is juxtaposed against rights established under state water law, as occurs in the west. Opposition to state planning been especially pronounced in Colorado:

> In recent years, calls for a 'state water plan' have often been heard. To the extent that this terminology contemplates that state government would decide how, when, where, and to what uses the state's water resources are to be put, it should be obvious. . . that there is no place within our existing water rights for such a 'state water plan.' State government agencies simply do not have the authority to direct the allocation of Colorado's water resources [among] competing uses in the manner in which such terminology seems to contemplate.
>
> On the other hand, it should be equally clear that many state policies can and do influence the use and allocation of our water resources, even within the confines of our existing market oriented water rights system.[32]

A chief complaint about water resource planning in Colorado has been that no clear definition of a state water plan is available. As in the case of least-cost

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31 See Western States Water Council, *State Water Plans: Water Management Symposium* (proceedings of a conference sponsored by the Western States Water Council and held in Reno, Nevada, September 7-8, 1989).

32 J. William McDonald, "A Primer on Colorado's Water Policies," in *State Water Plans: Water Management Symposium* (proceedings of a conference sponsored by the Western States Water Council, Reno, Nevada, September 7-8, 1989), 7.

planning, definitions have a substantial impact on policy implementation and there is disagreement over which definition should be applied. One Director of the Colorado Department of Natural Resources focused attention this problem:

> The first meaning of a state water plan, at least for some people, is an inventory of supplies and projected demands. The purpose of the plan is to match up the two. In other words, you allocate the remaining water. . . .
>
> A second meaning of a state water plan is a proposal for development. Again, I'm not quite sure what development of water means, but most notably it would mean construction of dams, proposals to withdraw groundwater, etc.
>
> A third meaning of a state water plan is simply the specific plans to use all of our compact shares, in whatever river we're talking about.
>
> A fourth meaning of the state water plan is that it's a means to stop the 'abuses or excesses' of our current system, whatever that may mean to whoever is talking about it.
>
> Finally, the fifth meaning of a state water plan is to answer the guy who has no water, or doesn't have enough or can't afford more. . . .[33]

Many state water resource plans contain more than one of the elements identified above. Every plan has a unique character because it is designed to address planning issues and propose solutions based on the unique characteristics and needs of the states. Still, a basic categorization can be formulated. A 1982 survey of thirty-three states published by the Corps of Engineers found essentially five types of state water planning documents:[34]

- **Framework Studies and Assessments** are designed to: (1) inventory the extent of water and related problems and needs for the conservation, development, and utilization of water and land resources throughout the state; (2) indicate the general approaches that appear appropriate for their solution; and (3) identify specific geographic areas with complex

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[33] Chips Barry quoted in David W. Walker, "A Colorado Water Plan: Do We Have One?" in *State Water Plans: Water Management Symposium* (proceedings of a conference sponsored by the Western States Water Council held in Reno, Nevada, September 7-8, 1989), 5-6.

[34] *The State of the States in Water Supply/Conservation Planning and Management Programs* (Fort Belvoir, VA: Institute for Water Resources, U.S. Army Corps of Engineers, 1983), B-6.

problems where more detailed planning, investigation and analysis are needed. [Nineteen states as of 1982]

- **Regional or River Basin Studies** are reconnaissance-level evaluations of water and land resources more detailed in scope and more limited in area than the framework studies. They are prepared to resolve complex long-range problems identified by framework studies and vary widely in scope and detail. They identify and recommend action plans and programs to be pursued by state and local entities. Regional or river basin planning studies are concerned with a broad array of multiobjective component needs. [Four states as of 1982]

- **Water Supply Plans** are detailed water supply programs or project studies undertaken by the state for the purpose of recommending authorizing legislation or initiating management policies to solve municipal and industrial water supply problems. These single-purpose plans of action are designed to meet long-term needs and alleviate problems. [Four states as of 1982]

- **Water Policy Assessments and Analyses** are interagency taskforce planning processes which examine individually a series of water issues (for example, water quality, instream flows, municipal water needs, and so on) at the margin for the purpose of providing information, alternatives, or policies for action to state legislators for decisionmaking. This approach departs significantly from in-depth technical basin planning and work on the development of a "State Water Plan." [Four states as of 1982]

- **Water Program Reports** present the results of existing state water resource programs. They are usually published on an annual or biannual basis. They do not include in depth technical analyses nor do they present detailed plans for action to meet long-range needs. [Two states as of 1982]

The survey report noted a trend away from river basin assessments in favor of multipurpose or single-purpose development plans. The survey also revealed that fourteen states had included an analysis of municipal and industrial water purveyors in their water planning documents and twelve included a water conservation component.

State water resource planning has dimensions of both water *quantity* and water *quality,* although state regulatory responsibility in these areas is highly fragmented (especially in the area of permitting). As reported in appendix C, total water withdrawals in the United States for 1985 were 338 billion gallons daily, with 36.5 billion gallons daily for public water supply. Leading the nation's public supply withdrawals were California, Texas, New York, Illinois, and Florida.[35] The issue of water availability to meet demand is an issue in most states. Appendix D provides a survey of state water resource management and planning issues highlighting the areas of availability (surface water and groundwater), water quality, hydrologic hazards and land use, and institutional and management. Today, more and more state water resources are threatened by pollution and hazardous waste; a significant number of states also face issues such as interbasin conflict and a lack of interagency cooperation.

Based on the water resource planning experience in Montana, Richard Moy identified some of the key statewide water management and planning issues that might be found in typical state water resource plans, organized into the categories of water supply, water quality, and fish, wildlife, and recreation, and reported in table 2-9.[36] Moy also identified some of the basic objectives and implementation steps of state water resource planning, which appear in table 2-10. These represent a straightforward application of the basic planning model set forth in chapter 1. Emphasized are the goals of objectivity, balance among competing interests, coordination among participants, and evaluation of alternative courses of action. An example of the procedural implementation of a water resource protection program at the river basin level in the state of Washington appears in table 2-11. The emphasis here is on public involvement and the involvement of all government officials and private interests affected by the planning process. Planning procedures, of course, vary from state to state. In addition to procedural concerns, a key part of the process is in plotting the course that a state water resource plan will follow. Table 2-12 provides the scope of work published recently for the Arizona Water Resources Plan. It includes a mission statement, objectives, and a general outline set forth for use in developing the plan.

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35 Jerry E. Carr, Edith B. Chase, Richard W. Paulson, and David W. Moody, *National Water Summary 1987--Hydrologic Events and Water Supply and Use* (Washington, DC: U.S. Geological Survey, Water-Supply Paper 2350, 1990), 126-27.

36 Richard M. Moy, "Montana's Water Plan: An Incremental Approach," *State Water Plans: Water Management Symposium* (proceedings of a conference sponsored by the Western States Water Council in Reno, Nevada, September 7-8, 1989).

TABLE 2-9

STATEWIDE WATER MANAGEMENT AND PLANNING ISSUES

Water Supply

- Water allocation/water availability
- Federal reserved water rights
- Water conservation
- Drought management
- Water development/storage
- Hydropower siting
- Dam safety
- Flood protection
- Interstate/international water problems
- Instream flow protection
- Groundwater management
- Weather modification
- Water resource information

Water Quality

- Water quality standards
- Point-source pollution control
- Nondegradation
- Public water supply protection
- Groundwater quality protection
- Toxic waste disposal

Fish, Wildlife, Recreation

- Riparian zone management
- Endangered species
- Wetlands preservation
- Wild, scenic, and recreational rivers

Source: Richard M. Moy, "Montana's Water Plan: An Incremental Approach," *State Water Plans: Water Management Symposium* (proceedings of a conference sponsored by the Western States Water Council in Reno, Nevada, September 7-8, 1989), 6.

TABLE 2-10

OBJECTIVES AND IMPLEMENTATION OF STATE WATER RESOURCE PLANNING

Objectives of State Water Resource Planning

- The planning process must transcend jurisdictional boundaries and involve all interested and affected water users, resource managers, and policymakers.

- The public, user groups, and management agencies need to work together to resolve conflicts.

- Consensus solutions that participants perceive as fair and reasonable by should be pursued.

- The planning process must be objective and fair in balancing the competing water uses as well as both public and private values.

- The process must enhance coordination among all entities that have responsibility or interest in water management, whether it concerns groundwater, surface water, quantity and/or quality.

- Resulting plans must be continually updated and revised in light of new problems and opportunities and the planning process must be flexible enough to respond to new policies and changing conditions.

Implementation Steps in State Water Resource Planning

- Gather all pertinent data relevant to the study area and issue.

- Specify the components that are relevant to the planning area and issue.

- Formulate alternative plans to reach differing levels of development of the study area and issue and the entire basin or state.

- Review the objectives and analyze the differences between the alternatives.

- Select a plan based upon an evaluation of the trade-offs among various alternatives.

- Distribute a report on the plan for review.

- Present a recommended plan for adoption.

Source: Adapted from Richard M. Moy, "Montana's Water Plan: An Incremental Approach," *State Water Plans: Water Management Symposium* (proceedings of a conference sponsored by the Western States Water Council and held in Reno, Nevada, September 7-8, 1989).

TABLE 2-11

PROCEDURAL STEPS IN WATER RESOURCE PROTECTION FOR WASHINGTON STATE

1. Select a Water Resource Inventory Area to be addressed. A priority list has been established so the next WRIA on the list is chosen.
2. Collect, develop, and assemble existing data on the basin. An inventory of the existing socioeconomic conditions, instream and our of stream uses, surface and ground water resources, problem areas, etc., is conducted.
3. Hold one or more public meetings and coordination meetings with major interests. These are primarily held to involve the public, other state, federal, or local government officials and special interest groups in the program. Comments and recommendations by these interested parties are sought.
4. Develop and distribute a draft report including proposed administrative rules. A document is prepared and distributed to the public.
5. Provide public notice of proposed rules and hearings. Distribution of the draft provides public notice. In the draft report, public hearing dates are listed to notify individuals of the time, place, and date of public hearings.
6. Hold public hearing(s). Interested individuals or groups give formal public input at these hearings. Written comments are also received.
7. Respond to public comments and finalize report. Written and oral comments are responded to and incorporated into the final report which includes revised proposed rules. This final [report] is distributed to the public for comment.
8. Hold a final hearing. The director hears any final comments at this adoption proceeding and makes a decision whether or not to adopt the rules.
9. Develop a standard operating procedure. If the rules are adopted, a standard operating procedure is developed for implementation.
10. Implement the program. Implementation is done by staff at four regional offices throughout the state.
11. Review and update the program within five years after its implementation. this allows [the Washington Department of Ecology] to revise a regulation if necessary.

Source: Marsha Beery, "Overview of Washington State's River Basin Planning Program," *1st Annual WSWC Water Management Symposium Proceedings* (Denver, CO: Western States Water Council, 1984), 6-7.

TABLE 2-12

ARIZONA STATE WATER RESOURCES PLAN SCOPE OF WORK

Mission Statement

The Arizona Water Resources Plan will provide current and projected water supply and demand data, analyze institutional arrangements, and identify issues and concerns statewide and by planning areas (Phase I). The plan will then identify and recommend alternative management strategies for each planning area, and the state as a whole (Phase II).

Objectives

1. Establish an ongoing communications process that includes all major water users from all areas of the state.
2. Provide a comprehensive and concise database that is necessary for the planning process.
3. Provide an analysis of water resources institutions, and whether decisions on future water resources needs can be met by these institutions.
4. Provide a plan that recognizes water resources related planning activities on a statewide and local level.
5. Identification of where data are inadequate and where further research is required.
6. Establish a flexible and responsive plan that is maintained and updated in accordance with changes in assumptions and data.

General Outline (Phase I)

1. Executive Summary
2. Introduction and Background
3. Statewide Physical, Demographic, Economic, and Environmental Considerations
4. Statewide Water Supplies and Demands
5. Statewide Legal/Regulatory/Institutional Considerations
6. Planning Area Analysis (For Each Area)
7. Statewide Issues and Challenges
8. Potential Alternative Strategies for Phase II

Source: Adapted from Arizona Department of Water Resources, "The Arizona State Water Resources Plan Phase I, Scope of Work (Draft)," August 1, 1990.

NRRI Survey on State Water Resource Planning

An NRRI telephone survey on water resource planning was conducted in early 1991, supplemented with other data sources.[37] Appendix E reports the detailed state-by-state results of the survey and highlights appear in table 2-13. All fifty states were surveyed in an essentially open-ended fashion to find out whether water resource planning occurred at the state level.[38] In addition, the survey was used to inquire about: the legal authority on which planning is based; planning process attributes; state, regional, or local agency coordination of the planning process; the time period in which water resource planning was initiated; and the completion date for the most recent planning document. Though not every contact person could provide all the information, these data typically provide a useful portrait of the current approach to water resource planning in each state.

Forty states appear to be undertaking some form of comprehensive water supply planning. Included are three states (Indiana, Mississippi, and Missouri) where implementation of comprehensive planning is now underway. For example, the Mississippi Water Resources Task Force recently submitted an interim report to the governor highlighting recommendations in twenty-three policy areas, including:[39]

- Endorsement of the concept of conservation.
- Water law and conservation education programs.
- Water-saving-device legislation.
- Drought and conservation contingency planning.
- Public water supply planning for catastrophic events.
- Increased financial support for research, development, and implementation of best water-use practices.

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[37] Of particular use in supplementing the survey were the papers presented in Western States Water Council, *State Water Plans: Water Management Symposium* (proceedings of a conference held in Reno, Nevada, September 7-8, 1989).

[38] All of the states were surveyed on the issue of water resource planning, even though some (Georgia, Minnesota, Nebraska, North Dakota, South Dakota, and Washington, D.C.) do not have commission jurisdiction over water utilities.

[39] Adapted from *Interim Report by the Mississippi Water Resource Planning Task Force* (January 1991).

TABLE 2-13

SUMMARY OF NRRI SURVEY ON STATE WATER RESOURCE PLANNING

State	Does the state conduct comprehensive planning?	When did the state initiate planning? (approximate)	What type of agency does the planning? (a)	What is the scope of the planning approach?
Alabama	yes	1989	GP	Regional
Alaska	no(b)	-	-	-
Arizona	yes	1940	W	Statewide
Arkansas	yes	1969	W	Basinwide
California	yes	1947	W	Statewide
Colorado	no	-	-	-
Connecticut	no(c)	-	-	-
Delaware	yes	1981	GP	Statewide
Florida	yes	1986	GP	Regional
Hawaii	yes	1987	W	Statewide
Georgia	yes	1981	GP	State/basinwide
Idaho	yes	1976	W	Basinwide
Illinois	yes	1967	GP	Statewide
Indiana	underway	1983	GP	Basinwide
Iowa	yes	1983	GP	Statewide
Kansas	yes	1985	W	Basinwide
Kentucky	yes(d)	1990	-	Local
Louisiana	no(b)	-	-	-
Maine	no	-	-	-
Maryland	yes(e)	na	-	Local
Massachusetts	yes	1979	W	Basin/statewide(f)
Michigan	no	-	-	-
Minnesota	yes	1979	W	Statewide
Mississippi	underway	1985	W	Statewide
Missouri	underway	1989	GP	Statewide
Montana	yes	1988	GP	Basin/statewide
Nebraska	yes	1971	W	Regional/statewide
Nevada	yes	na	GP	Statewide
New Hampshire	yes	1983	GP	Statewide
New Jersey	yes	1981	GP	Statewide

TABLE 2-13 (continued)

State	Does the state conduct comprehensive planning?	When did the state initiate planning? (approximate)	What type of agency does the planning? (a)	What is the scope of the planning approach?
New Mexico	yes	na	W	Statewide
New York	yes	1984	(g)	(g)
North Carolina	yes	1989	GP	Local/statewide
North Dakota	yes	1968	W	Statewide
Ohio	yes	1967	GP	Basinwide
Oklahoma	yes	1974	W	Statewide
Oregon	yes	1955	W	Statewide
Pennsylvania	yes	1966	GP	Statewide
Rhode Island	yes	1989	W	Statewide
South Carolina	no	-	-	-
South Dakota	yes	1972	W	Statewide
Tennessee	no	-	-	-
Texas	yes	1957	W	Statewide
Utah	yes	1990	W	Statewide
Vermont	no	-	-	-
Virginia	yes	1981	W	Basinwide
Washington	yes	1971	GP	Statewide
West Virginia	no	-	-	-
Wisconsin	yes	1985	GP	State/basinwide
Wyoming	yes	1982	W	Basinwide

Source: 1991 NRRI Survey on State Water Resource Planning. See appendix --.

(a) GP = General purpose agency with water as part of responsibility
W = Department, appointed authority, board, or commission having sole responsibility regarding water resources.
(b) Data regarding water supply and use is collected. In Louisiana, water demand projections are periodically prepared.
(c) Water utilities are required to submit supply plans and form regional authorities for water management planning.
(d) Counties and groups of counties are required to develop long-range water supply plans.
(e) County comprehensive plans are developed.
(f) A local planning process feeds into the statewide planning process.
(g) A statewide water management strategy is composed of 13 substate water resource management strategies, administered by the Department of Health, Department of Environmental Conservation, and regional planning and development boards.
na = not available

Widespread state involvement in water resource planning occurs in every state, with the exception of Kentucky and Maryland where state-mandated planning is conducted entirely at the county level. In Kentucky, county governments or groups of counties are required to develop long-range water supply plans. In Maryland, county governments alone are required to develop comprehensive water resource plans. Though comprehensive planning apparently is not performed in Alaska, Connecticut, or Louisiana, some supply related activity is occurring. In Alaska and Louisiana, resource data are collected and analyzed to evaluate current water supplies and usage. Moreover, projections of future water demand are completed periodically in Louisiana.

The responses indicate that state governments increasingly are taking steps to evaluate current water resource conditions, project future demand for water as well as future resource availability, and implement planning and control measures such that future water demand can be met. Indicative of the relatively recent advent of this approach, a considerable increase in state planning occurred during the 1980s. While twelve states initiated some type of water resource planning during the 1960s and 1970s, twenty-one started their processes during and after 1980. The survey identified only four states that initiated planning prior to 1960.

A principal finding of the survey was the variety of planning formats and processes. The organizational structure and jurisdictional responsibilities of the lead planning agencies vary from state to state. Typically, water resource planning is coordinated either by a general purpose executive agency, or an executive agency or appointed authority, board, or commission with the specific responsibility of managing water resources. Twenty states coordinate water resource planning through a water management agency or appointed body. Eighteen have lumped the responsibility for water resource planning into a general purpose executive agency, such as a natural resources department.

State water resource planning documents vary in size, style, and scope. Many emphasize broad policy goals and are relatively short in length, leaving room for more detailed documentation in later reports. Some are lengthy by virtue of detailed statistical data on water supply and demand. An emerging objective in many states is to maximize flexibility, thereby extending the life of the state water plan. Utah published its first comprehensive state water resource plan in 1990, using a three-ring-binder, "living-document" format that allows for updates of its twenty topical sections as needed. A public review draft was released prior to finalization of the plan. The plan's coverage is broad in scope and includes a section on federal water planning and development. It is the product of a time-consuming four-year process involving many different government agencies as well as private input. The general state plan will be supplemented by ten river basin plans that are more specific but follow the same format.

The level of authority vested in a given water resource management plan or strategy also varies. While several states have produced water resource plans mandating various planning related activities, many others have embarked on water resource evaluations or studies resulting in recommendations for further action by government and industry. A review of the water resource planning activities of selected states reveals the authoritative nature of state planning strategies as well as the effects their various stipulations or recommendations might have on water utilities and their regulators.

The New York Water Resources Management Strategy includes several recommendations related to planning and water management. Universal water service metering and surface water filtration is recommended, as is registration of water withdrawals exceeding 100,000 gallons a day and the requirement that registrants implement certain conservation measures. Implications of the strategy for water utilities are discussed below.

In Alabama, a Water Resources Study Commission called for a comprehensive system of water resource management, including establishment of a state water resources agency for planning and water management and a state water resources commission for policymaking and adjudication of disputes. In addition, the commission recommended consumptive use permitting by the state, mandatory conservation measures, and drought management planning for water users.

Delaware's Comprehensive Water Resources Management Committee completed a similar assessment of that state's water resources and recommended various measures to initiate more comprehensive resource management. The committee called for statewide water resources monitoring, forecasts of water supplies and demand, planning for future demand, consumptive use permitting, and mandatory conservation and drought management measures. A regionalization policy also was recommended as a means of improving interconnection of the water supply and distribution system within the state as well as a way to curtail the proliferation of water systems considered too small to provide safe and reliable service efficiently.

The Georgia Water Resources Management Strategy is a compilation of various state water resource laws, including sections on consumptive use permitting and conservation and drought management planning. Water withdrawal (use) permits are required of nonagricultural users withdrawing more than 100,000 gallons a day. Moreover, users holding water withdrawal permits are required to develop water conservation and drought management plans. The state Environmental Protection Agency is required to have an emergency water shortage plan and is empowered to control withdrawals during times of drought. In the area of long-term conservation strategies, installation of water-efficient plumbing fixtures is required in new and rehabilitated structures.

As in Georgia, Florida's water policy is written into the state's administrative code and is administered by the Department of Environmental Regulation. The policy contains several planning and conservation related requirements, including water use permitting and proof of reasonable or beneficial use of the water by applicants. Under certain conditions, the policy stipulates the use of conservation measures and reuse of reclaimed water. In fact, water conservation is required unless it proves economically or environmentally infeasible, and conservation measures can be considered in determining whether water use is reasonable or beneficial. Reusing reclaimed water is required in areas designated to have critical water supply problems, unless reuse is not economically, environmentally, or technically feasible.

One of the most recent and comprehensive set of recommendations for statewide water resource management has been published by the state of Minnesota. An important feature of the Minnesota Water Plan is its integration of the typical plan components--namely evaluation and forecasting activities, and control and conservation measures--with a strategy aimed at coordinating various water management activities and improving water protection awareness. A key recommendation calls for programmatic and jurisdictional coordination of water resource protection and management. The plan advocates establishing and monitoring a statewide strategy to coordinate implementation of various programs among the state's numerous water resource and related agencies. This element calls for coordination in the regulation of water quality and quantity, industrial, and residential development, and land use. The plan also emphasizes the need for better training of water managers and policymakers at all levels of government and better education of the public about the importance of water management, protection, and conservation. Another recommendation calls for a greater emphasis on research and data collection relating to water management by government agencies and state universities, enforcement of state water laws, and strategies for upgrading the water supply infrastructure, including modes of financing water system improvements.

In terms of the structure of the state water supply plans, twenty-eight states indicated that their plans were statewide in scope, while nine utilized some type of substate planning approach based on river basins, regional authorities, or local government entities. In many instances, substate planning is performed in conjunction with the broader statewide process. River basin planning has been implemented in Arkansas, Massachusetts, Wisconsin, and Nebraska (where river basin plans are developed by regional natural resource districts). Supply planning in Wisconsin occurs at two levels, with separate development of river basin management plans and statewide groundwater and surface water plans. In Massachusetts, the combination of separate river basin plans and various local water supply plans feeds into a centralized state water planning process.

Similar to Nebraska, regional planning and management authorities perform water planning activities in Alabama, Connecticut, and Florida (though not on a river basin basis). The regional water management districts in Florida are responsible for allocating water by assigning consumptive use permits. Connecticut law not only requires water utilities to submit supply plans for state approval, but that water utilities form regional cooperation authorities for planning purposes in water management regions. Finally, local government entities perform water supply planning in Kentucky (counties and groups of counties), Maryland (counties), Massachusetts, and North Carolina. While local planning in Massachusetts and North Carolina feeds into the state water planning process, the state merely oversees the rather freestanding local planning structures in Kentucky and Maryland.

Utility and Regulatory Implications

The existence of a state water resource plan can have a substantial effect on other federal and state agencies and programs, including other statewide plans.[40] Water resource planning, land-use planning, and planning for economic development,

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[40] See, for example, Lynn McIntosh and Allen Shea, *The Wisconsin Water Quality Resources Management Plan, Report No. 1, Overview* (Madison, WI: Bureau of Water Resources Management, Department of Natural Resources, 1987), 10.

for example, are intrinsically related.[41] Without coordination, these processes may work at cross purposes.

State water resource planning also can have sweeping implications for water supply utilities, including privately owned utilities regulated by the state public utility commissions. The utility sector can play an important role in implementing both long-term resource strategies (such as development of selected water resources) and drought and emergency management (such as imposing water-use restrictions). Also, planning options for public utilities may be *limited* by state water resource policies, such as restrictions on water withdrawal permits.

For example, the planning strategy for the State of New York recommends that the Department of Environmental Conservation and the Department of Health require water utilities serving more than 5,000 people to submit water supply management plans that include:[42]

- A water conservation program.
- Assessment of the safe yield and capacity of existing sources and facilities.
- Analysis of present and future demands, including the evaluation of the effectiveness of water conservation.
- A source and facility development program to meet current and projected demands.
- A system rehabilitation and improvement program, and preventive maintenance plan.
- A capital expansion and improvement plan.
- A contingency plan, including emergency sources (especially for droughts), interconnections for flexible and reliable system operation, water use restrictions, emergency response, and other appropriate actions.
- The creation of or revision to watershed rules and regulations.

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41 On the relationship of land use to water quality, see American Society of Civil Engineers, *Management of Urban Storm Runoff* (Springfield, VA: National Technical Information Service, PB-234-316, 1974).

42 New York State Water Resources Planning Council, *Water Resources Management Strategy* (Albany, New York: New York State Water Resources Planning Council, January 1989), SR-7.

Another important aspect of the New York planning strategy is that it calls for technical and financial assistance in the preparation of plans, including the development of a guidance manual and pilot management plan by the state.

Connecticut provides another example of state planning policies directly affecting water utilities. Although formal statewide water resource planning is not conducted, Connecticut water utilities are required by law to develop and submit to the state, for approval, their own water supply plans. State law further requires water utilities to form Regional Cooperation Authorities by which coordinated water management planning is to be conducted within specified water management regions.

Some state planning documents, and the statutes or administrative rules under which they were prepared, may provide a precedent for regulatory planning policies. Certainly, the formulation of an integrated resource planning policy for regulated public utilities requires consideration of the parameters set for in the appropriate state plans. Consideration of statewide policy goals, such as resource conservation, may be especially important. Commissions need to be aware of restrictions that may limit access to future water supplies by jurisdictional water utilities.

The process of planning may or may not include public utilities or their regulators. It may be incumbent on affected parties to become involved in the planning process at a stage early enough to make a difference. Unfortunately, the state public utility commissions are generally not well integrated within state water resource policy infrastructures, which may include the governor's office, the legislature, and any number of bureaucratic agencies. Also not well integrated in long-term planning are the state agencies responsible for compliance with federal drinking water standards. These public health or environmental agencies may issue operating permits or approve utility plans for treatment facilities, but are not necessarily consulted on the issue of resource planning.

The biggest obstacle to fully integrated water resource planning at the state level remains the fragmentation of government authority and policy. Different state agencies are responsible for different areas of water quantity and quality regulation. This is clearly apparent in the area of permitting. A water provider may be required to have a withdrawal permit from one agency, an operating permit from another agency, and a certificate of convenience and necessity from another. Typically, no central clearinghouse exists for information and data on a state's water utilities. The policy implications of this situation are becoming more obvious. Without interagency coordination the state cannot necessarily ensure that a given supply option proposed by a utility is one that satisfies the separate regulatory standards of environmental protection, public health, and least cost.

The California Memorandum of Understanding between the Department of Health Services and the Public Utilities Commission ("On Maintaining Safe and Reliable Water Supplies for Regulated Water Companies in California"), which appears as appendix F of this report, remains one of the best examples of interagency coordination at a level that promotes joint policymaking for water quantity and quality. More generally, interagency coordination can help agencies accomplish several mutual goals, such as:

- Developing comprehensive water policy goals for the state.
- Optimizing mutual water policy expertise among agencies.
- Avoiding duplicate efforts in water planning and management.
- Making informed and consistent policy decisions for the state.
- Providing less fragmented and more effective regulatory oversight.
- Providing checks and balances, especially in regulating small systems.
- Avoiding conflicting policy signals.
- Avoiding confrontations among agencies.
- Supporting each other politically and before the public.
- Ensuring high quality water at the least cost.

Appendix G provides a listing of the state agencies responsible for four aspects of water resource management planning: drinking water, water quality, groundwater protection, and water resources. Improved coordination among these state agencies would constitute a giant step toward integrated water resource planning. This may require a new legal framework for water policy at the state level and possibly a reorganization of some state authorities.

Although coordination among all of a state's water resource agencies may be wishful thinking it should not be ruled out. In any such scheme, the state public utility commissions should not be ignored. Absent the comprehensive integration of water resource planning, commission policy can promote integrated planning in other respects, cognizant of the larger planning context. The role of the state commissions in these regards is the subject of the next chapter.

CHAPTER 3

THE COMMISSION ROLE IN WATER RESOURCE PLANNING

As mentioned, state public utility commissions are not well integrated into the state water resource policy infrastructure. A key reason for this is the perception that commission jurisdiction in water is too limited to have much of an impact on statewide water policy. In some cases, this perception may be the reality, as seen in table 3-1. Although there are more than 50,000 water systems in the United States, only about 10,000 are under the jurisdiction of the state commissions and many of these serve relatively small population centers. Commission regulation is confined mainly to economic issues and directed at the investor-owned water utility industry; most large water utilities (serving most of the population) are municipal owned and therefore generally are exempt from commission regulation. Although a dozen commissions have some jurisdiction over municipal water utilities, it is generally limited.[1] Commission regulation of water utilities is entirely nonexistent in five states.[2] There also is an understandable preoccupation on the part of regulators with the very small and often nonviable water utilities under state commission jurisdiction.[3] Long-term planning is hardly the priority for these small systems, nor a realistic public policy goal.

Still, planning should not be ruled out as a potential regulatory tool on the basis of these limitations. For thousands of water systems and their ratepayers, planning may provide an important means of coping with the rapidly changing character of water supply, including more stringent drinking water regulations and the rising cost of complying with them. Moreover, jurisdictional water utilities

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1 Janice A. Beecher and Ann P. Laubach, *1989 Survey on Commission Regulation of Water and Sewer Utilities* (Columbus, OH: The National Regulatory Research Institute, 1989).

2 The five states are Georgia, Minnesota, Nebraska, North Dakota, and South Dakota. Water utilities are not regulated in Washington, D.C. or Puerto Rico either. Counting the Virgin Islands, there are forty-six state commissions with jurisdiction over water utilities.

3 See Raymond W. Lawton and Vivian Witkind Davis, *Commission Regulation of Small Water Utilities: Some Issues and Solutions* (Columbus, OH: The National Regulatory Research Institute, 1983).

TABLE 3-1

WATER SYSTEMS IN THE UNITED STATES

Total Water Systems(a)	Number of Systems
Public	
Local, municipal government	23,248
Federal government	528
On Indian land	127
Subtotal	23,903
Private	
Investor-owned	7,702
Homeowners' association or subdivision	6,163
Other	661
Not available	178
Subtotal	14,703
Ancillary	
Mobile home parks	10,150
Institutions	535
Schools	458
Hospitals	91
Other	2,638
Not available	31
Subtotal	13,903
Total Water Systems	**52,509**

Jurisdictional Water Systems(b)	Number of Systems	Number of States
Investor-owned	4,527	46
Municipal	2,615	15
Water districts	1,176	9
Cooperatives	1,349	13
Homeowners' associations	114	9
Other systems	155	7
Total Jurisdictional Water Systems	**9,936**	**46**

Sources: (a) Frederick W. Immerman, *Financial Descriptive Summary: 1986 Survey of Community Water Systems* (Washington, DC: Office of Drinking Water, U.S. Environmental Protection Agency, 1987), table 2-2; and (b) 1989 NRRI Survey on Commission Regulation of Water and Sewer Systems.

could take the lead in promoting integrated planning for the water sector and establish precedents for nonjurisdictional utilities to follow.

This chapter addresses the issue of the commission role in implementing water resource planning and related issues. One is the extent to which commissions currently address planning for water supplies. Another is the adaptation of integrated energy resource planning techniques (already in use by a number of commissions) to water. Still another is the added responsibility that planning brings to the commissions. Perhaps most challenging is the reconciliation of traditional rate of return regulation and integrated resource planning. Many analysts have pointed out that without changes in regulation, least-cost planning will not yield desired results, mainly because of the problem of devising incentives that induce utilities to perform in ways that are consistent with least-cost planning criteria.[4]

NRRI Survey on Commission Planning

A 1990 survey of state public utility commissions asked staff to provide information about planning activities related to water utilities. The state-by-state results are provide in appendix H. Table 3-2 provides a summary.

One of the basic tools of regulatory oversight is the utility's annual report to the commission. Annual reports are filed in all forty-six commissions with jurisdiction, and all include financial data about the utility. An outline of a typical annual report filed with the regulatory commissions appears in table 3-3. Five commissions exempt some utilities from filing annual reports while some smaller utilities are exempt in Maine, New York, and Rhode Island. Connecticut exempts homeowners' and condominium associations and Montana exempts nonprofit systems. Simplified forms are used in twenty-six states. Only one state commission, Delaware, indicated that some recently added sections of the report address long-term planning issues. It is possible that the annual report for water utilities could evolve as a better planning tool, at least in making it a basic source of supply data for regulators. In any case, annual water utility reports actually may grow in complexity as increasing financial obligations associated with system improvements affect the industry.

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[4] For a representative discussion, see David Moskovitz, "Will Least-Cost Planning Work Without Significant Regulatory Reform?" a speech to the National Association of Regulatory Utility Commissioners in Aspen, Colorado, April 12, 1988.

TABLE 3-2

SUMMARY OF NRRI SURVEY ON COMMISSION PLANNING ACTIVITIES AFFECTING WATER UTILITIES

Survey Questions	Number of Commissions
Water Utility Annual Reports	
Are annual reports filed?	46
Are some utilities exempt from reporting?	5
Is a simplified form available?	26
Do reports include financial data?	46
Do reports address long-term planning?	1
Water Supply Planning	
Are long-term supply plans required?	9
Are some utilities exempt from planning?	4
Is a long-term supply planning policy under consideration?	8
Does another agency prepare a statewide water resource plan?	30
Water Conservation, Demand Management, and Drought Planning	
Is there a policy on conservation or demand management?	14
Has conservation been addressed in rate cases or other cases?	35
Is there a policy on drought management?	12
Are drought contingency plans required?	9
Water Supply Shortages	
Have any water systems been affected by supply shortages?	34
Reason for supply shortage*	
Drought	21
Population growth	16
Impairment of supplies	14
Other	8

Source: 1990 NRRI Survey on Commission Regulation of Water Systems. A total of 46 commissions (all of those with jurisdictional water utilities) responded to the survey. See appendix H.

* More than one reason could be mentioned.

TABLE 3-3

ANNUAL REPORT OUTLINE

Chief Officer's Statement of Authenticity (notarized)
Descriptive Information
Comparative Balance Sheet: Assets and Other Debits · Utility plant, other property investments, current and accrued assets, deferred debits.
Comparative Balance Sheet: Liabilities and Other Credits · Proprietary capital, long-term debt, current and accrued liabilities, deferred credits, operating reserves, contributions in aid of construction.
Plant in Service · Intangible plant, source of supply plant, pumping plant, water treatment plant, transmission and distribution plant, general plant.
Accumulated Provision for Uncollected Accounts
Capital Stock
Long-Term Debt
Accumulated Provision for Depreciation of Utility Plant in Service
Income and Earned Surplus Statement · Utility operating income, other income, miscellaneous income deductions, interest charges, earned surplus, credits during the year, debits during the year.
Operating Revenues · Sales of water, other operating revenues.
Operation and Maintenance Expense Accounts · Source of supply expenses, pumping expenses, water treatment expenses, transmission and distribution expenses, customer accounts expenses, sales expenses, administrative and general expenses.
Descriptive of Facilities · Source of supply facilities, reservoirs and standpipes, power and pumping equipment, water treatment plant, mains, services and meters, hydrants.
Power, Pumping, and Purchased Water Statistics

Source: Derived from "Major Water Utilities Annual Report to the Delaware Public Service Commission" (Doc. #3011851204).

Nine state commissions require some form of long-term planning for water utilities, though four provide exemptions. In Nevada, for example, planning is required of larger utilities and characterized as least-cost while Rhode Island characterized these plans as traditional. Planning in Missouri is of the traditional and integrated resource varieties. At the time of the survey, eight commissions were considering a long-term water supply planning policy. Finally, in thirty states commission respondents said they were aware that another state agency prepared a statewide water resource plan.

Commission staff were also asked about water conservation, demand management, and drought contingency planning. Fourteen commissions reportedly have established a policy on water conservation or demand management (for Missouri, "no" on the former and "yes" on the latter). More than twice as many (thirty-five), however, have addressed water conservation in rate cases or other proceedings. Twelve state commissions have a policy on drought management for their water utilities; nine require drought contingency plans. In Rhode Island, utility drought plans are not required, but utilities adhere to the Commission's drought policy.

Respondents in thirty-four states acknowledged that jurisdictional water systems had been affected by supply shortages. Twenty-one of these states were east of the Mississippi River, thirteen were west. The three principal reasons for the shortages were: drought (mentioned in twenty-one cases), population growth (sixteen cases), and impairment of supplies (fourteen cases). States in both the east and the west have experienced these problems and seven commissions were familiar with all three. Other reasons provided for supply shortages were:

- Lack of planned expansion (Connecticut)
- Overuse of aquifer (Mississippi)
- Demand-management problems (Missouri)
- Shortage due to unmetered system (New Hampshire)
- Use of aquifer beyond capacity (New York)
- Poor system design and system overload (Oklahoma)
- Leaking distribution system (Vermont)
- Poor system operation (Wyoming)

Finally, table 3-4 reports on water utility expansion planning. In 1989 expansion plans were filed in twenty-five state commissions. Delaware is unique in that plans are filed with the state Department of Natural Resources and Environmental Control but provided to the commission. Ten commission respondents reported that expansion plans were contested in their states. The data indicate a fairly significant amount of commission activity in this area and a potential need for new analytical tools in the decisionmaking process as well as methods of conflict resolution. Integrated resource planning may be suited to these emerging commission needs.

Commission Experience with Integrated Resource Planning

Fortunately, commission experience with least-cost or integrated resource planning for electricity and natural gas utilities appears to be largely transferable to water utilities, with some straightforward modifications. As table 3-5 indicates, commission experience with conservation, demand management, and least-cost planning is significant, though mostly for electricity utilities. By the end of 1990, thirteen state commissions had least-cost electricity planning programs in place; several more had programs under implementation (six commissions), under development (sixteen commissions), or under consideration (five commissions).

The uses of planning by regulatory agencies are numerous. A survey by the staff of the Arizona Corporation Commission found that the most common uses of least-cost planning in the electricity sector are:[5]

- To approve generation projects prior to construction.
- To improve staff or commission review of energy supply and demand factors in rate cases.
- To inform the commission of major issues in energy supply and demand.
- To induce utilities to improve their long-range planning.

5 Arizona Corporation Commission, *Regulatory Institutions,* 7.

TABLE 3-4

WATER UTILITY EXPANSION PLANNING

State Commission	Were any expansion plans filed in 1989?	Were any of these plans challenged?	State Commission	Were any expansion plans filed in 1989?	Were any of these plans challenged?
Alabama	no	na	New Hampshire	no	na
Alaska	no	na	New Jersey	no	na
Arizona	yes	no	New Mexico	yes	yes
Arkansas	no	na	New York	no	na
California	yes	yes	North Carolina	na(b)	na
Colorado	no	na	Ohio	yes	yes
Connecticut	yes	yes	Oklahoma	no	na
Delaware	yes(a)	yes	Oregon	no	na
Florida	yes	no	Pennsylvania	yes	na
Hawaii	yes	no	Rhode Island	yes	yes
Idaho	no	na	South Carolina	yes	no
Illinois	yes	no	Tennessee	na	na
Indiana	yes	no	Texas	yes	na
Iowa	no	na	Utah	no	na
Kansas	no	na	Vermont	no	na
Kentucky	yes	no	Virginia	no	na
Louisiana	no	na	Washington	yes	no
Maine	yes	no	West Virginia	yes	yes
Maryland	yes	no	Wisconsin	yes	yes
Massachusetts	no	na	Wyoming	no	na
Michigan	yes	no	Virgin Islands	no	na
Mississippi	yes	yes			
Missouri	yes	no			
Montana	yes	no			
Nevada	yes	yes	**Number of commissions responding yes**	25	10

Source: 1990 NRRI Survey on Commission Regulation of Water Systems.

na = not applicable/not available

(a) Filed with the Department of Natural Resources and Environmental Control and provided to the commission.
(b) Utility expansion plans are not filed with the commission.

TABLE 3-5

COMMISSION ADOPTION OF CONSERVATION, DEMAND-SIDE MANAGEMENT, AND LEAST-COST PLANNING FOR ELECTRIC AND GAS UTILITIES

	Number of Commissions with Programs Addressing					
	Conservation		Demand-side Management		Least-Cost Planning	
Status	Gas	Electric	Gas	Electric	Gas	Electric
In practice	30	39	15	28	0	13
In implementation	6	5	8	6	5	6
Under development	0	2	3	7	8	16
Under consideration	1	1	1	1	6	5
Not actively considered	14	4	24	9	32	11
Total	51	51	51	51	51	51

Source: Survey of commission staff reported in Mary Ellen Fitzpatrick Hopkins, "Least-Cost Planning for Gas Utilities," *Public Utilities Fortnightly* 126 (November 8, 1990): 53.

Based on commission experience with integrated energy resource planning, a number of institutional impacts have been identified, as listed in table 3-6.[6] These impacts are grouped according to procedure (such as the consideration of risk and cost in utility planning and commission review), application (such as informing the commission on major supply and demand issues), and effects (such as reduced chances of excess capacity, lower costs, and lower rates). All of these issues arise in applying integrated resource planning to water. Certainly the reasons for implementing integrated energy resource planning (such as rising costs and uncertainty), are becoming familiar to the contemporary water industry.

Few commissions, therefore, must "reinvent the wheel" for water utilities. In fact, some planning issues for water are far simpler than for the energy sectors

[6] David Berry, "Least-Cost Planning and Utility Regulation," *Public Utilities Fortnightly* 121 (March 17, 1988): 14.

TABLE 3-6

INSTITUTIONAL IMPACTS OF INTEGRATED ENERGY RESOURCE PLANNING

Procedural Impacts

- Integration of demand and supply analysis concerning electricity and possibly other energy issues
- Incorporation of demand management alternatives and supply alternatives into commission review and utility planning
- Consideration of risk and cost in utility planning and commission review
- Continual review of supply and demand issues by commission

Application of Integrated Resource Planning

- Evaluating proposed generation or transmission projects
- Improving commission review of energy supply and demand factors in rate cases or other proceedings
- Informing the commission on major issues in energy supply and demand
- Inducing utilities to improve their long-range planning

Effects of Integrated Resource Planning

- Improved commission review of utility plans and proposed projects
- Allowance for prospective assessment of generation and transmission projects
- Greater utility acceptance of demand management and alternatives sources of supply
- Adoption of wider scope of demand and supply alternatives by utilities
- Reduced chances of excess capacity
- Lower costs, lower rates
- Improved knowledge of energy supply and demand issues
- Greater public involvement in planning issues

Source: David Berry, "Least-Cost Planning and Utility Regulation," *Public Utilities Fortnightly* 121 (March 17, 1988): 14.

because of the simpler technologies involved and the straightforward measurement of water (a gallon is a gallon, unlike the complexity of measuring units of electrical energy). Most of the basic planning concepts (such as avoided cost), standards of service (such as reliability), and evaluation methods (such as cost effectiveness) are readily transferable. Unique to water are such issues as safe yield and drinking water standards. These do not necessarily pose a barrier to integrated resource planning, though they may constitute a priori planning criteria. Another unique aspect of water is the relationship between supply and demand (that is, in dry weather supplies are depleted while demand increases). Still another issue is the highly interdisciplinary nature of the water sector. These features only lend support to the rationale for integrated resource planning.

Commission experience with least-cost energy planning includes both individual utility plans and statewide planning processes, the latter sometimes incorporating or coordinating with utility plans. David Berry of the Arizona Corporation Commission compared these approaches.[7] In the *utility planning* approach, the utility prepares a plan using carefully developed commission guidelines and rules. The utility "buys-in" to the least-cost planning process and plans are subject to commission approval. The approach emphasizes the development of rules and guidelines and relies heavily on utilities for data and methods of analysis. In the *statewide planning* approach, commission staff or a state energy office develops a statewide analysis of demand and supply, including demand management and alternative supply sources. Statewide analysis is regularly presented to the commission and is used to help organize thinking about regulatory and energy issues and as a reference point in evaluating utility plans and projects. The approach is ends-oriented and independent of utilities in terms of analytical methods.

Statewide planning for water by public utility commissions alone would be extremely difficult. In many cases, commission jurisdiction encompasses many water systems, but only a small portion of all customers served by community water systems. Statewide water resource planning requires coordination by a state agency with broader authority.

This is not to say that public utility commissions have no role to play. Within the commissions a coordinated planning effort can occur, even if it is not comprehensive across all water systems in the state. Moreover, the commission can

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[7] Ibid.

participate with other agencies in the water planning process. This is comparable to the case in energy when statewide planning is facilitated by a state energy or other policy office.

The greatest potential for commission application of integrated water resource planning is in requiring utilities to perform a more comprehensive planning process, taking into consideration the planning context (including relevant state laws and resource plans) and the adaptation of state-of-the-art approaches to least-cost energy planning. Furthermore, commissions can incorporate least-cost planning standards in other forms of regulatory oversight, particularly ratemaking.

Elements of Integrated Water Resource Planning

As introduced in chapter 1, integrated resource planning departs from traditional supply planning in its emphasis on the comprehensive evaluation of supply and demand alternatives and a more open and participatory decisionmaking process. With water resources there is an added concern for the integration of utility and regulatory planning processes with other planning processes affecting the water sector, discussed in chapter 2.

The key elements of integrated resource planning, as developed for electricity utilities by Eric Hirst, are presented in table 3-7.[8] The first is integration of resources. As in electricity, water resources can be broadly defined in terms of supply, demand, system facilities, and pricing. System facilities with significant water losses can constitute an important water resource. In addition, there may be multiple source-of-supply options with different cost characteristics. Pricing water to accurately reflect costs is an ongoing concern in water supply.[9]

Second on the list is integration of people and departments within the utility. This goal may be easier to achieve in water utilities that are not as large in size or as structurally complex as electricity utilities. Third, the planning process must emphasize the explicit treatment of uncertainty. For water utilities, much uncertainty stems from water quality regulations and project financing. The fourth

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[8] Hirst (1988) as cited in Eric Hirst, Martin Schweitzer, Evelin Yourstone, and Joseph Eto, *Assessing Integrated Resource Plans Prepared by Electric Utilities* (Oak Ridge, TN: Oak Ridge National Laboratory, 1990).

[9] Janice A. Beecher and Patrick C. Mann, *Cost Allocation and Rate Design for Water Utilities* (Columbus, OH: The National Regulatory Research Institute, 1990).

TABLE 3-7

KEY ELEMENTS OF INTEGRATED RESOURCE PLANNING

Integrate resources

- Supply, demand, system facilities, and pricing

Integrate people and departments

- Cooperation, coordination, and communication

Treat uncertainty explicitly

- Alternative resource portfolios
- Factors external to the utility

Involve the public in the planning process

- Customers, nonutility experts, related industries, and government agencies, including the state public utility commission

Consider environmental factors

Implement plan

- Acquire demand and supply resources
- Collect and analyze additional data

Continue planning process

- Feedback from implementation to planning
- Develop new plans

Source: Adapted from Hirst (1988) as cited in Eric Hirst, Martin Schweitzer, Evelin Yourstone, and Joseph Eto, *Assessing Integrated Resource Plans Prepared by Electric Utilities* (Oak Ridge, TN: Oak Ridge National Laboratory, 1990), 7.

element focuses on the involvement of the public in the planning process. The water sector is highly diverse, with many potential participants in planning. Especially important are state planning agencies that can provide data as well as information on state laws and regulations affecting water resources.

The consideration of environmental factors is the fifth element of integrated resource planning. Since water itself is a part of the natural environment, this element is critical. Planning should address ways to prevent the contamination or depletion of a water source. The sixth element involves implementation of the integrated resource plan, and the seventh involves a continuation of the process. As in integrated energy resource planning, water planning has to be an ongoing concern and integrated with all other activities of the water supplier.

One of the first large-scale applications of least-cost planning in the water sector came when the Kentucky Public Service Commission ordered the Kentucky-American Water Company to produce a comprehensive strategic planning and resource acquisition study that would include:[10]

- An evaluation of conservation and curtailment programs during periods of peak water demand.
- An evaluation of the impacts of the company's declining block rate structure on water consumption.
- An evaluation of alternative rate designs and their effect on the efficient use of water.
- Development of a program to encourage the construction industry to install more water-efficient plumbing fixtures.
- Development of an aggressive public education campaign to cultivate a conservation ethic among the company's customers.
- A summary of conservation programs initiated by other water utilities that might be relevant to the company's efforts.
- A summary of the anticipated role of the company's consumers advisory council in encouraging the efficient use of water.

Since then, the public utility commissions of Rhode Island, New York, Pennsylvania, Connecticut, and other states have used rate cases, certification

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[10] American Water Works Service Company, Inc., *Kentucky-American Water Company Least Cost/Comprehensive Planning Study Technical Appendix* (Haddon Heights, NJ: American Water Works Service Company, Inc., 1986), A-1.2.

hearings, and other proceedings to require water utilities to improve resource planning, especially by reducing water losses, modifying rate structures, and promoting wise-use and conservation.[11] Recurring drought and cost impacts of drinking water standards have stimulated commission interest in the planning issue, as well as attention to the added regulatory responsibilities that planning involves.

Integrated resource planning brings with it numerous additional responsibilities for state public utility commissions. Eric Hirst identifies several areas of commission concern that arise under integrated resource planning for electricity utilities:[12]

- Protection of utility from prudence reviews associated with decisions to construct resources included in approved plans.
- Definition of the appropriate economic test(s) to be used in assessing demand-side programs.
- Consideration of alternative treatment of utility conservation-program costs.
- Review of automatic adjustment of rates because of lost revenue associated with conservation programs.
- Inclusion of marketing activities, economic development, and competition in the integrated planning process.
- Treatment of uncertainty about the costs, online dates, and performance of all resources and the utility's external environment.
- Consideration of environmental, social, and political factors related to different resources.
- Development of appropriate staffing and funding levels needed by public utility commissions to properly review utility plans.

Addressing these concerns may require additional commission resources or the reallocation of existing resources toward planning and away from other regulatory functions. The level of resources required depends on: (1) the need for extensive meetings, workshops, or hearings to prescribe plan contents and methodologies, (2)

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11 See National Association of Regulatory Utility Commissioners, *Bulletin* (weekly).

12 Eric Hirst, *Regulatory Responsibility for Utility Integrated Resource Planning* (Oak Ridge, TN: Oak Ridge National Laboratory, 1988), 4.

the degree of commission review of utility plans, and (3) the extent to which commissions adopt their own forecasts and planning alternatives.[13] With the resource commitments involved, integrated planning has the potential to affect the very character of the regulatory process, including the "regulatory bargain" between the states and the public utilities they regulate:

> A dynamic planning process like [least-cost planning] has the potential of changing regulation from an after-the-fact adjudication procedure to a system able in large part to avoid future major errors. [Least-cost planning] is, in many ways, a partnership between the utility and regulatory communities. It provides a continuously updated view of what is coming and offers a menu of adjustments to help minimize the risks accruing from an uncertain future.[14]

Some may argue that a regulatory commission's acceptance of a least-cost plan, or any other plan for that matter, constitutes approval of the utility's expansion program. In other words, utilities would like commissions to believe that "we're in this together." Utilities do not want commissions to use certification cases, rate cases, management audits, prudence reviews, or other proceedings to take another look at the construction program already "settled" in the course of least-cost planning. One water utility executive made the point as follows:

> The fact is, when a utility and a commission adopt least-cost planning, they have adopted a joint planning effort. Therefore, it is my opinion the Commission should bear some of the responsibility in the decision-making process and assure the company it will not second guess utility management after the project has been built.
>
> Bear in mind, even the large investor-owned water utilities are fragile, financial institutions and denying a water utility a substantial portion of its rate base after the fact could literally destroy the financial integrity of the utility.[15]

Integrated resource planning does not constitute a blanket approval of utility programs nor does it preclude the assessment of management prudence. For

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13 Berry, "Least-Cost Planning and Utility Regulation," 14.

14 NARUC, *Least-Cost Utility Planning Handbook, Volume 1,* 58.

15 Edward W. Limbach, "Least Cost Planning for Water Utilities: A Balancing Act," a paper presented at the regional meetings of the National Association of Regulatory Utility Commissioners (NARUC), June and July 1989, 7-8.

example, water utilities should not be allowed to "gold plate" systems in the name of compliance with safe drinking water regulations or use captive ratepayers to subsidize unjustified system expansion. In some jurisdictions, the regulatory process directly facilitated by planning is the certification of new facilities for construction, based on the public's *need and convenience.* However, all new facilities still must meet the standard of *used and useful* and constitute a *prudent investment.* Resulting rate schedules must be *just and reasonable.* The quality, safety, and reliability of utility service should not be unduly compromised. Still, the cost of unavoidable mistakes by the utility should be treated as recoverable from ratepayers. A comprehensive, integrated planning approach should enhance each of these regulatory determinations, but it is not a substitute for them.

Commission responsibility may be greatest in confronting one of the key obstacles to integrated resource planning: the potential loss of revenues and profits in utility adoption of demand-side alternatives. Commissions must decide, for example, whether rate adjustments or other mechanisms are appropriate when sales decline as a result of a successful water conservation program. Discussions about incentive regulation provide the appropriate forum for considering these issues.

Providing Incentives[16]

One can argue that integrated resource planning cannot be divorced from incentive regulation.[17] Least-cost planning can and has been implemented under traditional rate base/rate-of-return regulation. However, a growing literature emphasizes the inherent limitations of traditional regulation, particularly in terms of incentives. A frequently held view is that traditional ratemaking presents barriers both to cost efficiency and technological innovation.[18]

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16 Adapted in part from Patrick C. Mann, "Incentive Regulation for Commission Regulated Water Utilities," *Proceedings of the Seventh NARUC Biennial Regulatory Information Conference* (Columbus, OH: The National Regulatory Research Institute, 1990), 229-45.

17 David Moskovitz, *Profits and Progress Through Least-Cost Planning* (Washington, D.C.: The National Association of Regulatory Utility Commissioners, 1989).

18 James C. Bonbright, Albert L. Danielsen, and David R. Kamerschen, *Principles of Public Utility Rates* (Arlington, VA: Public Utilities Reports, 1988), chapters 21 and 22.

With respect to electric utilities, David Moskovitz points out that: (1) each kilowatthour a utility sells, no matter how much it costs to produce or how little it sells for, adds to earnings; (2) each kilowatthour saved or replaced with an energy efficiency measure, no matter how little it costs, reduces utility profits; (3) the only direct financial aspect of regulation that encourages utilities to pursue cost-effective conservation is the risk that dissatisfied regulators may disallow costs; and (4) purchases of power from cogeneration, renewable resources, or other nonutility sources add nothing to utility profits, no matter how cost-effective they are.[19] For their part, utility managers conventionally are motivated to pursue strategies that increase revenues, keep expenses down, and increase investments on which a return can be earned.[20]

Thus traditional regulation may incorporate substantial disincentives for some important aspects of integrated resource planning. For example, least-cost planning emphasizes providing utility services with the least-cost mix of supplies and efficiency improvements. However, even if cost-effective, conservation and demand management may add little to utility earnings and thus discourage utility managers from including these options in long-term plans. Incentive regulation can be used to help overcome this problem.

Incentive regulation in general consists of innovative regulatory approaches designed to provide utilities with incentives to achieve specified performance goals or standards. Most incentive regulation programs that have been initiated or proposed have occurred in either the energy or telecommunications sectors. In many cases, incentives have been provided in a partially deregulated environment.

Each form of incentive regulation generally involves a mechanism by which utilities are induced to increase efficiency through a system of rewards and penalties.[21] One form incorporates rates of return tied to cost performance while another form involves cost-of-service indexing. Another form incorporates price regulation, with the purpose of providing the utility with enhanced pricing

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19 Moskovitz, *Profits and Progress Through Least-Cost Planning*, vi.

20 See Myron B. Katz, "Utility Conservation: Everyone Wins," *The Electricity Journal* 2 no. 8 (October 1989): 27.

21 Robert F. Wilson, "The Role of Regulation in Increasing the Productivity of Utilities," *Proceedings of the Fifth NARUC Biennial Regulatory Information Conference, Volume 2* (Columbus, OH: The National Regulatory Research Institute, 1986), 789-829.

flexibility. Yet another form consists of incentives for capital investment in demand management. Most forms, whether involving performance assessment or price caps replacing rate of return restraints, have the intent of promoting cost efficiency. Incentive regulation addresses the problem of cost control under traditional regulation. Incentive regulation can incorporate the yardstick or benchmark approach in which the performance of the target utility is evaluated on the basis of the performance of the same utility over time or through the use of an index or a control group of comparable utilities. These forms of regulatory innovation obviously can affect utility costs, rates, and quality of service. Some forms of incentive regulation can reduce regulatory costs, but this is not typically the case with demand management and conservation incentives.

Demand Management Incentives

Traditional regulation provides strong incentives for the utility to avoid conservation or demand-management investments. For example, investment in supply-side facilities generally is easier to recover than investment in conservation. Even when the conservation investment is more efficient than either producing or purchasing the incremental supplies, cost recovery is easier for the supply-side investment.[22] The bias against demand-side investment in traditional ratemaking is simple. With traditional regulation, short-term profit considerations motivate utility managers to increase utility sales; conservation poses the threat of revenue erosion, which in turn threatens earnings. If the utility installs conservation equipment on the premises of the ratepayer, it may be allowed to recover its capital investment (with a lesser possibility of a return on that investment) from ratepayers. However, the real savings from the conservation investment accrues to the ratepayer.[23] Thus, there persists an incentive-driven bias toward meeting incremental demand by increasing supplies.

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[22] Charles J. Cicchetti and William Hogan, "Including Demand-Side Options in Electric Utility Bidding Programs," *Public Utilities Fortnightly* 123 (June 8, 1989): 9-20.

[23] M. Curtis Whittaker, "Conservation and Unregulated Utility Profits: Redefining the Conservation Market," *Public Utilities Fortnightly* 122 (July 7, 1988): 18-22.

Because traditional regulation does not necessarily provide utilities with incentives to implement conservation and load management, a number of alternative ratemaking approaches have been proposed.[24] The goal is to make cost-effective conservation and demand management at least as attractive an investment as supply alternatives. Some of the incentive mechanisms that have been proposed for use in promoting demand-side management by electric utilities include: shared savings, bonuses based on units saved, adjustments to overall rates of return and return on equity, mark-up on expenditures, ratebasing of demand management investments, an employee bonus pool, and various other cost recovery and revenue recovery mechanisms.[25] Thus far, the application of these methods in the water sector is almost nonexistent. Their use, of course, requires commission approval.

State regulators have recognized the argument for providing utility incentives for conservation programs and other means of implementing integrated resource planning.[26] According to Oregon Commissioner Myron Katz, treating conservation as a resource is an approach that provides utilities with incentives to invest in cost-effective conservation, achieves least-cost system objectives, is theoretically sound, and is fair to all ratepayers.[27] In this view, allowing utilities to charge consumers for conservation services serves equity and efficiency policy goals.

Nevada Commissioner Stephen Weil has advocated several regulatory incentives for the utility to make conservation investment.[28] One is to establish a revenue

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[24] National Association of Regulatory Utility Commissioners, *Least-Cost Utility Planning Handbook for Public Utilities Commissioners, Volume 2* (Washington, DC: The National Association of Regulatory Utility Commissioners, 1988), IV-23.

[25] John H. Chamberlin and Philip E. Hanser, "Current Designs of Regulatory Techniques to Encourage DSM," a paper presented at the NARUC Third National Conference on Integrated Resource Planning, April 8-10, 1991, Santa Fe, New Mexico; and Eric Hirst, Charles Goldman, and Mary Ellen Hopkins, "Integrated Resource Planning for Electric and Gas Utilities," a paper presented at the conference on Energy Efficiency in Buildings sponsored by the American Council for an Energy-Efficient Economy, August 1990, 2.

[26] On July 27, 1989 the Executive Committee of the National Association of Regulatory Utility Commissioners (NARUC) adopted a "Resolution in Support of Incentives for Electric Utility Least-Cost Planning."

[27] Katz, "Utility Conservation Incentives," 35.

[28] Stephen Weil, "Making Electric Efficiency Profitable," *Public Utilities Fortnightly* 124 (July 6, 1989): 9-16.

adjustment mechanism that insures that unexpected changes in sales volume do not affect earnings; this revenue adjustment mechanism would eliminate the short-term disincentive of potential revenue erosion with demand-side programs. Another regulatory incentive is commission allowance of both capital recovery and return on demand-side investment. Most state commissions permit both recovery and a rate of return on supply-side investment but permit only the recovery of demand-side investment as an operating expense. Allowing a rate of return on demand-side investment would provide equal treatment for demand-side and supply-side programs.

The incentives for demand management can serve either as an alternative to the construction or leasing of new capacity. Similar incentives could be designed to induce water utilities to develop automatic meter reading capability that could be marketed to other utilities. Incentives could be employed to induce water utilities to develop new services including maintenance services for water consuming equipment (for example, fire protection systems) and the marketing of both water-using and water-conserving equipment.

Most incentives are directed toward utility investors; that is, they provide ways for investors to earn a higher return on their investment. The logic behind investor incentives is that higher earnings are linked, at least psychologically, to demand growth. There is some limited evidence to suggest, however, that growth is not a necessary condition of profitability. According to one study, changing the corporate culture of public utilities may prove more essential to the adoption of demand-side management programs:

> There is a widespread misconception that limiting utility sales growth is bad for [electricity] utility investors. The evidence overwhelmingly contradicts this view. Limiting sales growth via [demand-side management] programs should not, therefore, be assumed to be financially unattractive to utility investors. Growth-limiting [demand-side management] programs may be unattractive to utility managers, however, because less growth could mean lower salaries and less power and prestige. The analysis suggests that the focus of [demand-side management] incentive programs should be on utility employees, not the stockholders. The ultimate challenge for utilities and commissions is to find ways to change utility corporate cultures to be more supportive of [demand-side management].[29]

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[29] Steven G. Kihm, "Do Electric Utilities Need Financial Incentives to Promote Demand-Side Measures? Investor and Managerial Perspectives," a paper presented at the NARUC Third National Conference on Integrated Resource Planning, April 8-10, 1991, Santa Fe, New Mexico.

Managers in the water utility industry have been as supply oriented as in electricity, and understandably so given the past abundance of water resources and the incentives provided under traditional regulation. In the design of incentive regulation programs, therefore, it might be worthwhile to consider managerial incentives for adopting conservation and demand management along with incentives directed toward utility investors. It is particularly important that managers do not perceive the regulatory interest in integrated water resource planning as punitive in nature.

Implementation Issues

Demand management raises several implementation issues. Obviously, the selection of the reward mechanism (for example, rate of return versus management bonuses), the specification of how savings from demand-side programs are to be shared between the utility and its ratepayers, and regulatory treatment of demand-side investments relative to supply-side investments are the key regulatory issues. Other implementations issues are of a more technical nature, such as those relating to measuring the effectiveness of demand-management incentives.

Incentive regulation aimed at demand management provides the potential for cost efficiency but does not reduce regulatory costs as would incentive regulation aimed at pricing. The demand management incentive approach suffers an acceptability problem in the context of regulators being reluctant to provide parallel treatment for demand-side and supply-side investment. By contrast, there are no specific characteristics of water utilities that would hinder the application of demand management incentives to water utility regulation. Indeed, some demand management incentives may have more potential benefits in water than in other utility sectors.

The various incentive approaches need to be examined in the context of standard regulatory practice and operating procedures. The key issue is whether incentive regulation can improve the performance of water utilities under commission jurisdiction. As Dennis Goins indicates, the answer to this question is a function of answers to a set of other questions including:[30]

- Which aspect of water utility operations should the incentive approach be directed at improving?
- How should performance of this operation component be measured?
- Should performance be evaluated against an index group of similar utilities?
- How should the utility receive the rewards and penalties associated with its performance?
- What level of rewards and penalties is required to induce performance improvements?

Conceptually, incentive regulation approaches should be based on comprehensive performance measures to avoid the deliberate sacrifice of one performance dimension for another. The incentive approach should be easy to understand and reliable in achieving cost efficiency. The incentive approach should address only the aspects of utility performance under management control; it should avoid penalizing or rewarding for performance results beyond management control. An effective approach should provide a framework to promote efficiency through management decisionmaking; that is, management must have appropriate and fair incentives to improve performance. The approach should provide signals to management to be efficient in both the short-term and the long-term, and not sacrifice long-term for short-term performance.

In brief, the incentive regulation plan must achieve a balance between predictability (to motivate performance) and flexibility (to accommodate changes in environment). An effective incentive system must be redesigned and reevaluated constantly to allow for changing economic conditions, regulatory conditions, and risks. And if an appropriate level of regulatory oversight is to be maintained, incentive plans must avoid "giving away the store."

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[30] Dennis Goins, "Can Incentive Regulation Improve Utility Performance?" *Public Utilities Fortnightly* 115 (January 10, 1985): 20-3.

Commission Planning Strategies

A model integrated planning strategy for state public utility commissions is provided in table 3-8. The three key elements of the strategy are:[31]

- **Planning.** Utilities must submit resource plans that document how they will meet demand at the lowest possible cost.
- **Evaluation.** Proposed utility plans are carefully evaluated by the regulatory commission and the public.
- **Enforcement.** The commission accepts a revised utility plan, and uses its regulatory authority over certification and rates to ensure that actual utility investments conform to the adopted resource plan.

In an integrated planning approach all three ingredients are essential. It makes little sense, for example, to mandate plan preparation only to have them sit idle in a commission file cabinet. They must be evaluated and used subsequently in commission proceedings. Commissions are encouraged to perform an assessment of existing strategies in each of the three areas. The evaluation process might be improved, for example, with the establishment of guidelines. Commissions also are encouraged to be aware of statewide resource plans as they may affect the evaluation of utility plans. Finally, for plans to be effective in meeting policy goals, it is essential for commissions to establish methods of enforcement. In some jurisdictions, for example, water utility performance in implementing conservation programs has already been used in evaluating requests for rate increases.[32] The greatest limitation to this scheme is the sometimes limited jurisdiction of the state public utility commissions over water supply. Commissions with broader authority or those who are actively involved in the planning processes of sister agencies may be in a better position to advance integrated resource planning at the state level.

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[31] Paul Markowitz, *Is Your State Charting a Least-Cost Electrical Strategy?* (Washington, DC: Public Citizen Critical Mass Energy Project, August 1986).

[32] See *NARUC Bulletin* (December 17, 1990) for an example from Idaho.

TABLE 3-8

MODEL INTEGRATED RESOURCE PLANNING STRATEGY

Planning. Utilities must submit resource plans that document how they will meet demand at the lowest possible cost.

Are your utilities required to file long-range resource plans?
- forecast of future demand
- assessment of supply-side resource options
- assessment of demand-side resource options
- integration of supply and demand-side resource options
- two-year implementation plan
- plan summary

Evaluation. Proposed utility plans are carefully evaluated by the regulatory commission and the public.

Has your regulatory commission established specific guidelines for utility plans and other filings?

Has your state developed a statewide resource plan?

Does your commission have special provisions for public participation in the resource planning process?

Enforcement. The commission accepts a revised utility plan, and uses its regulatory authority over certification and rates to ensure that actual utility investments conform to the adopted resource plan.

Does your commission have the authority to approve or disapprove utilities' long-range resource plans?

Does your state require a certificate of public need before authorizing the siting or construction of new utility facilities?
- the plant is in compliance with the utility's resource plan
- the need for the plant has been firmly established
- the plant is the least-cost means of meeting the need

Has your commission used its ratemaking powers to encourage utility least-cost investments?

Does your commission have authority to require utility conservation programs?

Has your commission set avoided cost rates?

Source: Adapted from Paul Markowitz, *Is Your State Charting a Least-Cost Electrical Strategy?* (Washington, DC: Public Citizen Critical Mass Energy Project, August 1986).

Not all regulatory commissions may find it desirable to adopt a program for integrated water resource planning. Indeed, planning may not be cost effective at this time for some jurisdictions. It is useful, therefore, to think of planning at the top of a hierarchy of policies aimed at promoting the wise use of water, a sample of which is illustrated in figure 3-1. Ascending the steps is a means of gradually initiating wise-use strategies. Thus, even without adopting a comprehensive integrated water resource planning policy, commissions can promote awareness of the planning implications of other regulatory decisions without necessarily committing a burdensome level of regulatory resources.

At the foundation are very basic, potentially mandatory, measures such as universal metering (to send appropriate pricing and usage signals to customers) and leak detection and repair by water utilities (to reduce water losses). Next is consumer information and education to discourage waste by ratepayers. Rate cases provide an opportunity to review rate structures, particularly the use of rate blocks to encourage or discourage water use. Many commissions, for example, have opted to eliminate decreasing block rates (which can induce consumption) in favor of uniform rates. In the course of certification and finance proceedings, utilities might be required to submit analyses of need and cost studies for system improvements or expansion, at which time least-cost tests might be applied. Moving up the hierarchy, some commissions might consider requiring water systems (especially large systems) to submit some long-term planning data in their annual reports. Another option is to have utilities prepare a basic water system planning inventory, as appears in appendix I of this report. Planning is addressed explicitly through commission policies requiring drought contingency planning as well as conservation and demand management programs. Finally, implementation of an integrated water resource planning program by a commission would provide an opportunity to link all these strategies and more, including commission participation in other state water resource policy forums. Elements of a hypothetical comprehensive integrated water resource plan for a water utility appear in appendix J of this report.

In sum, integrated resource planning is not a panacea for the many problems confronting water supply utilities. However, it offers a promising approach to water utility regulation by state commissions who are uniquely qualified to evaluate such issues as the relationship between planning and pricing. It requires regulatory

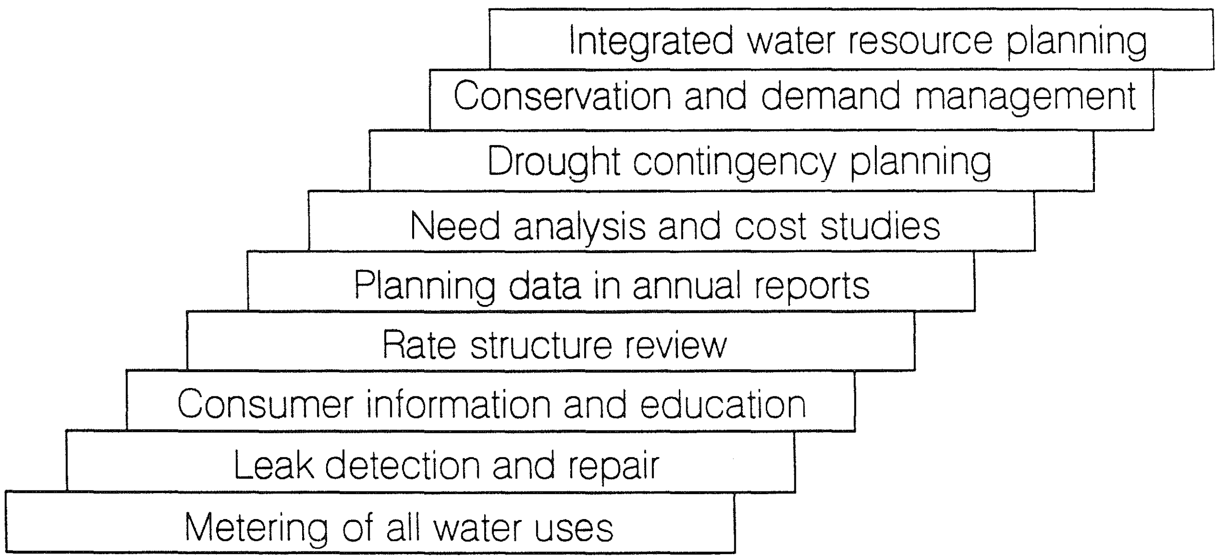

Fig. 3-1. Sample hierarchy of commission policies promoting the wise use of water (authors' construct).

commissions to adopt a more forward-looking perspective than has been associated with traditional rate base regulation. Admittedly, the forward-looking orientation means that regulators must contend with substantial uncertainty in regulatory decisions. The difficulties associated with the reliance on incomplete and imperfect information should not become the rationale for delaying consideration of a planning strategy. Instead, these difficulties could become the rationale for cooperation among commissions, utility managements, and other stakeholders to engage in the continual improvement of the integrated water resource planning process.

CHAPTER 4

THE PUBLIC UTILITY ROLE IN WATER RESOURCE PLANNING

Successful integrated resource planning is highly dependent on the commitment by public utilities, not just in terms of resources but in terms of actually making the process work. Water suppliers can take the initiative by adopting an integrated planning approach, even if it is not mandatory.

For water utilities, integration of planning activities has both internal and external implications. The least-cost planning literature tends to emphasize internal coordination of utility management functions (forecasting, financial analysis, engineering, and so on). At least as important is the integration of water utility planning externally, not only with members of the public and regulatory agencies but with other water resource planning processes, especially at the state level. Public utility commissions can facilitate this form of integration by helping ensure that water utility plans are consistent with state water resource plans and policies.

Water utilities, like all organizations and most people, already perform a variety of planning activities. Indeed, utilities themselves are uniquely qualified to perform many of the analyses that planning requires. An integrated approach expands upon this expertise and adds additional challenges and responsibilities. Larger water utilities may be called upon to perform a full spectrum of planning activities, some of which they have not performed in the past. Even smaller systems should not be exempt entirely from some form of planning. In fact, cost considerations for smaller systems lacking economies of scale may make planning even more important. A recent report, for example, recommends that small systems develop a business plan (actually, a *viability* plan) consisting of a facilities plan, a management plan, and a financial plan.[1]

While the principles of integrated resource planning are reasonably constant, their implementation can be molded to the particular interests and needs of various jurisdictions and service territories. This chapter explores integrated water resource planning from the perspective of the water utility. An integrated water resource planning framework is described, including a delineation of short-term and

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[1] Wade Miller Associates, Inc., *State Initiatives to Address Non-Viable Small Water Systems in Pennsylvania* (Arlington, VA: Wade Miller Associates, Inc., 1991).

long-term water supply and demand options. Special attention is paid to some emerging areas of water utility responsibility that may play an integral role in integrated planning.

Traditional v. Integrated Planning

Considerable attention was paid in chapter 1 to the contrast between traditional public utility planning and integrated resource planning. It was pointed out that today, a greater emphasis is placed on the tenets of least-cost planning, or the somewhat more encompassing principles of integrated planning.[2] One way for water utilities to think about integrated water resource planning is to view it as an extension of the traditional approach with which they are familiar, as illustrated in figure 4-1.

Traditional public utility planning consists of the rather discrete steps of load forecasting, supply planning, production costing, financial analysis, rate allocation, and, finally, identifying and choosing among supply-side alternatives. In the integrated planning model, demand-side alternatives are identified prior to the development of a resource planning portfolio from which supply options can be selected. Another important feature is the feedback from this portfolio both to load forecasting (because of potential effects of changes in demand) and supply planning. A further delineation of the steps involved in least-cost utility planning, adapted from the handbook of the National Association of Regulatory Utility Commissioners, appears in table 4-1. For the purposes of integrated water resource planning, appendix I of this report provides a basic water supply planning inventory for systems of all sizes. Appendix J provides an outline of a comprehensive integrated plan suitable to relatively large water systems.

An essential step in least-cost planning is the identification of cost-effective planning options that meet a priori planning criteria, such as conformance with state water resource plans and drinking water regulations. As has been discussed, state water resource plans can constrain utility supply options; some directly promote demand management. Another critical consideration involves the judgment by state drinking water regulators as to the appropriateness of planned treatment

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[2] Again, the distinction should not be overstated. Least-cost planning and integrated planning are virtually interchangeable for the purposes of analysis.

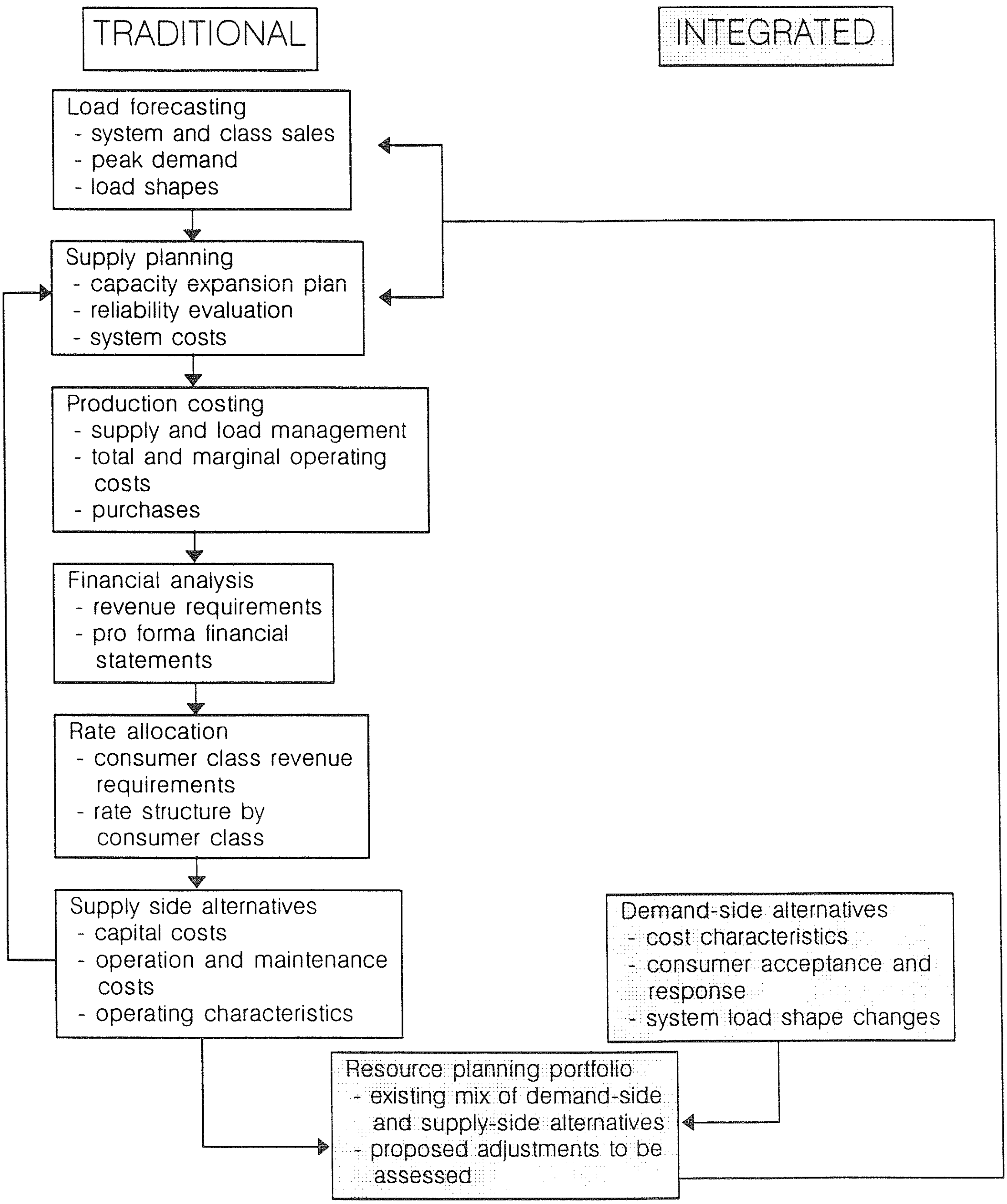

Fig. 4-1. Traditional and integrated utility planning as adapted from William M. Smith and Clark W. Gellings, "Demand-side Management: Implications for Planning and Operations," Least-Cost Energy Planning in the Midwest: A Symposium (Palo Alto, CA: Electric Power Research Institute, 1987), 10-3 and 10-5.

TABLE 4-1

BASIC STEPS IN LEAST-COST UTILITY PLANNING

1. Identifying the objectives of the plan.
2. Developing one or more load forecasts.
3. Determining the levels of capacity expected for each year of the plan.
4. Identifying needed resources.
5. Evaluating all of the resources in consistent fashion.
6. Selecting the most promising options for fashioning an effective, flexible, and responsive plan.
7. Integrating methods of supply with methods for controlling and moderating demand.
8. Constructing scenarios and pitting the selected mixes of options against possible economic, environment, and social circumstances.
9. Evaluating the economic and technical success of each mix of options under the circumstances of the various scenarios.
10. Analyzing the uncertainty associated with each possible plan of action.
11. Screening the alternatives to eliminate those that are not suitable.
12. Rank ordering the alternative courses of action.
13. Testing each alternative for cost effectiveness from a variety of viewpoints.
14. Reevaluating the alternatives considering economic, environmental, and societal factors.
15. Selecting and approving a plan for implementation, one that most nearly satisfies all the objectives of the plan.
16. Developing a plan of action.
17. Implementing the plan of action to bring about the least-cost provision of service.
18. Monitoring and evaluating the operating of the utility under the plan and revising the plan as necessary.

Source: Adapted from National Association of Regulatory Utility Commissioners, *Least-Cost Utility Planning Handbook for Public Utility Commissioners,* Volume 1 (Washington, DC: National Association of Regulatory Utility Commissioners, 1988).

facilities for dealing with particular water contamination problems and ensuring that the utility will be in compliance with federal and state drinking water standards. The integrated planning process must take into account the other governmental permitting processes that the water utility must satisfy in the exercise of certain planning options.

Once a priori criteria are satisfied, potential supply and demand alternatives are ranked according to some cost-based methodology, such as cost per thousand or million gallons or revenue requirement effects. Determining the least-cost mix for implementation can involve numerous considerations (such as risk and uncertainty), and a combination of utility management and regulatory judgments. The rationale behind each planning decision should be explicit. At this point, the planning process can become more art than science.

Table 4-2 provides an example from the Kentucky-American Water Company of the specific tasks developed for the purpose of least-cost planning. Formulating these tasks anticipated use of the system's earlier planning study. However, the updated baseline data would be used to develop alternative scenarios based on different assumptions about conservation, including use restrictions and modifications in the utility's rate structure. The utility also planned to develop a number of other information sources, including a summary of other American System conservation programs and a customer survey, for use in its planning process. The Kentucky-American experience is especially useful in highlighting the importance of developing these information sources and in presenting them to a state public utility commission for review.

A Water Resource Planning Framework

A central feature of integrated resource planning is the balanced consideration of supply and demand options. This is an area where little can be borrowed from the experience in integrated energy resource planning.[3] A three-dimensional framework for use in integrated water resource planning is proposed in table 4-3. The first dimension distinguishes between supply management and demand management. The second dimension identifies short-term and long-term strategies,

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3 An exception might be on the demand side, where there are certain similarities between electricity and water, for example, in the area of appliance efficiency.

TABLE 4-2
KENTUCKY-AMERICAN WATER COMPANY
ORIGINAL LEAST-COST PLANNING TASKS

Planning Task I
- Update the company's 1980 Comprehensive Planning Study.
- Using this update, develop baseline data covering a fifteen-year period addressing demand projections, capital additions, operation and maintenance expenses, and revenue requirements.

Planning Task II
- Using the baseline data, develop several scenarios to determine the end result if the basis is altered by imposing several conservation alternatives.
- Conservation alternatives include enactment of a plumbing code requiring water-efficient fixture units on new construction as well as remodeling, retrofitting existing plumbing fixtures, imposition of lawn sprinkling restrictions during peak demand periods, and modification of the existing pricing structure.

Planning Task III
- Research and develop a model ordinance to revise the existing plumbing code to require water efficient plumbing fixtures in new construction and remodeling projects.

Planning Task IV
- Conduct a literature search to assemble case studies of actual conservation programs.
- Study utility water conservation programs outside of Kentucky.

Planning Task V
- Brief the company's Consumer Advisory Council about conservation, with the Public Service Commission's participation.

Planning Task VI
- Present to the Commission examples of customer information programs about conservation and efficiency used by other American System Companies.

Planning Task VII
- Purchase a computerized leak detection system.

Planning Task VIII
- Develop an aggressive public education program concerning conservation alternatives.

Planning Task IX
- Commission an independent survey of Kentucky-American customers for opinions on various topics related to water conservation.

Source: American Water Works Service Company, Inc., *Kentucky-American Water Company Least-Cost/Comprehensive Planning Study: Technical Appendix* (Haddon Heights, NJ: System Engineering, American Water Works Service Company, Inc., 1986).

TABLE 4-3
A FRAMEWORK FOR INTEGRATED WATER RESOURCE PLANNING

Managing Agent	Supply Management	Demand Management
Water Suppliers	Short-term strategies	
	Supply audits and metering Leak detection and repair Pressure reduction Resource management Transfers, diversions, and auxiliary supplies Relaxation of standards (extreme emergencies only)	Voluntary (plea for use reduction) Coercive (rates, penalties, and surcharges) Mandatory (use bans and rationing)
	Long-term strategies	
	Phased source development Additional storage and conveyance capacity Loss reduction program Resource management, such as conjunctive use Imports (Canada and Mexico) Transfers, diversions, and reallocation Reclamation and reuse Operational efficiency, including rehabilitation Intervention/modification of natural processes Desalinization facilities	Conservation programs for each water use sector, including incentives Metering of all water uses Conservation rates, such as including seasonal rates, excess use charges, etc. Water use audits Public information and education Plumbing efficiency standards and retrofits
Water Consumers	Short-term strategies	
	Participation in planning processes	Curtailment of water use
	Long-term strategies	
	Participation in planning processes	Wise use of water, both (indoors and outdoors) Use of efficient appliances and fixtures Xeriscaping Irrigation practices Reuse, recycling, and recirculation Agricultural, commercial, and industrial applications

Source: Authors' construct.

which is especially relevant for differentiated between drought contingency options from long-term planning options. Short-term strategies can be implemented with a relatively short lead time. The third dimension distinguishes between strategies for which water suppliers are the managing agent and those for which water consumers are the managing agent. Both suppliers and consumers play essential roles in promoting the wise use of water. This issue of control is particularly important to utilities is assessing risk and uncertainty. For each combination, a selected group of key water management strategies is identified.[4] The framework can be adapted to a variety of strategic planning purposes.

As can be seen in table 4-3, water suppliers can engage in a wide variety of supply and demand management activities in the short- and the long-term. In some instances, using these options depends on approvals from other entities, so while the utility is the managing agent it does not have unbounded discretion. By contrast, water consumers are somewhat limited in their ability to affect supply management. Were it not for potential consumer participation in planning processes, this role actually would be considered "not applicable." Consumers are in control, however, when it comes to curtailing water use in the short term and in implementing a variety of long-term demand management techniques. These activities may occur as a consequence of utility activities, as when consumers choose to change water use habits or install water-efficient fixtures in response to an increase in price.

A comparison of supply management and demand management is provided in table 4-4 using a variety of evaluation criteria. On various grounds, advocates of supply options tend to discredit demand options, and vice versa. In a balanced approach, the costs and benefits of both sides should be considered carefully and objectively. Both supply-side and demand-side options involve complexities and risk.[5] On the supply side, the difficulties include uncertainties about economies and diseconomies of scale, capacity expansion lead times, construction cost escalation, temporal aspects of utility demands, service reliability and quality, and impacts on

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[4] For more detail, see Janice A. Beecher and Ann P. Laubach, *Compendium on Water Supply, Drought, and Conservation* (Columbus, OH: The National Regulatory Research Institute, 1989).

[5] National Association of Regulatory Utility Commissioners, *Least-Cost Utility Planning for Public Utility Commissioners, Volumes 1 and 2* (Washington, D.C.: The National Association of Regulatory Utility Commissioners, 1988).

TABLE 4-4

COMPARING SUPPLY MANAGEMENT AND DEMAND MANAGEMENT FOR WATER UTILITIES

Comparison Criteria	Supply Management	Demand Management
Consumer cooperation	Not dependent on consumer cooperation	Dependent on consumer cooperation
System characteristics	Can be dependent on water system characteristics	Usually not dependent on water system characteristics
Conservation goals	Meets long-term goals effectively	Can meet both long- and short-term goals
Demand problems	Suitable for average or peak demand problems due to inadequate system capacity	Solves average and peak demand problems
Speed of implementation	Usually requires a long lead time	Some measures can be implemented very quickly
Usage reduction goals	Best for low percentage reduction goal	Low or high percentage reduction goal
Long-term effectiveness	Expected to be high	May diminish over time
Flexibility	May still require demand management	Versatile and flexible during emergencies
Predictability	Higher	Lower
Expense	Sometimes requires large expenditures	Can require large or small expenditures
Operating costs	Can be reduced	Not necessarily affected
Labor requirements	Usually large	Can be small or large
Impact on revenues	Lost revenues can be recovered	Some programs can cause revenues to drop
AWWA assessment	Generally preferable	Generally not preferable

Source: Authors' construct from American Water Works Association, *Before the Well Runs Dry: Volume I--A Handbook for Designing a Local Conservation Plan* (Denver: CO: American Water Works Association, 1984), 21-23.

utility revenue flows and earnings. On the demand side, difficulties include measurement of social cost savings, impacts on load factors, conservation program costs, uncertainties associated with consumer acceptance and participation, and effects on utility revenue flows and earnings. Supply-side and demand-side alternatives differ in important ways in terms of operational characteristics, impacts on the utility system, and the availability of utility-owned capacity.[6] Given that some demand-side options involve customer participation and customer ownership or both, the costs and benefits of demand-side options are dispersed differently than they are for traditional supply-side options. These costs and benefits are used to determine which options are cost effective.[7]

The Role of Conservation in Planning

The issue of integrated planning, especially least-cost planning, inevitably raises the issue of conservation. Conservation (or more generally, demand management) has been a central part of the public policy debate over costly and increasingly scarce energy resources. Conservation is particularly controversial in water supply because water is a renewable resource; some say there is no point in conserving just for the sake of conservation, especially given the cost characteristics of water utilities (where fixed costs tend to be high and variable costs low). Further, water conservation is sometimes viewed as antidevelopment.

Another point of view, based on the experience in the energy sector, is that conservation and other demand management investment may be less risky than supply-side investment given regulatory uncertainty, public resistance to large capital projects, and the potential cost escalation associated with supply-side investments.[8] In water supply as well, conservation may provide greater flexibility. Darryll Olsen and Allan Highstreet apply an argument to water that is familiar to least-cost electricity planning proponents:

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6 Ibid.

7 Cost effectiveness and other evaluation methods are addressed in chapter 6.

8 Stephen P. Reynolds and Linda G. Baldwin, "Cost-Effectiveness in Meeting Capacity and Energy Requirements through Conservation Alternatives," in Harry M. Trebing, ed., *Challenges for Public Utility Regulation in the 1980s* (East Lansing, MI: The Institute of Public Utilities, Michigan State University, 1981), 65-85.

> From an engineering perspective, water conservation is perhaps the most flexible resource available because there is not a lengthy period of siting and licensing for the design and construction of conservation. It can be quickly brought on-line, and conservation can be acquired in varying increments. However, to be effective, conservation cannot be turned on and off, and programs must be continuously and consistently applied.[9]

Water conservation is sometimes equated with a curtailment to or sacrifice in consumer lifestyles, as may occur under emergency situations such as those arising during prolonged periods of drought. As has been pointed out, customers may be unwilling to accept long-term use curtailments absent extraordinary circumstances.[10] However, consumers largely may be indifferent to many water efficiency measures, especially improved toilets where water savings are highly significant. Consumers are probably more sensitive to curtailing outdoor water use when it threatens expensive landscapes. Improved irrigation efficiency partly addresses this concern. Many utility conservation programs address potential efficiency gains in both indoor and outdoor water use.

One way to understand the idea of conservation is the term "wise use of water."[11] Wise use essentially means that wasteful use should be avoided. Wise use strategies can be adopted both by water suppliers and water users. The water industry itself has taken substantial measures to promote wise use. In January 1991, the American Water Works Association adopted a resolution strongly encouraging water utilities to adopt certain basic water conservation measures, as shown in table 4-5.[12] The language of the resolution and its specific recommendations can be viewed as an important step toward a more integrated-planning approach for the water supply industry, including a role for water conservation.

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9 Darryll Olsen and Allan L. Highstreet, "Socioeconomic Factors Affecting Water Conservation in Southern Texas," *American Water Works Association Journal* 79 no. 3 (March 1987): 68.

10 Thomas R. Stack, "Least-Cost Planning for Water Utilities from the View of a State Regulatory Staff Member," *NAWC Water* 30 no. 3 (Fall 1989): 21.

11 Beecher and Laubach, *Compendium.*

12 See also, "AWWA Makes Strong Pitch for Conservation Aspects in Legislation," *AWWA Mainstream* 35 no. 8 (August 1991): 9.

TABLE 4-5

AMERICAN WATER WORKS ASSOCIATION POLICY STATEMENT ON WATER CONSERVATION

Approved by the Board of Directors January 27, 1991.

AWWA strongly encourages water utilities to adopt policies and procedures that result in the efficient use of water, by utilities and the public, through a balanced approach combining demand management with phased traditional source development.

To this end, AWWA recommends and supports the following basic water conservation principles and practices:

- management and efficient utilization of sources of supply;
- accurate monitoring of customer water consumption;
- leak detection and repair and appropriate rehabilitation or replacement;
- establishment of water-use efficiency standards for new plumbing fixtures and appliances and the encouragement of conversion of existing high-water-use plumbing fixtures to more water-efficient designs;
- encouragement of use of efficient irrigation systems;
- development and use of educational materials on water conservation;
- public education and information programs promoting efficient practices;
- encouragement of self-administered water conservation programs for all water users;
- wastewater reclamation for nonpotable uses; and
- continued research on more efficient water-use techniques and practices.

Source: "Policy Statements," *American Water Works Association Journal* 83 no. 7 (July 1991), 110.

Emerging Utility Responsibilities

Integrated water resource planning brings with it new challenges and responsibilities to the water utility. Revised thinking in some areas of utility management may be necessary. Addressed below are five areas that play a role in implementing integrated planning: supply conservation, load management, drought planning and management, conservation pricing, and conservation programs. While not necessarily a comprehensive list, these areas highlight some of the key issues raised in the integrated planning perspective.

Supply Conservation

Integrated planning emphasizes conservation as a resource option. The first order may be conservation implemented by water suppliers themselves. Conserving water supplies makes good business sense for the water utility. Methods for controlling evapotranspiration and seepage at the source of supply are examples of supply conservation as are leak detection and repair in the transmission, storage, and distribution systems. As water becomes more costly to develop, treat, and deliver, the benefits of supply conservation are more likely to outweigh its costs. With supply conservation, as compared with conservation on the demand side, utility revenues are not impaired by reduced sales. Supply conservation also helps the utility minimize environmental externalities, increase system efficiency to the benefit of ratepayers, and set an example for all consumers in terms of the wise use of water. Conservation may help forestall the need for developing new supplies. When developing additional water supplies is deemed necessary, a phased approach along with continued conservation may be preferred to limit environmental and cost impacts.

Modern water resource planning, including planning by state water resource agencies, often incorporates water conservation goals. A leading example is conjunctive use, which is the use of groundwater basins along with surface water facilities as part of a network for water supply.[13] This usually is accomplished through artificial groundwater recharge, using recharge basins or injection boreholes depending on the hydrogeological properties of the aquifer. Conjunctive use considers all available sources of water, timing requirements, and other constraints to maximize the yield capability of both the sources.[14] It is a highly integrated approach to water resource management at the source of supply. The benefits of conjunctive use are:[15]

- A higher total amount of supply.
- Better regulation of the combined system, thanks to the added storage volume of the aquifer.
- A staged development of a water supply or irrigation project, by utilizing groundwater first, at small increments of growth, well by well, and later diverting streamflows.
- Savings in evaporation losses from surface reservoirs, by using instead the aquifer as a storage reservoir.
- Higher flexibility in supply according to the demand curve, by evening-out peaks in streamflow and pumping groundwater as and when needed.
- Mixing of different quality water, either in the supply system or in the aquifer, to reduce salinity or concentration of other water quality indicators.
- Reducing capital investments and operational expenditures by shortening conveyance distances for surface water.
- Inducing groundwater replenishment from streams by extending the duration of flows in the stream by means of dams, or retarding the flow by means of groynes or levees.

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[13] United Nations, *Water Resources Planning to Meet Long-term Demand: Guidelines for Developing Countries* (New York: United Nations, Natural Resources/ Water Series No. 21, 1988), 76.

[14] Ibid., citing Guna N. Paudyal and A. Das Gupta, "Operation of a Groundwater Reservoir in Conjunction with Surface Water," *Water Resources Development* 3 no. 1: 31-43.

[15] Ibid.

- Augmenting low flows in rivers that act as the drainage basins for aquifers, by artificially recharging the aquifer with streamflows during months of high flow, thus inducing groundwater drainage into the stream during low-flow months.

Another area of supply conservation is to develop methods to reclaim and reuse water. An example is the use of graywater, particularly in agricultural, industrial, and commercial applications. Another is the more limited use of sewage effluent, although this is usually a costly alternative. As raw water sources become harder to develop, these conservation methods may prove more attractive.

Utilities may have limited options in source development, but reducing water losses in the transmission and distribution systems is a critical area of utility concern.[16] Unaccounted-for water includes: major breaks, leakage, water main flushing, fire fighting, recreation (open hydrants), street washing, sewer flushing, illegal connections, miscellaneous inadvertent losses, and metering errors, many of which constitute potentially recoverable losses to the utility.[17]

Transported water and treated water are value-added commodities. Their loss is costly to utility and ratepayer alike. The rising cost of treated water provides an additional incentive to reduce losses in the distribution system. An aggressive leak detection and repair program should be a part of any utility conservation program and a prerequisite to any new supply program. Supply audits and metering also can facilitate loss reductions. These issues are not merely matters of wise use, but of utility management prudence as well.

Load Management

Integrated resource management can be used to help utilities achieve load management goals to use their existing and planned resources most efficiently. Load management provides an engineering perspective on the relationship between supply and demand. Some load management techniques developed for use in the electricity sector can be applied to water utilities for the purpose of manipulating

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[16] See James W. Male, Richard R. Noss, and I. Christina Moore, *Identifying and Reducing Losses in Water Distribution Systems* (Park Ridge, NJ: Noyes Publications, 1985); and Lynn P. Wallace, *Water and Revenue Losses: Unaccounted-For Water* (Denver, CO: American Water Works Association, 1987).

[17] Male, Noss, and Moore, *Identifying and Reducing Losses.*

load shapes on a seasonal or daily basis (although the latter application is more limited because of inherent aspects of water system design). The six general approaches used in the electricity sector are:[18]

- **Peak clipping** or the reduction of the system peak loads. Embodies one of the classic forms of load management. Peak clipping generally connotes the reduction of peak load through the direct control of customers' appliances, and/or interruptible rate programs.

- **Valley filling** is the second classic form of load management. Valley filling involves building off-peak loads, which may be particularly desirable when average price exceeds long-run incremental cost.

- **Load shifting** is the last classic form of load management, involving shifts of load from on-peak to off-peak periods.

- **Strategic conservation** results from utility-stimulated programs directed at reducing end-use consumption. Such load shape modifications reduce sales and change use patterns.

- **Strategic load growth** involves increasing the "size of the pie" by increasing sales beyond valley filling. Load growth may involve increased market share of loads served by competitors as well as area development.

- **Flexible load shape** is a concept related to reliability, a planning constraint. Once the anticipated load shape, including demand-side activities, is forecast over the corporate planning horizon, the planner studies the final optimum supply-side options. Among the criteria used is reliability, and load shape can be made flexible--if customers are presented with options that tie quality of service to various incentives.

In water supply, peak clipping may be used as a drought management strategy when supplies run low and demand runs high. Customers may help reduce peaks through voluntary cooperation (through public education campaigns), coercive methods (such as higher prices that induce conservation), or mandatory measures (such as use restrictions). A familiar example is the use of restrictions or bans on outdoor water use (especially lawn irrigation). For annual load curves, valley filling is a short-term solution to load management and may be accomplished through seasonal pricing or other methods of marginal-cost pricing. Strategic

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[18] William M. Smith and Clark W. Gellings, "Demand-Side Management: Implications for Planning and Operations," *Least-Cost Energy Planning in the Midwest: A Symposium* (Palo Alto, CA: Electric Power Research Institute, 1988), 10-8 to 10-9.

conservation takes a long-term view at the potential of efficiency improvements in controlling average demand growth. The importance of this measure is its potential to forestall the need for additional capacity. Strategic load growth has limited applications in water but may be relevant for utilities with excess capacity, particularly if expansion takes advantage of economies of scale for the expanded service territory. Finally, flexible load shape may have limited applicability in drought management. If a utility's customers are willing to endure water use curtailments under drought or emergency circumstances, this might affect decisions about long-term capacity expansion. Obviously, the risks involved limit the application of this technique.

An example of load management for a water utility that incorporates moisture conditions appears in figure 4-2, where unmanaged water use is compared to managed water use under increasingly dry conditions. When water use is unmanaged, drier conditions result in an increasing shortfall in water supplies. When water use is managed, demand can be met even when supplies are becoming depleted. As conditions become drier, demand is controlled through conservation, restrictions, and ultimately emergency bans on use. Thus load management provides an analytical tool for short-term and long-term strategic planning.

Drought Planning and Management

One of the most important attributes of water is that supply and demand are intrinsically related through the natural processes that produce precipitation. When drought conditions arise, demand increases (especially for outdoor uses) while water supplies become impaired. An unfortunate thing about drought is that once the rains come, the issue tends to disappear from public and governmental agendas.[19] There also is a tendency to deal with drought through crisis management (a short-term approach) as compared with risk management (a long-term approach). Two things about droughts are certain: they always end and they always return. While water suppliers cannot be held accountable for drought, they can be held accountable for being caught unprepared. The same is true for managing other water system crises, as can be caused by other natural disasters (such as earthquakes and hurricanes) or manmade disasters (such as chemical spills). Recent

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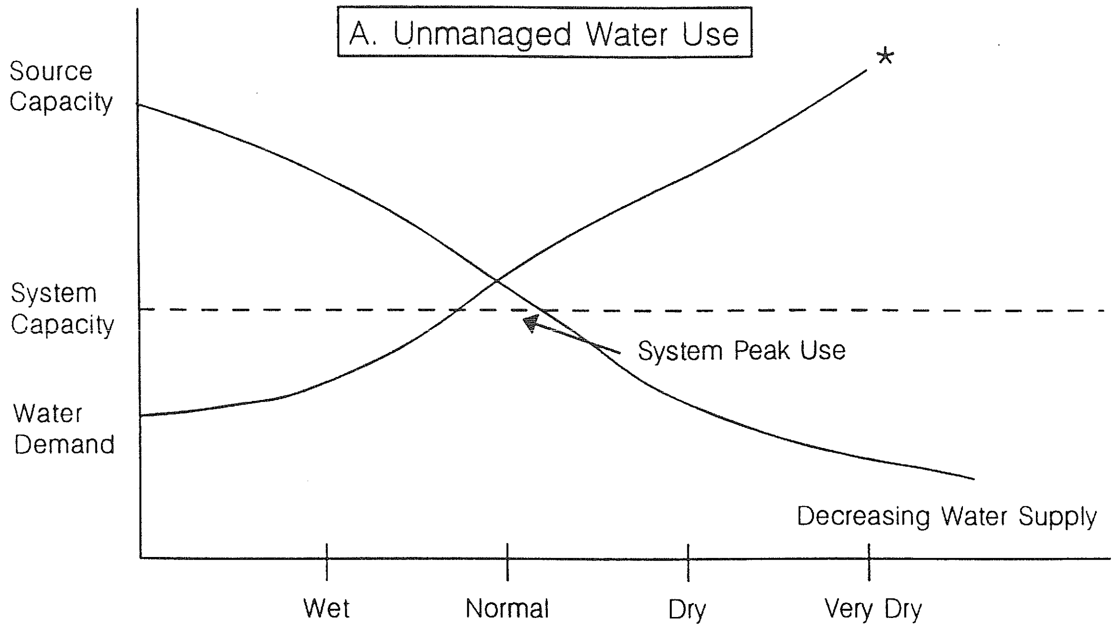
[19] Beecher and Laubach, *Compendium.*



* Increasing demand for lawn watering, bathing and other uses if water was available.

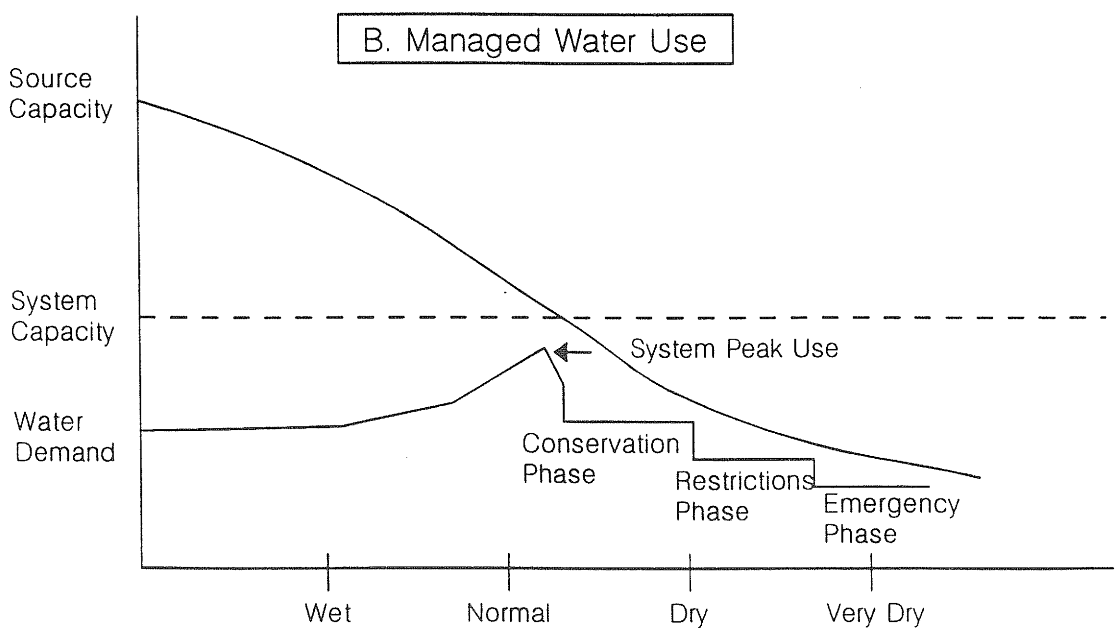


Fig. 4-2. Balancing the water system's supply and demand as depicted in Tennessee Department of Health and Environment, Local Drought Planning Guide for Public Water Suppliers (Nashville, TN: Tennessee Department of Health and Environment, 1988), 5.

experiences have brought home the point that drought contingency and emergency management planning are essential.[20]

Like planning processes in general, drought contingency planning involves several distinct steps:[21]

- Develop local goals and objectives, determine an acceptable level of risk, and establish a framework for responses. Provide opportunities for public education and participation in plan development and implementation.

- Estimate current and projected demand, assess source capacity and identify triggerpoints for management, and identify potential water quality problems.

- Establish a classification of uses (essential and nonessential) and develop water monitoring program).

- Select appropriate responses to meet objectives and mitigate problems.

- Assess the system's ability to enforce selected responses and assess administrative needs necessary to implement plan.

- Adopt ordinance or bylaws and provide for implementation needs.

- Revise and update the plan as necessary.

Mitigating the effects of drought or other water emergencies generally involves short-term strategies, as identified earlier. These include identifying auxiliary supplies as well as curtailing use through various demand management techniques. Utilities must know the feasibility of various alternatives before emergency conditions materialize. However, long-term supply and demand strategies also have implications for mitigating or even avoiding the adverse impacts of a water emergency. For example, a well-educated, water-wise consumer population may be more responsive to pleas for curtailment necessary during a crisis.

In essence, no public water supplier should be without a drought contingency and emergency management plan that prepares the water utility for crisis management. This plan should be incorporated in any long-term integrated supply

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20 See Donald A. Wilhite and William E. Easterling, eds., *Planning for Drought: Toward a Reduction of Societal Vulnerability* (Boulder, CO: Westview Press, 1987).

21 Tennessee Department of Health and Environment, *Local Drought Management Planning Guide for Public Water Suppliers* (Nashville, TN: Office of Water Management, Tennessee Department of Health and Environment, 1988).

plan. For its part, the long-term plan should take a risk management perspective and address means to avoid the adversities of drought and other disasters, knowing they inevitably will arise.

Conservation Pricing[22]

Water pricing is an essential part of integrated water resource planning. Water prices should accurately reflect the utility's cost of service so that the utility can make plans to meet future needs. In regions where the development of new water supplies is particularly costly, price is the key to making consumers aware of this fact. For their part, consumers need price signals to make informed consumption decisions. Pricing may have its greatest impact on outdoor water use, reflecting more price-elastic demand.

Steve Hanke has argued for integrating engineering and economic planning through implementation of marginal-cost pricing.[23] By pricing water at marginal cost, allocation is more efficient and water suppliers are sent appropriate signals about how much capacity to provide. The price elasticity of demand will determine the level of consumption expected under different planning scenarios. In this sense, price becomes a critical variable in the planning model.

Thus the rate schedule is a potentially powerful tool of demand management for which water suppliers are the managing agent, even though the effectiveness of this tool depends on consumers' responsiveness to price. Six rate structures that encourage water conservation appear in figure 4-3. As shown, even uniform metered rates encourage conservation, in comparison to unmetered flat charges, because they send consumption signals to ratepayers and provide no discounts for higher levels of consumption (as do decreasing block rates). Increasing block rates, seasonal rates, indoor-outdoor rates, excess use charges, and scarcity pricing are variations on the theme of conservation ratemaking.

Increasing block rates are frequently advocated as a method of conservation pricing and have been implemented in several major United States cities,

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[22] Adapted in part from Beecher and Laubach, *Compendium*, chapter 8.

[23] Steve H. Hanke, "A Method for Integrating Engineering and Economic Planning," in American Water Works Association, *Energy and Water Use Forecasting* (Denver, CO: American Water Works Association, 1980), 76-80.

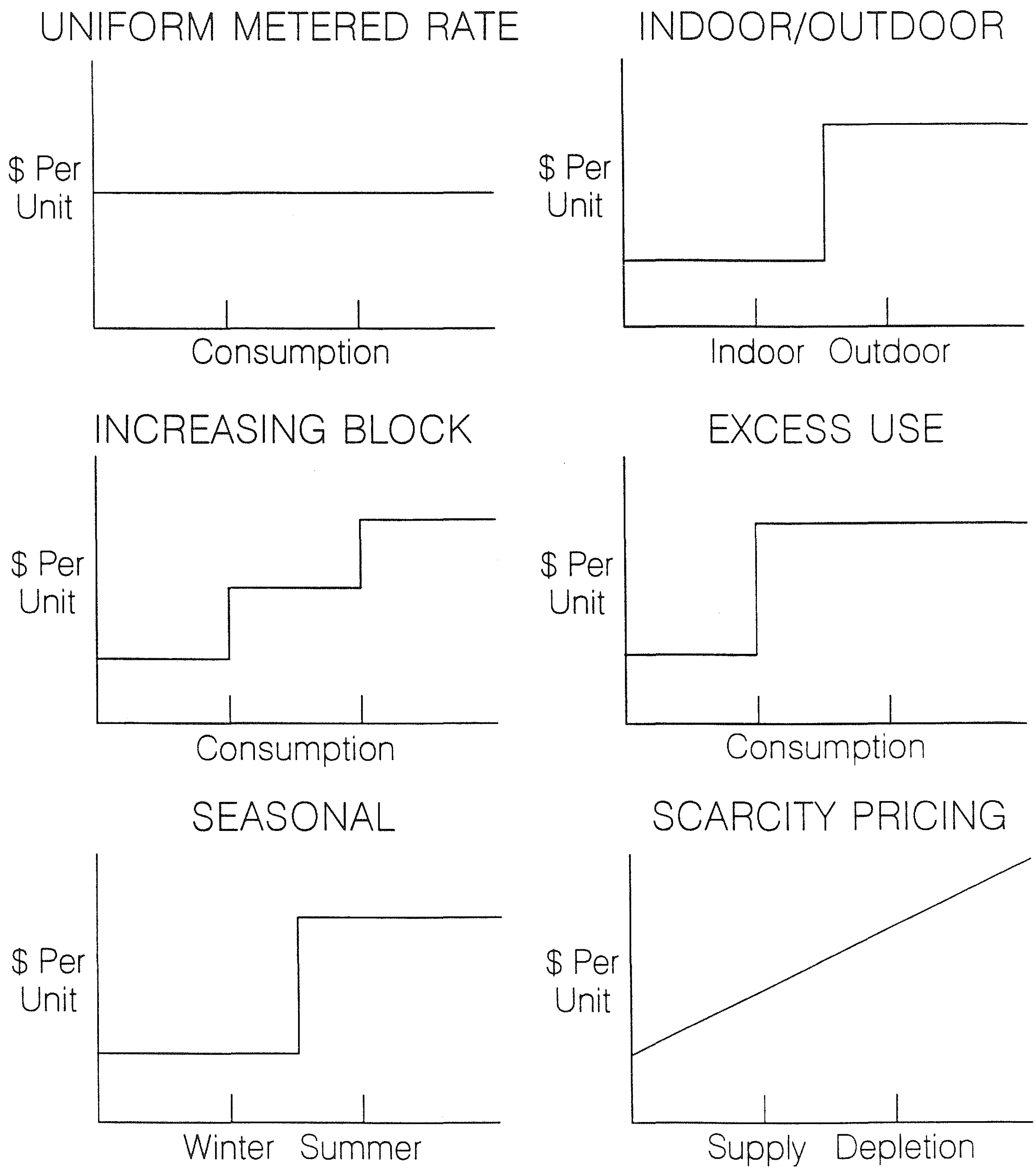

Fig. 4-3. Water rate structures that encourage conservation (author's construct).

particularly where water is sometimes in short supply.[24] Caution must be taken in considering increasing block rates.[25] First, they meet the test of economic efficiency only under unique conditions. Second, prices below incremental costs in the initial blocks and prices above costs in the tail blocks promote neither conservation nor efficient water use. Third, like decreasing block rates, designing increasing block rates poses problems associated with determining the number of blocks, consumption breakpoints, and rate differentials. Finally, these rates can result in a decrease in average consumption without necessarily decreasing peak demand, which is the goal in the first place. This may lead in turn to deteriorating load factors and the creation of needle peaks for the water utility. The American Water Works Association cautions that increasing block rates can be considered cost-of-service based only under special circumstances.[26] John Russell adds that the increasing block rate schedule "unduly penalizes large customers who may have very favorable annual consumption characteristics."[27]

Many proponents of marginal-cost pricing also advocate seasonal pricing for conservation purposes because it ties prices to peak periods of water use. Seasonal pricing can accomplish several goals:[28]

- **Cost recovery.** Higher rates during the summer season may reflect a more equitable recovery of the cost of providing water service from those who use more water than average during the summer season.
- **Peak demand reduction.** Higher summer prices are intended to reduce peak daily and peak hourly demands, thus postponing or eliminating new capacity construction.
- **Extension of available water supplies.** Where the supply is limited, or the development of additional sources is more expensive than available

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24 *Ernst and Young's 1990 National Water and Wastewater Rate Survey* (Charlotte, NC: National Environmental Consulting Group, Ernst and Young, 1990).

25 Patrick C. Mann, *Water Service: Regulation and Rate Reform* (Columbus, OH: The National Regulatory Research Institute, 1981).

26 American Water Works Association, *Water Rates* (Denver, CO: American Water Works Association, 1983), 58.

27 John D. Russell, "Seasonal and Time of Day Pricing," in American Water Works Association, *Water Rates: An Equitability Challenge,* AWWA Seminar Proceedings (Denver, CO: American Water Works Association, 1983), 96.

28 Ibid, 92.

at present, the seasonal rate is considered a mechanism to postpone or eliminate the need for a major expansion of the system.

- **Conservation.** Higher summer prices are thought to encourage conservation and better utilization of the water supply and as a means of conserving natural resources, energy, and chemicals.

For a utility to adopt seasonal pricing, there must be substantial variation between peak and off-peak periods, installed capacity requirements must be determined primarily by peak demand, peak demand must occur consistently during the same season of each year, and the utility must be able to estimate the different costs associated with meeting peak and off-peak demand.[29] Russell provides several special considerations regarding the use of seasonal rates:[30]

- Detailed planning, complete and adequate information programs for customers, and careful administrative and computer procedures are essential for a successful program.

- Any seasonal rate introduced should be relatively modest in price as compared with winter rates at the outset, with later adjustments to increase the differential.

- The summer excess charge methods appears to be the superior method for matching revenues with costs and discouraging maximum summer demands.

- Any type of summer seasonal rate can cause more variations in revenue than a uniform annual rate.

- A seasonal rate may not be appropriate for all water systems. Where annual supplies are more than adequate and the system capacity is adequate or possibly excessive, a seasonal rate may discourage water sales and thus increase the cost of water for the remaining sales, without any substantial benefit to the water system except to possibly better recover costs from summer peaking customers.

Russell prefers the excess-use method for seasonal pricing, even though the summer-winter form may be easier to administer and understand because it is more

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[29] Patrick C. Mann and Donald L. Schlenger, "Marginal Cost and Seasonal Pricing of Water Service," *American Water Works Association Journal* 74 no. 1 (January 1982): 6.

[30] Russell, "Seasonal and time of Day Pricing," 96.

effective for purposes of cost recovery and conservation.[31] However, determining excess use is difficult and may be perceived as arbitrary. A similar means of seasonal differentiation is the indoor-outdoor rate schedule.[32] These rates target the problem of inequity occurring when large households with water-efficient landscaping (xeriscapes) pay more for water than small households with inefficient landscaping, even though the latter is contributing more than its fair share to the summer peak.

Indoor-outdoor rates can be implemented by installing two water meters per household, though this may not be cost effective under many circumstances. Another approach is to use consumption levels during the off-peak seasons to determine a base level of use for the peak season; use above this base level would be charged at a higher rate. In Fairfax County, Virginia, for example, the utility imposes a surcharge on summer consumption exceeding 1.3 times winter consumption, with new customers charged at a higher rate until winter consumption is established.[33] Although many utilities may have the capability to use these methods, the added administrative expense must be taken into account in comparing them to other ratemaking options.

Some cities make aggressive use of water rate structures in their conservation programs. Tucson, Arizona's water system, serving 554,00 customers, has a rate structure consisting of increasing block rates, higher summer rates, and a surcharge on water provided outside city boundaries.[34] In addition, the city plans to consider revisions to the local plumbing code, use of efficient turf irrigation systems, and applications for recycled water. Other cities, such as Denver, have explicitly rejected the use of water rates for conservation, opting instead to focus on other

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31 Ibid.

32 Gary C. Woodard, "A Summary of Research on Municipal Water Demand and Conservation Methodologies," in Arizona Corporation Commission, *Water Pricing and Water Demand: Papers Presented at a Water Pricing Workshop* (Phoenix, AZ: Utilities Division, Arizona Corporation Commission, 1986) 43-47.

33 Ken Koehler, Peter Buetow, Michael Follett, and Ray Tufgar, *Development of a Plan for Equitable and Effective Water Rates in the Region of Waterloo* (Kitchener, Ontario: Stevenson Kellogg Ernst and Whinney, Management Consultants, 1989), 28.

34 Koehler, Buetow, Follett, and Tufgar, *Development of a Plan,* 28.

means of promoting water efficiency, such as xeriscape. Denver maintains a decreasing block rate schedule.[35]

Conservation through pricing can be an especially effective tool for managing demand when the objective is to avoid or forestall the need for additional capacity under conditions of growth. In 1977, Dallas became one of the first major cities to adopt a pricing policy that imposed a surcharge on peak residential use. Although large peak-time users (more than 20,000 gallons in the summer) experienced a 58 percent rate increase, the overall increase in the revenue requirement was 12 percent. A preliminary assessment attributed a reduction in demand to the new pricing system, with water savings equivalent to the construction of a 50 to 75-million-gallon-a-day treatment plant.[36]

For publicly owned water utilities, it may be easier to incorporate policy goals such as conservation into the ratemaking process. For investor-owned water utilities under the jurisdiction of state public utility commissions, these goals must be reconciled with traditional principles of regulation. The inclination of the commissions to promote wise use or other policies may depend on legislative mandates, precedents in other utility areas, and whether outcomes are considered consistent with the public interest and other policy goals. Integrated water resource planning may be a forum in which to contemplate these issues.

Conservation Programs

Water suppliers can implement demand management through programs that promote conservation and water-use efficiency. As in the pursuit of energy efficiency, water planners can make use of a checklist, as appears in table 4-6, to aid them in identifying efficiency potential, designing efficiency programs, and integrating efficiency resources.[37] The same checklist can be used in the ongoing evaluation of utility conservation programs.

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35 *Ernst and Young's 1990 National Water and Wastewater Rate Survey.*

36 I. M. Rice and L. G. Shaw, "Water Conservation--A Practical Approach," in American Water Works Association, *Water Conservation Strategies* (Denver, CO: American Water Works Association, 1980), 73.

37 Paul Chernick and John Plunkett, "A Utility Planner's Checklist for Least-Cost Efficiency Investment," a paper presented at Seventh NARUC Biennial Regulatory Information Conference, September 12-14, 1990, Columbus, Ohio.

TABLE 4-6

EFFICIENCY CHECKLIST

Identifying Efficiency Potential

- Efficiency potential should be estimated by examining the components of load, and determining the potential reduction for each component, rather than by estimating the effects of particular programs or measures.
- For each type of unrealized economic efficiency potential, planners should identify the specific market barriers that result in the failure to achieve the identified potential, and should identify the amount of potential that can be achieved by overcoming these barriers.
- Analysis and action should be coordinated, with the results of implementation improving assessment of potential, even while analysis of potential continues to identify opportunities for additional and improved implementation efforts.

Designing Efficiency Programs

- Program delivery should be organized by customer and market segment, rather than by end use or by technical measures.
- Programs should be designed to be as comprehensive as possible, to reduce costs, avoid lost opportunities, and exploit all economic possibilities.
- Incentives must be as strong as the market barriers they must overcome.
- Program delivery must also be designed to address the actual market barriers; for example, financial incentives may do little to overcome information or convenience barriers.
- Program evaluation should be coordinated with program design from the onset.
- Special attention should be paid to capturing transient efficiency opportunities, which would be lost if not captured in a narrow time window.
- The design of demand-side management programs is likely to be more efficiency and the review of results is likely to be less contentious if the utility collaborates with other players in the planning process.

Integrating Efficiency Resources

- Demand-side management must be evaluated with economic tests that properly reflect the total social benefits of the measures.
- The avoided cost estimates used in evaluating demand-side management should be coordinated with utility load forecasts and supply plans, and should reflect the full benefit of demand-side management.
- Financial disincentives to utility efficiency efforts must be removed.
- Externalities should be incorporated in resource integration and in the evaluation of demand-side management and supply options.

Source: Adapted from Paul Chernick and John Plunkett, "A Utility Planner's Checklist for Least-Cost Efficiency Investment," a paper presented at the Seventh NARUC Biennial Regulatory Information Conference, September 12-14, 1990, Columbus, Ohio.

Water efficiency especially is important for indoor water use, where demand is generally price inelastic. In other words, even at higher prices people are not likely to change the frequency with which they use water fixtures (such as the number of showers they take). They may be unopposed to efficiency improvements that result in savings on a per-use basis (such as the amount of water used during each shower). The greatest potential for indoor water-use efficiency is in the installation of improved toilets, which makes them the target of many conservation programs.[38] However, problems remain in getting aesthetically acceptable efficient toilets on the market at a price consumers are willing to pay.

The Rocky Mountain Institute, a long-time proponent of energy efficiency and a more recent advocate of water-use efficiency, reported three prominent examples of high-impact local water conservation efforts:[39]

- To conserve water supplies and reduce loads on its wastewater treatment plant, Santa Monica, California is planning to replace 12,000 conventional toilets with ultra-low-flow fixtures; anticipated savings are 835,000 gallons a day. The old toilets will be used to construct an artificial reef to increase habitat for marine life.

- A hotel in Michigan saved a $70,000 tap fee the year it was built by installing water-efficient toilets, faucets, and showerheads. In addition, $237,000 was saved in upfront construction costs, and $35,000 to $45,000 a year was saved in water and sewer bills, with total savings estimated at $750,000 over eight years.

- In Fresno, California, overpumping of aquifers polluted by pesticides and fertilizers forced the shutdown of 35 wells. Fresno is trying to reduce water demand to slow the migration of contaminants toward the city's other wells by retrofitting 81,000 homes with water meters and 125,000 homes with water-efficient showerheads.

Though not yet widely implemented, water utility conservation programs range from consumer education to xeriscape (water efficiency landscaping) to audits of water use (similar to those used in energy conservation) to retrofits of water-using fixtures. In the energy sector, some rather persuasive arguments have been made in

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38 Carol J. Allen, "The Increased Usage and Importance of Low-Consumption Water Closets," *Proceedings of the Seventh NARUC Biennial Regulatory Information Conference* (Columbus, OH: The National Regulatory Research Institute, 1990), 247-79.

39 *Rocky Mountain Institute* 6 no. 2 (Summer 1990): 4.

favor of demand-management programs run by utilities as compared with other entities, such as government agencies.[40] Utilities are well equipped to implement conservation programs because their relationship with customers is already established and their knowledge of water use markets and the potential for efficiency gains is great. Utility programs are believed to produce better results in terms of assuring ratepayer equity, reducing transaction costs, and allowing for geographic, programmatic, and technological flexibility. In addition to residential programs, utilities can target high-use customers, such as industrial and commercial water users, and design conservation programs that meet their particular production needs (for example, food processing or cooling).

Many larger water utilities, especially those in water-poor regions, already have substantial experience with demand management programs and conservation strategies. Many combine water pricing with other activities, such as plumbing retrofit programs and consumer education. For example, the city of San Francisco, which provides water service to 2.2 million residents, uses an increasing block rate structure and use restrictions based on a percentage of past usage.[41] Plans for the future include expanding the city's water conservation program and considering a rebate program and financial incentives for retrofits. The city also is considering regulating landscaping activities.

In preparing its least-cost plan, the Kentucky-American Water Company identified several institutional, mechanical, and pricing options to promote water conservation in its service territory, as summarized in table 4-7. After initial review, some measures were rejected for policy or cost reasons. Others were rejected after additional analysis. In the end, the utility chose to pursue plumbing code changes, a retrofit program for residential customers, and the use of seasonal and increasing block rates, in addition to its consumer education efforts.

A key concern about conservation and demand management programs sponsored by a water utility is their potential to bestow unequal benefits on ratepayers, even though ratepayers share equally in the cost of supporting the programs. Thus, similar to the design of rates to cover the cost of new capacity investment and

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40 The National Association of Regulatory Utility Commissioners, *Least-Cost Utility Planning Handbook for Public Utility Commissioners, Volume 2* (Washington, DC: The National Association of Regulatory Utility Commissioners, 1988), II-11.

41 Koehler, Buetow, Follett, and Tufgar, *Development of a Plan,* 28.

TABLE 4-7

EVALUATION OF CONSERVATION OPTIONS BY KENTUCKY-AMERICAN WATER COMPANY

	Options Rejected: Policy reasons	Options Rejected: Cost reasons	Options selected for further consideration	Options Selected
Institutional options				
Plumbing code changes	-	-	X	X
Public education	-	-	X	-
Citizen involvement	-	-	X	-
Odd-even watering	X	-	-	-
Forced curtailment	X	-	-	-
Rationing	X	-	-	-
Mechanical options				
Low-water landscaping	X	-	-	-
Recycle/graywater systems	-	X	-	-
Plumbing device changeout	-	X	-	-
Plumbing device retrofit				
Multifamily and municipal	-	X	-	
Single family and university	-	-	X	X*
Pressure reducing valves	-	X	-	-
Leak detection	-	-	X	-
Pricing options				
Seasonal rates	-	-	X	X
Uniform rate (replace declining)	-	-	X	-
Increasing block rate	-	-	X	X
Peak demand or capacity charges	-	X	-	-

Source: Authors' construct from American Water Works Service Company, Inc., *Kentucky-American Water Company Least-Cost/Comprehensive Planning Study: Technical Appendix* (Haddon Heights, NJ: System Engineering, American Water Works Service Company, Inc., 1986), appendix C-2.

* A conservation program for the University of Kentucky was rejected (because many measures were already in place) but both low-cost and high cost retrofits for residential customers were deemed appropriate.

other supply-side options, the concepts of equity and fairness must be considered in implementing conservation programs. Several approaches to management have been proposed to reconcile rate impacts, distributional equity, and utility competitiveness with economic efficiency.[42] These methods include:

- Offering efficiency programs in lieu of promotional industrial rates.
- Moderating the timing of demand-side resource acquisition.
- Minimizing utility incentive and administrative costs through improved delivery.
- Sharing savings between ratepayers and program participants.
- Constructing a low-impact demand-side management plan by mixing programs with positive and negative rate impacts.
- Offering a broad set of programs that allow all to participate.

Only a few years ago articles that advocated conservation through the use of water-efficient fixtures concluded with lists of the barriers to their actual development and application.[43] *Technical barriers* included insufficient operational and performance data, unconventional physical characteristics, and uncertainties about waste transport. *Economic barriers* included high capital and potentially high operation and maintenance costs. *Regulatory barriers* included nonconformance with plumbing codes and institutional resistance to change. *Social barriers* included actual or perceived adverse effects, limited public awareness, and resistance to change. Today, valuable data on the performance of conservation strategies are available and formerly exotic measures (such as ultra-low-flush toilets) are gaining acceptance among water managers and consumers. Gradually, many of the barriers to implementation are being overcome, further enhancing the potential of water utility conservation programs.

Still, some water utilities like some electricity utilities, may resist taking on the responsibility of a conservation program. Some may hold tight to the belief that utilities should promote sales, not conservation. For this reason, utilities and utility regulators may need to consider incentive systems, discussed in chapter 3, to

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42 Ibid., IV-12.

43 Robert L. Siegert, "Minimum-Flow Plumbing Fixtures," *American Water Works Association Journal* 75 no. 7 (July 1983): 342-347.

provide encouragement when it is determined that a conservation program would be consistent with the goals of integrated resource or least-cost planning. In some cases, it may be necessary to effect a change in the rate structure along with the implementation of a utility conservation program in order to maintain the utility's revenue stream.

Like the commissions that regulate them, water utilities need not reinvent the wheel when it comes to designing water conservation programs. The experiences of the electricity and natural gas industries provide a wealth of information on how to design, implement, and evaluate these programs. Some of the analytical tools and evaluation methods of integrated water resource planning are discussed in the following chapters.

CHAPTER 5

WATER RESOURCE PLANNING TOOLS

Analytical tools are essential to integrated resource planning. The toolbox grows fuller as the complexity of the planning process mounts and as new tools for analysis are discovered and applied. These tools come from a variety of disciplines: engineering, economics, natural resources, the policy sciences, and so on. Resource planning deals mainly with the issue of uncertainty, particularly future patterns of supply and demand. While planning cannot overcome uncertainty, better planning methods can mitigate its effects. Knowing where the risks lie is half the battle.

In water utility planning there is considerable uncertainty, partly because the forces of nature influence both water supply and demand, and partly because nature is highly unpredictable. Uncertainty exists about long-term availability of water supplies as well as about future natural resource and environmental regulations affecting water's availability. Forecasts of demand can be particularly uncertain. Planning itself involves decisionmaking under varying degrees of uncertainty or, put differently, the assumption of risk. Even a least-cost option may translate into increased risks both to utilities (such as revenue uncertainty) and their ratepayers (such as uncertainty about service reliability). However, the process of planning and the integration of supply and demand options may help water utilities and regulators cope with the environment of increased uncertainty. Ultimately, the quality of planning depends on the quality of evolving planning methods. This chapter describes water resource modeling applications, supply and demand forecasting methods, and, briefly, some other tools of integrated water resource planning. A review of evaluation methods is reserved for the next chapter.

Modeling Applications in Water Resource Planning

Planning is made far easier with the use of models, which essentially are representations of real world phenomena.[1] Put another way, a model is an analytical tool using a parsimonious number of variables to represent a problem,

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[1] Andrew A. Dzurik, *Water Resources Planning* (Savage, MD: Rowman and Littlefield Publishers, Inc., 1990), 224.

situation, or systems. The goal of parsimony is achieved by including all statistically significant variables (in other words, not too many variables but not too few). The art of modeling is in selecting variables for analysis and determining their significance in explaining the phenomenon under study.

Types of Models

The models used frequently by planners of all types (water resource planners, land use planners, and so on) fall into general categories based on mathematical and applicational distinctions:[2]

- **Predictive and estimating models.** These are designed to explain real-world phenomena and the patterns that may be expected over time. Predicting and estimating models used in planning are usually standard curves fitted to the appropriate data.
- **Linear models.** Simple and complex linear models are useful tools in planning analysis, but should be employed with care as they have several limitations which should be noted. First, they assume that the future is an extension of the past. Second, linear models based on a correlation of variables do not show cause-and-effect relationships. Finally, averaging occurs in order to make the linearity assumption work. This can distort the results.
- **Nonlinear models.** These are used when linearity does not adequately explain the relationships between variables. Examples are second-order polynomial models, Gompertz models, and logistic models.
- **Optimizing models.** Given a set of constraints, optimizing models are a group of methods useful in estimating the "best" solution. Among the most commonly used optimizing models are classical calculus, linear programming, nonlinear programming, and dynamic programming.
- **Stochastic (probabilistic) models.** These are optimizing methods used when the terms of the problem are probabilistic (that is, expressed in terms of uncertainty).

According to Andrew Dzurik, water resource models can be distinguished according to a number of key features.[3] Some address water *quality* while others

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2 Thomas Debo, et al., "Planning Tools," in American Society of Civil Engineers, *Urban Planning Guide* (New York: American Society of Civil Engineers, 1986), 29.

3 Dzurik, *Water Resources Planning,* 224-5.

focus on water *quantity.* These can be further distinguished according to spatial dimensionality. Some models are descriptive, others predictive; some are deterministic, others stochastic; some are static, others dynamic. Most water resource models take a systems approach in general but use a variety of analytical methods within this framework, as seen in table 5-1.

Modeling applications in water resource planning are numerous, including: conflict resolution involving water quantity, quality, use, and regulation; surface and groundwater quality protection and management; multipurpose, regional, and interbasin management and planning; design and operation of water distribution and wastewater systems, irrigation systems, and hydroelectric power facilities; flood control and floodplain development; reservoir operation for multiple purposes; and environmental protection.[4]

The long-time champion of water resource modeling has been the U.S. Army Corps of Engineers. Figures 5-1 and 5-2 provide the short-term and long-term drought management decision models published by Corps. These models illustrate one of the key modeling applications in water resource management and the emphasis on mathematical optimization. The models also illustrate how forecasts of water supply and demand are used as key inputs in water resource modeling.

Computer Modeling

Computer modeling is rapidly becoming an essential tool of water supply planning. In addition to general statistical and engineering software, a variety of special-purpose software is available for water resource planning applications:[5]

- Water resources data bases are used to store information and time series of observation data on groundwater and surface water, and to produce various statistical reports.
- Rainfall/runoff models are designed to simulate and project streamflows on an hourly or daily basis, using input rainfall data and a set of parameters describing the hydraulic properties of the catchment area.

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4 Adapted from D. P. Louks, J. R. Stedinger, and U. Shamir as cited in Dzurik, *Water Resources Planning,* 236.

5 United Nations, *Water Resources Planning to Meet Long-term Demand: Guidelines for Developing Countries* (New York: United Nations, Natural Resources/ Water Series No. 21, 1988), 32-33.

TABLE 5-1

SYSTEMS ANALYSIS METHODS USED IN WATER RESOURCE PLANNING

Optimization Models	Statistical Techniques
Mathematical programming · linear · quadratic · nonlinear · integer Dynamic programming Goal programming Lagrangian analysis Geometric programming Control theory	Multivariate analysis Regression analysis Factor analysis Principal component analysis **Simulation Models** Simulation Sampling theory
Probabilistic Models	**Related Techniques**
Queuing theory Information theory Statistical decision theory Inventory analysis	Game theory Benefit-cost analysis Input-output

Source: Meta Systems, Inc., *Systems Analysis in Water Resources Planning* (Port Washington, NY: Water Information Center, Inc., 1975).

- Groundwater simulation models are designed to simulate and project the movement of groundwater in single or multilayered phreatic or artesian aquifers by a multicell representation on the hydraulic properties of the aquifer, using series on natural and artificial recharge, pumping, evapotranspiration, boundary inflows and outflows.
- Models of groundwater pollution processes are available.
- Pipe network analysis models can give an optimal solution to the problem of expanding an existing network or designing a new one.
- Hydraulic analysis of a system of open channels can be modelled.
- Multiobjective analysis can relate agricultural production to irrigation development.
- Integrated planning of agriculture and water allocations (involving crop yields, produce values, production costs, water transfer costs from a number of sources to a number of irrigated zones) can be used to compute the optimal combination of areas of various crops in each zone, given land and water availability constraints.

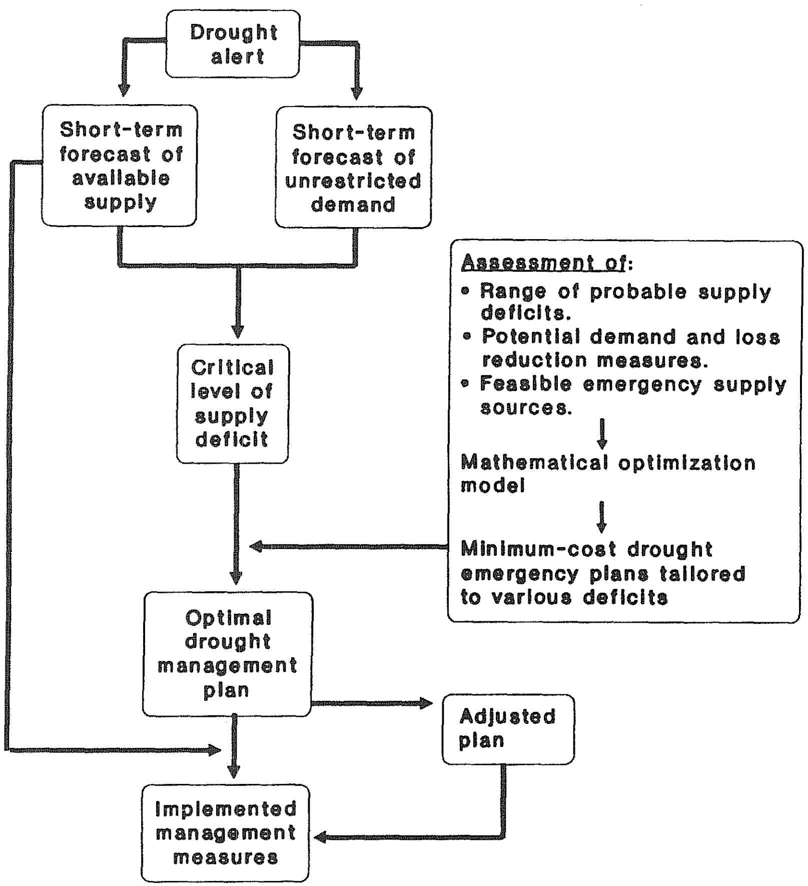

Fig. 5-1. Short-term drought management decision model as adapted from Benedykt Dziegielewski, Duane D. Baumann, and John J. Boland, *Evaluation of Drought Management Measures for Municipal and Industrial Water Supply* (Fort Belvoir, VA: Institute for Water Resources, U.S. Army Corps of Engineers, 1983), 18 and 22.

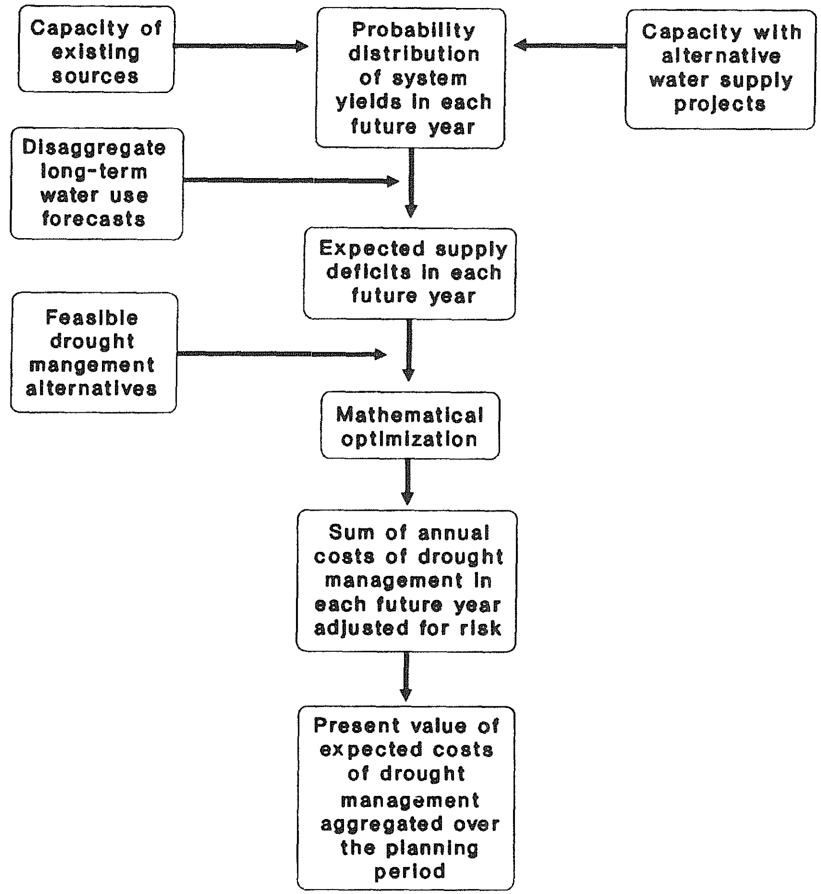

Fig. 5-2. Long-term drought management decision model as adapted from Benedykt Dziegielewski, Duane D. Baumann, and John J. Boland, *Evaluation of Drought Management Measures for Municipal and Industrial Water Supply* (Fort Belvoir, VA: Institute for Water Resources, U.S. Army Corps of Engineers, 1983), 23.

- Models can be used to determine optimal planning of water allocations, transportation, resource development and storage management, subject to a set of constraints (hydrological, hydraulic, water demand, capital) and using unit values of benefit for water supplied and losses for water shortages.

- A multicriteria economic ranking model can define a set of water-related projects, including weights that allow subjective preferences of projects (or types of projects) to affect the final priority ranking.

- Optimal operation rules for seasonal storage reservoirs can be determined.

- Simulation models can be made of water resource systems with several sources, reservoirs, transfers and supply areas.

Modeling Issues

In general, advances in modeling have greatly enhanced decisionmaking in water resource planning and management. Observers of governmental research on water resource modeling applications highlight the following findings:[6]

- Mathematical models have significantly expanded the nation's ability to understand and manage its water resources.

- Models have the potential to provide even greater benefits for water resources decisionmaking in the future.

- Water resource models vary greater in their capability and limitations and must be carefully selected and used by knowledgeable professionals.

- Models are not explicitly required in any federal water resources legislation, but they are often the method of choice to meet the requirements of legislation.

- Development and use of models are complex undertakings, requiring personnel with highly developed technical capabilities as well as adequate budgetary support for computer facilities, collecting and processing data, and numerous additional support services.

- Virtually all federal modeling activities are currently managed on an agency-by-agency basis, and little coordination of efforts occurs between agencies.

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[6] R. Friedmann, et al. as cited in Dzurik, *Water Resources Planning,* 235-6.

- Most federal agencies have no overall strategy for developing and using models; consequently, many legislative requirements and decisionmakers' needs for information are not being met.

- Successful modeling requires adequate resources for support services, such as user assistance, as well as for development. At present, model development has outstripped corresponding support for models.

- State governments frequently use water resource models, although may wish to use them more extensively than is currently possible.

Factors affecting the success or failure of modeling include: the institutional and political context of the application, the commitment to establishing plans, procedures, and policies; relationships between clients and modelers, modeling experience and expertise within the client agency, resistance to new approaches or technologies, availability of data and appropriateness of the model given that data, scope and complexity of the problem being addressed, and the extent and duration of the study as well as followup by the modelers.[7]

Analysts engaged in modeling for integrated planning purposes must take special care in selecting an appropriate time horizon.[8] A planning horizon is used for forecasting demand and assessing various scenarios; this planning horizon should be sufficiently long to cover the benefits and costs of supply or demand management options. An analysis horizon is used to evaluate alternatives over the long run and should be long enough to cover the entire life of supply or demand management options. The analysis horizon may be much longer than the planning horizon and uncertainty increases substantially with longer time frames.

Not all participants in water resource planning will embrace modeling and computer applications. In fact, it is likely that only the largest water supply utilities will be using advanced modeling techniques in the next decade. However, modeling capability is becoming more accessible to smaller utilities as well. Also, utilities of all size may be incorporated into federal, state, and regional water resource planning models. In this sense, all utilities may need to provide data for

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[7] Ibid., 237.

[8] National Association of Regulatory Utility Commissioners, *Least-Cost Utility Planning, Volumes 1 and 2,* (Washington, DC: The National Association of Regulatory Utility Commissioners, 1988).

modeling purposes as well as to be aware of modeling results and their policy and planning implications.

Forecasting Water Supply[9]

Water use is often classified either as instream or offstream. Offstream water uses are made possible through water withdrawals, namely the extraction or diversion of groundwater or surface water by human intervention. Withdrawn water is either put to consumptive or nonconsumptive uses. Water for nonconsumptive uses is released from the point of use and discharged through return flows to surface or groundwater sources. Water for consumptive uses, by contrast, is withdrawn but not returned directly to any water source, although it does return to the hydrologic cycle at some point.[10]

The amount of water available for withdrawal and use can be expressed by the following equation:[11]

$$W_t = N_t - T_t - D_t - r_t + E_t$$

where for a given time period (t):

W_t = total available withdrawals for consumptive and nonconsumptive uses;

N_t = new water (liquid) from precipitation and inflow (via rivers, streams, underground flows, aqueducts, and so forth);

T_t = the sum of losses from liquid water through transpiration and evaporation other than vapor losses associated with withdrawal;

D_t = liquid discharge away from the area through surface streams underground flows, storm drains, sewers, and the like;

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9 Adapted from Janice A. Beecher and Ann P. Laubach, *Compendium on Water Supply, Drought, and Conservation* (Columbus, OH: The National Regulatory Research Institute, 1989), 35-37, 44-47.

10 Wayne B. Solley, Charles F. Merk, and Robert R. Pierce, *Estimated Use of Water in the United States,* Circular 1004 (Washington, DC: U.S. Geological Survey, 1988).

11 Richard A. Berk, et al., *Water Shortage: Lessons in Conservation from the Great California Drought, 1976-77* (Cambridge, MA: Abt Books, 1981), 10.

r_t = the net change in the liquid water stored either on the surface or underground through natural or artificial means (such as underground aquifers or reservoirs); and

E_t = the amount of effluent withdrawals in the form of recycled water, also called nonconsumptive water use.

Predicting the availability of water supplies is no easier than predicting the weather, which of course plays an integral role in determining water availability in many areas. Like any type of forecasting, uncertainty grows with the length of the forecast period and continual adjustments may be necessary. Even though the hydrologic cycle is closed, meaning that expectations about supply are shaped by certain general parameters, fluctuations around mean values can be substantial. Supply forecasts can help explain these fluctuations as well as assist in planning the development of a water resource to achieve its appropriate capacity.

For supply forecasts, the variables used in most models fall into three general categories: hydrologic, topographic, and climatic.[12] Hydrologic indicators include reservoir rating curves, drainage area, streamflow, raw water quality, and the hydrologic characteristics of alternative sources (including yield estimates, water quality, and minimum flow requirements). Topographic indicators include regional maps, soil moisture conditions, and the extent to which drought-tolerant landscaping is used. Climate indicators include air temperature, precipitation (rainfall and snowfall), and moisture deficiencies.

The U.S. Army Corps of Engineers has published a series of reports on water supply forecasting and planning. One study summarizes several methods of water supply forecasting, as reported in table 5-2. Each method has different data requirements, depending on its focus, and advantages and disadvantages depending on its application. Most are highly technical in nature and limited in the sense that they focus strictly on the hydrologic supply side. Supply forecasting grows in complexity when water supplies become impaired by natural or artificial causes.

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[12] See J. J. Boland, et al., *Forecasting Municipal and Industrial Water Use: A Handbook of Methods* (Fort Belvoir, VA: Institute for Water Resources, U.S. Army Corps of Engineers, 1983); B. Dziegielewski, D. D. Baumann, and J. J. Boland, *Prototypical Application of a Drought Management Optimization Procedure to an Urban Water Supply System* (Fort Belvoir, VA: Institute for Water Resources, U.S. Army Corps of Engineers, 1983); and David W. Prasifka, *Current Trends in Water Supply Planning* (New York: Van Nostrand Reinhold Co., 1988).

TABLE 5-2
SELECTED WATER SUPPLY FORECASTING METHODS

Method	Type of Forecast	Data Requirements
Basin Climatic Index (BDI) Method	Expected total for 12 months' runoff, with 10, 25, and 50 percent probability of occurrence.	Drainage basin or regional data; long-term average BCIs and runoff, monthly precipitation and temperature.
Position Analysis	Percent probability of complete exhaustion of the reservoir storage during drought.	Monthly inflow, withdrawals and evaporation for a reservoir plus current reservoir storage.
U.S. Geological Survey Technique	Percent probability of a dry reservoir based on representative trace of inflows.	Historical and filled-in streamflow data.
National Weather Service River Forecasting Systems (NWS-RFS)	Simulated stream flows; total volume of flow; maximum, minimum, and average mean daily flow.	Hydrological parameters and initial conditions of a watershed, including moisture storage contents snowpack water equivalents, future time-series of mean areal precipitation, and temperature (at least 10-20 years of record).
Snow Accumulation and Ablation Model	Snow cover outflow plus rain that fell on bare ground.	Air temperature, snowpack water equivalents, other snow-cover variables.
Sacramento Soil Moisture Accounting Model	Five components of water flow: direct runoff, surface runoff, lateral drainage interflow, supplementary baseflow; and primary baseflow.	Same as for the NWS-RFS model (above).
Sensitivity Approach (for the NWS-RFS rainfall-runoff procedures)	Same as for the NWS-RFS model (above).	Typical trace of 6-hour-interval rain data, current soil moisture, variance of rainfall input.
Stochastic Conceptual Hydrologic Model (based on NWS-RFS)	Streamflow forecasts 6, 12, 18, 24, 30, and 36 hours in advance.	Rainfall data in 6-hour time steps and incoming real-time discharge.

Source: Benedykt Dziegielewski, Duane D. Baumann, and John J. Boland, *Evaluation of Drought Management Measures for Municipal and Industrial Water Supply* (Fort Belvoir, VA: Institute for Water Resources, U.S. Army Corps of Engineers, 1983), 26-27.

Understandably, not all utilities prepare water supply forecasts, relying instead on the analyses of other agencies with the resources to devote to this area of inquiry. Regional planning organizations, such as river basin agencies, may be better equipped to provide supply measurements and predictions. Regardless of where they originate, supply forecasts are relevant in integrated approaches that combine expectations about supply with expectations about demand for planning purposes.

Forecasting Water Demand[13]

Forecasting water demand is no simpler than forecasting any other type of demand. Moreover, the intricate relationship between water supplies and water demand can complicate matters. Spells of dry weather, for example, may not only impair supplies but also lead to high levels of water use, mainly outdoors.

Forecasting serves several short-term and long-term purposes.[14] In the short term, forecasting facilitates financial planning and management, projecting revenues to assess if and when a rate change is needed, estimating cost of service and setting rates, and risk management. In the long term, forecasting plays a role in developing a long-term financial strategy for the water supplier, planning the water system, and setting objectives for rates and policy. Both long-term and short-term demand forecasting play a role in integrated water resource planning models.

The evolution of demand forecasting is apparent in the experience of the Seattle Water Department. As seen in table 5-3, the department over the years has expanded the types of planning issues it addresses as well as the analytical techniques and data bases used in forecasting. Today, numerous forecasting methods are available. Some have special applications, as in forecasting water demand during periods of drought.[15] Others have more general relevance for planning and policy analysis purposes. Three approaches to forecasting are described below.

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[13] Adapted from Beecher and Laubach, *Compendium,* 81-94.

[14] U.S. Water Resources Council, *The Nation's Water Resources 1975-2000, Volume 2* (Washington, DC: U.S. Water Resources Council, 1978), part III, 2.

[15] Benedykt Dziegielewski, Duane D. Baumann, and John J. Boland, *The Evaluation of Drought Management Measures for Municipal and Industrial Water Supply* (Fort Belvoir, VA: Institute for Water Resources, U.S. Army Corps of Engineers, 1983).

TABLE 5-3
EVOLUTION OF DEMAND FORECASTING FOR THE SEATTLE WATER DEPARTMENT, 1940-1984

Period	Issues	Techniques	Data Bases
1940-1950	---	Per-capita methods	System total diversions
1950-1965	Planning size and timing of major facilities	Per-capita methods	System total diversions
1965-1970	Long-range planning	Unit-use coefficient method	Billing data from three geographic areas: CDB, industrial, all other
1970-1974	Revenue forecasts for rate studies	Judgmental methods	Three geographic areas: in city, outside city, wholesale
1973-1975	Regional water planning	Multivariate requirements models; demand model methods; scenarios; sensitivity analysis	Cross-sectional billing data for thirteen residential areas; retail sales for four sectors for one year; time-series for system total diversions
1976-1979	Medium- and long-range facilities planning; hydraulic modeling; conserva-plan analysis	Demand model methods; sensitivity analysis; scenarios; confidence intervals; per-capita methods	Three years of monthly sales data for five sectors; cross-sectional data for sixty-three residential areas
1979-1981	Short-term revenue forecasts for rate setting; conservation plan analysis	Time-series analysis combined with multivariate regression; confidence intervals	Five years of monthly sales data for eleven sectors
1982-1984	Medium- and long-range facilities planning; revenue forecasts for rate setting; conservation plan assessment; analysis of costs of shortages; risk analysis	Demand model methods; scenarios; confidence intervals; judgmental estimates of long-term price elasticities; Monte Carlo studies; per-capita methods	Five to eight years of wet season, dry season data for sixty revenue classes; cross-sectional data by census tract for all revenue classes

Source: C. Frederick DeKay, "The Evolution of Water Demand Forecasting," *American Water Works Association Journal* 77 no. 10 (1985): 56.

Extrapolation of Time-Series Data

Analysts using the extrapolation method place great faith in historical demand patterns to predict future demand patterns. Estimating future demand this way usually assumes linear or slightly curvilinear growth in demand and makes no attempt to predict deviations of a significant magnitude. One of the key problems with this method is that the period of demand used as the basis for extrapolation greatly affects demand projects, even from year to year.

Unless the pattern of demand is particularly stable, using a long time series of data does not necessarily yield more reliable results. Frequent adjustments to the forecast may be required, and planning may be greatly hindered. Clearly, the different projections of water demand would lead planners to draw different conclusions about the need for supply adjustments.

Extrapolation is unconcerned about the factors underlying changes in water demand. The method is especially weak with regard to changes in different components of water use. One study points out, for example, that extrapolation assumes continuous growth in all use categories, including leakage and other forms of unaccounted-for water, even though this assumption is not necessarily valid.[16] Nor does extrapolation account for efficiency gained through innovations in technologies, economies of scale, management, planning, or even regulation.

Statistical, Econometric, and Stochastic Models

Forecasts of water demand do not have to rely solely on the pattern of historical demand. Several modeling techniques allow researchers to make forecasts based on projections of explanatory variables that are known to correlate with water demand. The Corps of Engineers has identified six variations of this type of forecasting: per capita methods, per-connection methods, unit-use coefficient

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[16] George Archibald, "Demand Forecasting in the Water Industry," in Vince Gardiner and Paul Herrington, eds., *Water Demand Forecasting* (Norwich, UK: Geo Books, 1986).

methods, multivariate requirements models, demand models, and probabilistic methods.[17]

The first three are statistical methods that employ only single explanatory variables. Per capita methods use population only for predicting water use. As such they are criticized for excluding other known factors influencing water demand and possible differences among usage categories. The per-connection method is also limited to a single explanatory variable, but has the advantages of better data availability and a closer correspondence to the number of households in the utility service territory. Analysts using this method also can draw upon other research findings about household water consumption patterns, including case studies. Unit-use methods apply single explanatory variables, other than population size or service connections, to total water use or disaggregated categories, such as residential use. An example would be a method relating the number of manufacturing sector employees to industrial water use.

Requirements models and demand models are both econometric (or multiple-coefficient) methods that incorporate more than one explanatory variable. Requirements models use variables that are significantly correlated with water use. Demand models incorporate price, income, and other variables while emphasizing economic theory, implied causality, and the statistical significance of coefficients. The development of a causal econometric model of water demand is shown in table 5-4. Because they provide a more comprehensive picture, multivariate models are usually regarded as more useful for planning purposes. These also may be more or less complicated, which in turn affects the degree of difficulty in acquiring and analyzing the necessary data. Moreover, multivariate forecast models require forecasts of the chosen explanatory variables, such as population projections. If the population forecast is off the mark, the forecast of water demand likewise will be off, to the detriment of planning.

One way to consider uncertainty in forecasting is to use a stochastic or probabilistic approach, such as a contingency tree or a "what if" analysis, in combination with another base forecasting method. A contingency tree takes into account different combinations of variables, based on different probability assumptions, making it possible to produce alternative demand forecasts. The result actually is a range of forecasts to which different probabilities may be assigned. In

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[17] Boland, et al., *Forecasting Municipal and Industrial Water Use*.

TABLE 5-4

DEVELOPING A CAUSAL MODEL OF WATER DEMAND

(1)	Average-day residential water use	=	*f*(time).
(2)	Average-day residential water use	=	population x per capita use.
(3)	Average-day residential water use	=	*h*[(initial population + births - deaths + net migration) x per capita use].
(4)	Births	=	*j*(age distribution).
(5)	Deaths	=	*k*(age distribution).
(6)	Net migration	=	*l*(economic activity).
(7)	Average-day residential water use	=	[initial population + *j*(age distribution) - *k*(age distribution) + *l*(economic activity)] x per capita water use.
(8)	Per capita water use	=	*m*(marginal price of water, household income, climate factors).
(9)	Average-day residential water use	=	[initial population + *j*(age distribution) - *k*(age distribution) + *l*(economic activity)] x *m*(marginal price of water, household income, climate factors).

Source: Jerry E. Carr, Edith B. Chase, Richard W. Paulson, and David W. Moody, compilers, *National Water Summary 1987--Hydrologic Event and Water Supply and Use* (Washington, DC: U.S. Geological Survey, Water-Supply Paper 2350, 1990), 118-19.

a sophisticated analysis, such as one using a simulation model, both supply and demand could be manipulated to arrive at alternative forecasts. This may be an especially useful tool in planning for the possibility of drought or other water shortages. Proposed measures to mitigate the effects of a shortage, such as rationing, could be incorporated within the model to assess their impact. Probabilistic methods tend to involve significant data and computational demands. While they may enhance planning efforts, they also add a high degree of complexity to the process. Advances in computer hardware and software, however, have made multivariate modeling more accessible and less expensive. In particular, computers make it easier for analysts to conduct sensitivity, contingency, and probabilistic analyses as well as simply to "explore" the available data.

Each of the methods described by the Corps of Engineers has certain advantages. A single-coefficient method, for example, may serve the purposes of preliminary assessments. Probabilistic methods are too complex for this purpose but have advantages in terms of other planning criteria, especially in dealing with uncertainty. Data requirements and availability, however, depend on the particular forecasting application.

End-Use Methods

Other approaches to water demand forecasting include the use of end-use or component methods that emphasize estimating different water use categories and adding these to arrive at an aggregate demand forecast. A range of values is sometimes used within components and for the aggregate amount. For example, four general categories of water demand used in an end-use study by the Severn-Trent Water Authority in Great Britain are domestic use, industrial and commercial use, agricultural use, and unaccounted-for water.[18] Components of domestic use include personal use, toilet flushing, clothes washing, dish washing, other appliance use, and outdoor use. Industrial and commercial use consists of domestic uses as well as processing, and direct and recycled cooling. Agricultural use can be divided into domestic, livestock, and irrigation uses. Finally, unaccounted-for water may be attributable to customer connections, the distribution system, trunk mains, and reservoirs.

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18 Archibald, "Demand Forecasting."

In an end-use model, the different components of each general category are forecast according to expectations about that type of use. Domestic use, for example, may be affected by changes in plumbing codes or the degree of market saturation for different fixtures and water-using appliances. Introducing metering or changing the water rate schedule may affect the consumption patterns of industrial and commercial users. The availability of alternative sources (such as self-operated wells) might affect agricultural use. A leak detection and repair program could affect the unaccounted-for water category. In each case, the method can account for the effect of these issues on total water consumption. End-use methods also can accommodate changes in the behavior of water users or water-use technologies. Promoting water conservation through a public education campaign, installing low-volume toilets in a housing development, or implementing water recycling at an industrial plant are examples.

The best approach to water demand forecasting may be a hybrid approach that provides the policy analyst with a means of verifying the validity and reliability of the models and resulting forecasts. This is particularly important when data may be insufficient. Further, the use of any stochastic technique that allows the planner to assess alternative contingencies is likely to enhance planning capabilities. Table 5-5 compares time-series, econometric, end-use, and hybrid forecasting techniques in terms of certain advantages and disadvantages.

Data Requirements for Demand Forecasting[19]

Regardless of what is being modeled (requirements, demand, or end use) and whether a stochastic approach (such as a contingency tree) is being incorporated, econometric modeling requires a set of explanatory variables. Table 5-6 provides some of the variables that may be used in projecting future water needs for a given locality or water utility service territory. Each variable is thought potentially to affect water demand. Analysts, of course, choose a set of explanatory variables that they believe are the best predictors. Four major categories are identified: resources utilization, socioeconomic, cultural/institutional, and water system.

Water planners are increasingly aware of some variables that are difficult to quantify but that may have a significant effect on water consumption and thus on

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[19] Adapted from Beecher and Laubach, *Compendium,* 87-93.

TABLE 5-5

COMPARISON OF ALTERNATIVE DEMAND FORECASTING METHODS

Time-Series
- Advantages
  - Minimal data requirements
  - Low cost
  - Forecast accuracy generally good in short run
  - Can predict seasonal and daily patterns
- Disadvantages
  - Does not treat underlying factors explicitly
  - Not useful for policy analysis
  - Accuracy low in the long run

Econometric
- Advantages
  - Explicitly models underlying influences on demand
  - Based on explicit theory of consumer behavior
  - Less date-intensive than end-use models
- Disadvantages
  - High skill level required to develop models
  - Difficult to address or impossible to identify individual variable impacts (e.g., multicolinearity)

End-Use
- Advantages
  - Good policy-analysis capabilities
  - Relatively understandable
- Disadvantages
  - Often lacks endogenous behavioral component
  - Data-intensive
  - Costly

Hybrid
- Advantages
  - Better behavioral component than pure end-use models
  - Better policy analysis capabilities than most econometric models
- Disadvantages
  - Date-intensive
  - Costly
  - Ad hoc nature can make interpretations difficult
  - Can lack efficiency and elegance

Source: S. S. George as reported in David W. Prasifka, *Current Trends in Water Supply Planning* (New York: Van Nostrand Reinhold Company, 1988), 98.

TABLE 5-6
DATA USED IN WATER DEMAND FORECASTING

Categories	Variables
Resource Utilization	
Land use	Proportions of land in various use categories (such as urbanized, cropland, woodland) Agricultural production statistics Recreational uses
Water use	Water use by self-supplied industry Water use by agricultural sector Recreational uses Irrigated areas
Socioeconomic	
Demographic	Population (number of households, number of connections, number of users, etc.) Household size Characteristics of the population (such as age distribution)
Economic	Income level (persons or households) Assessed value of residential properties Size of residential properties Number of commercial and institutional establishments Value of commercial receipts Employee productivity Price elasticities for water demand
Housing	Housing density Type of housing Construction grading Size of lots Connections to public sewer
Cultural/Institutional	
Cultural	Consumer preferences, habits, and tastes Acceptability of demand reduction measures by consumers Cultural constraints or incentives Consumer education Policy variables
Legal/political	Legal barriers to implementation of alternatives Political constraints and opposition Historical experience

TABLE 5-6 (continued)

Categories	Variables
Water System	
Operational	Historical water use Total treated water Total delivered water Daily reservoir levels
Technological	Inspection and repair of faulty plumbing Leak detection program Efficiency of water-using fixtures and appliances Distribution pressure Supply reliability Allocations of water of differential quality Industrial processes and applications Industrial water reuse, recycling, and recirculation
Costs and Revenues	Operation and maintenance costs of water-supply system Investment and operation-maintenance costs for alternative water-supply sources Water and sewer revenues (aggregate and by customer class) Water and sewer rate structures Width and level of price blocks

Source: Authors' construct based on J. J. Boland, et al., *Forecasting Municipal and Industrial Water Use: A Handbook of Methods* (Fort Belvoir, VA: Institute for Water Resources, U.S. Army Corps of Engineers, 1983); B. Dzielielewski, D. D. Baumann, and J. J. Boland, *Prototypical Application of a Drought Management Optimization Procedure to an Urban Water Supply System* (Fort Belvoir, VA: Institute for Water Resources, U.S. Army Corps of Engineers, 1983); and David W. Prasifka, *Current Trends in Water Supply Planning* (New York: Van Nostrand Reinhold Company, 1988).

determining both average and peak demand in both the short term and the long term. David W. Prasifka suggests that besides fluctuations in rainfall, the following factors should be considered:[20]

- Variations in lawn irrigation demands associated with differences in residential housing density.

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20 David W. Prasifka, *Current Trends in Water Supply Planning* (New York: Van Nostrand Reinhold Company, 1988), 10.

- Differences in greenbelt irrigation requirements and in the availability of untreated or reclaimed water for these needs.
- Differences in the degree to which structural and nonstructural water conservation measures have been implemented in the area.
- Variations in person per household.
- Variations in the concentration of water-intensive industrial and commercial land uses.
- Effectiveness of public education programs to increase consumer awareness.
- Variations in income levels and other economic criteria.
- Intensity of construction activity, such as grading and site work.

There are numerous potential sources of data for use in water demand forecasting.[21] The water supply utility itself can provide essential data to the water planner. The National Weather Service, other federal agencies, and universities can provide climate and weather data. In addition, demographic and socioeconomic data are available from the U.S. Department of Commerce and the Bureau of the Census as well as state and local planning, economic development, and tax assessment agencies. End-use data are more costly and require a well-planned and often time-consuming research effort; the same is true for attitudinal data on consumer acceptance issues, as might be collected through a customer survey. Consultants and universities sometimes generate these types of data. For some forms of contingency analysis, it may be appropriate to use hypothetical data for certain variables, such as weather, in order to generate alternative scenarios.

The Role of Price in Demand Forecasting[22]

In economics, demand is viewed as the inverse relationship between price and quantity consumed. The price elasticity of demand measures the percentage change in quantity demanded in response to a percentage change in price. That is, price

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21 Boland, *Forecasting Municipal and Industrial Water Use.*

22 Adapted from Janice A. Beecher and Patrick C. Mann, *Cost Allocation and Rate Design for Water Utilities* (Columbus, OH: The National Regulatory Research Institute, 1990), 31-34.

elasticity measures the sensitivity of quantity consumed to price changes. Estimating price elasticity is an important component of demand forecasting and revenue projection. If a rate change is anticipated, such as implementation of a conservation pricing, its effect on demand and revenues must also be anticipated by utilities and their regulators. Moreover, no demand forecast is complete without a consideration of the price variable, whether or not price is being used as a tool of conservation.

In a demand model, the price elasticity of demand (n) is calculated as:[23]

$$n = \frac{\text{change in quantity/mean quantity}}{\text{change in price/mean price}}$$

where:

$n = 0.0$		perfectly inelastic demand
$0.0 > n > -1.0$		relative inelastic demand
$-1.0 > n > -\text{infinity}$		relatively elastic demand
$n = -\text{infinity}$		perfectly elastic demand.

Water, since it is used in a wide variety of ways, is likely to be characterized by a number of different demand curves each of which may reflect a different price elasticity. For some types of water use, a change in price is likely to bring about a substantial change in the quantity consumed. Water for swimming pools and landscapes (mostly outdoor uses) may have price-elastic demands. In contrast, demand for water used for drinking, bathing, laundering, and other more fundamental needs (mostly indoor uses) may be more price-inelastic.

The principal research findings about price elasticity of water demand can be summarized as follows:[24]

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[23] A linear model is appropriately applied to water demand. But it is relevant only in the range for which the analyst has data and results cannot be assumed valid for segments of the demand curve where prices are markedly different.

[24] Patrick C. Mann, *Water Service: Regulation and Rate Reform* (Columbus, OH: The National Regulatory Research Institute, 1981), iii.

- Aggregate municipal demand is relatively price-inelastic.
- Price elasticity appears to vary positively with water price levels; that is, there is more usage-price sensitivity with higher rates than with lower rates.
- The price elasticity of residential demand is similar to aggregate municipal demand except when disaggregated into seasonal and nonseasonal components, in which case seasonal demand is more elastic than nonseasonal demand.
- Commercial and industrial demands appear to be more sensitive to price changes than residential demand.
- The price-elasticity coefficients associated with water demand generally indicate that water rates changes can alter usage levels.
- The relatively low coefficients associated with residential demand along with evidence that average sprinkling demand is more sensitive to price than maximum sprinkling demand suggests that time-differentiated rates may be more effective than general rate increases in altering consumption patterns.

Estimates of price elasticities vary widely.[25] According to Baumann, the literature as a whole suggests that a likely range of elasticity for residential demand is between -0.20 and -0.40, which is relatively price-inelastic.[26] Although its statistical significance is questionable, an estimate of elasticity for industrial demand ranges between -0.50 and -0.80, somewhat less price-inelastic than residential demand. The implication is that industrial users will tend to reduce consumption in response to price increases by a larger quantity than residential users. Presumably, a large enough increase will cause some of these users to seek alternative water supplies.

As part of a comprehensive analysis of water pricing in Tucson, Arizona, William E. Martin and others conducted a longitudinal analysis of changes in prices

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25 For a summary, see U.S. Army Corps of Engineers as adapted by William O. Maddaus, *Water Conservation* (Denver, CO: American Water Works Association, 1987), 66, reprinted in Beecher and Laubach, *Compendium*, 242.

26 Duane D. Baumann, "Issues in Water Pricing," in Arizona Corporation Commission, *Water Pricing and Water Demand,* papers presented at a Water Pricing Workshop, Utilities Division, August 21, 1986, 7.

and quantities of water pumped to assess price elasticity.[27] In eleven of sixteen years studied, the researchers found the implied elasticity to be negative, as expected. While people appeared to respond to higher prices by cutting back consumption, the authors concluded that major cutbacks could be expected only when a rate increase was accompanied by enough publicity to increase public awareness. Further, price was only one of several variables, including weather, that appeared to affect consumption significantly. In periods of drought, changes in water practices, perhaps induced by public information campaigns, actually may prove to be more influential than the simple price-quantity relationship.

Positive price-elasticity coefficients indicate that water rate changes have some potential for altering water usage levels and patterns. However, given findings that water price changes affect average sprinkling demand substantially more than maximum sprinkling demands, extreme demand patterns may be minimally affected by rate changes. Thus, a seasonal increase in price may provide an incentive to reduce average use during the summer, but not peak use on especially dry days.

The statistical findings regarding the price elasticity of water demand have several implications for integrated resource planning. The relationship of the quantity demanded of water service and price complicates the task of water system design. Water system design is a function of average and peak demands, which are a function of water price, which is a function of the cost of service, which is a function of system design, and so on. Therefore, price-elasticity coefficients exceeding zero produce a circularity problem that has significant implications for planning and, in particular, the implementation of water conservation.

Other Planning Tools

Modeling and forecasting are not the sole analytical tools available to the resource planner. In fact, in an integrated framework an interdisciplinary approach should be encouraged, along with the use of a wide variety of methods. Planning on a regional basis, for example, is highly interdisciplinary in nature. As seen in table 5-7, the data requirements in a regionally integrated planning study, such as

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27 William E. Martin, et al., *Saving Water in a Desert City* (Washington, DC: Resources for the Future, 1984).

TABLE 5-7

DATA USED IN REGIONAL INTEGRATED WATER RESOURCE PLANNING

Base Data
- Digitized water well locations
- Remote sensing data
- Geographic profile

Meteorological Data
- Precipitation
- Minimum and maximum temperatures (daily, monthly)
- Pan evaporation (daily, monthly)
- Lake surface evaporation (gross, net)

Biological Resources
- Microorganisms (bacterial water quality, rivers, lakes, streams)
- Coastal zone biological information

Geological and Land Resources
- Soils
- Water injection
- Agricultural land use

Water Resources

Surface
- Streamflow (daily, monthly)
- Sediment load (daily, monthly)
- Coastal zone hydrographical information
- Surface water temperature (daily)
- Surface water conductance
- Surface water runoff

Subsurface
- Water level measurements
- Groundwater quality

Human Activities
- Water use by hydrographic unit
- Reservoir contents (daily, monthly)
- Municipal return flow
- Waste discharge data
- Municipal, industrial water use
- Permit master file
- Water use file
- Waste or wastewater operator data
- Community profile (water utilities information)

Socioeconomic Resources

Social
- Census
- Community profile (population and education)

Economic
- Earnings and income
- Business statistics

Source: Texas Natural Resources Information System as reported in United Nations, *Water Resources Planning to Meet Long-term Demand: Guidelines for Developing Countries* (New York: United Nations, Natural Resources/Water Series No. 21, 1988), 58-9.

one prepared for a river basin region, can be extensive. Such planning depends on a skilled combination of data from the "hard sciences" (such as geology, meteorology, and biology) and the social sciences (such as economics). The challenge in this sort of planning is not only in the merging of disciplines and data but in the communication of findings to policymakers.

At the utility level integrated planning can incorporate other planning processes internal to the utility. Financial planning, for example, is critical to the success of any long-range utility plan. Preparing and publishing long-range financial plans can build confidence in the water utility by customers and policymakers.[28] Moreover, structuring financial mechanisms should be consistent with least-cost principles. The development of financial planning model can help utilities achieve their financial and supply planning objectives.[29]

Finally, public utilities and their regulators may turn to public policy analysis, particularly economic and legal analysis, in considering integrated planning options. State water resource planning and statutes may constrain future supply options as well as lay the foundation for conservation and other goals. An economic framework provides means of evaluating utility planning efforts over time. Economics-based and other evaluation methods are addressed in the concluding chapter.

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28 Robert L. Brice and Eric R. Unangst, "Long-Range Financial Planning for Water Utilities," *American Water Works Association Journal* 81 no. 5 (May 1989): 48-52.

29 Jack A. Weber and David S. Hasson, *Reference Manual: A Financial Planning Model for Small Water Utilities* (Denver, CO: American Water Works Association, 1991).

CHAPTER 6

INTEGRATED PLANNING EVALUATION METHODS

This study has emphasized that integrated resource planning must be evaluated in the context of multiple perspectives.[1] The water utility will be interested in the effect of planning options on costs, revenue requirements, earnings, and future operations (perhaps especially in terms of supply reliability). Ratepayers will be interested in their effect on water service rates, total water bills, as well as on their water consumption lifestyles. Regulators will be concerned not only with the impact of planning on utilities, ratepayers and their own agencies, but with implications for efficiency, equity, environmental externalities, and other societal issues, especially over the long run. In the end, analyst judgment becomes an explicit evaluation technique in making the tradeoffs necessary in the course of planning. Only through ongoing evaluation can course adjustments be made in time to avoid planning catastrophes. The flexibility of the integrated planning approach allows for ongoing evaluation. This chapter reviews some of the methods that have emerged for doing so, including means of assessing planning decision instruments, incremental costs, utility programs, social acceptability, and externalities and environmental impacts.

Planning Evaluation Methods

A specialized literature is evolving on measuring and evaluating the benefits and costs associated with integrated resource or least-cost utility planning.[2]

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[1] See also, Linda G. Baldwin, "Evaluating Utility Options: Integrating Supply-Side and Demand-Side Resource Planning," in Harry M. Trebing, ed., *Adjusting to Regulatory, Pricing, and Marketing Realities* (East Lansing, MI: The Institute of Public Utilities, Michigan State University, 1983), 250-86.

[2] See National Association of Regulatory Utility Commissioners, *Least-Cost Utility Planning Handbook for Public Utility Commissioners, Volumes 1 and 2* (Washington, DC: The National Association of Regulatory Utility Commissioners, 1988); National Association of Regulatory Utility Commissioners, *National Conference on Integrated Resource Planning,* proceedings of a conference held in Santa Fe, NM, April 1990 (Washington, DC: National Association of Regulatory Utility Commissioners, 1990); and Narayan S. Rau, et al., *Methods to Quantify*

Demand-side management programs, in particular, are usually subjected to a variety of analytical tests to ensure that these investments yield the desired results. The choice of methodology is often debated for analytical, policy, and strategic purposes. Those in favor of demand-side management may be inclined to favor methodologies that support its adoption. Likewise, opponents of demand-side management may use tests that make this option appear less favorable. The need for valid and reliable data as well as objective analysis is crucial in this area of research.

Many conceptions of integrated or least-cost planning are available, which at times may complicate the evaluation process.[3] Particularly problematic is the definition of "least cost" and the choice of an appropriate evaluation time frame. A narrowly conceived definition of least cost may seem "penny wise and pound foolish" in the long run. Similarly, some measures (supply-side or demand-side) may appear too costly according to one standard, but not so according to another. As noted earlier, least cost can mean the minimization of rates, customer bills, utility revenue requirements, or production (both capacity and operating) costs. Given the many available definitions, there are at least as many standards applied to the decision of whether to implement supply-side or demand-side options.

So complex has the evaluation needs of integrated resource planning in the electricity sector become that participants have developed specialized computer applications to evaluate both supply and demand management alternatives.[4] Some involve specialized software packages while others can be implemented on a standard spreadsheet program. The complexity of emerging analytical methods, however, should not deter consideration of integrated water resource planning. The scope of evaluation should be suited to the scope of the particular planning effort. Some of the evaluation tools discussed in this chapter can be implemented even with limited resources.

Energy Savings from Demand-Side Management Programs: A Technical Review (Columbus, OH: The National Regulatory Research Institute, 1991).

[3] Cynthia K. Mitchell, "Application and Utilization of Cost-Benefit Analysis in the Evaluation of Competing Resources," *Proceedings of the Fifth Biennial Regulatory Information Conference, Volume 3* (Columbus, OH: The National Regulatory Research Institute, 1986), 2043-54.

[4] For references to some of these, see Barakat and Chamberlin, Inc. *Proceedings: Innovations in Pricing and Planning* (Palo Alto, CA: Electric Power Research Institute, CU-7013, 1990).

Planning Decision Instruments

Successful implementation of any proposed course of action may depend heavily on the quality of planning decision instruments, including planning documents. Some evaluation guidelines have been developed for water resource plans prepared by government agencies that are generalizable for the evaluation of other planning documents. In the 1970s, the now defunct National Water Commission (NWC) identified several criteria for determining whether a water resource plan (such as those prepared by government agencies) is good. In the NWC framework, a good plan would:[5]

- Be a document that is, indeed, a plan.
- Meet the goals stated at the beginning of the plan.
- Cover a rational planning area.
- Have adequate detail to fit the type of action proposed.
- Fit into a multisectoral plan.
- Illuminate the alternatives that were considered.
- Equitably allocate the resources.
- Have proper balance to meet uncertainties.
- Be politically, technically, financially, and legally implementable.
- Have adequate public involvement.
- Be technically sound.

Table 6-1 sets out some U.S. Army Corps of Engineers criteria for assessing water resource plans and the means of assessment that go along with them. The nine criteria specified are: acceptability, effectiveness, efficiency, completeness, certainty, geographic scope, benefit-cost ratio, reversibility, and stability. Again, these criteria were developed in the water resource planning context but are generally applicable to other planning efforts, such as those involving public water utilities.

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[5] Adapted from the National Water Commission as reported in Neil S. Grigg, *Water Resources Planning* (New York: McGraw-Hill, 1985), 38.

TABLE 6-1

CRITERIA FOR ASSESSING WATER RESOURCE PLANS

Criterion	Means of Assessment
Acceptability	Assess the workability and viability of a plan in terms of its acceptance by affected parties and its accommodation of known institutional variables.
Effectiveness	Appraise a plan's technical performance and contribution to planning objectives.
Efficiency	Assess the plan's ability to meet objectives functionally and in the least costly way.
Completeness	Assess whether all necessary investment to fully attain a plan are included.
Certainty	Analyze the likelihood of the plan meeting planning objectives.
Geographic scope	Determine if the area is large enough to fully address the problem.
Benefit-cost ratio	Determine economic effectiveness of the plan.
Reversibility	Measure the capability to restore a complete project to original condition.
Stability	Analyze sensitivity of the plan to potential future developments.

Source: U.S. Army Corps of Engineers as reported in Andrew A. Dzurik, *Water Resources Planning* (Savage, Maryland: Rowman and Littlefield Publishers, Inc., 1990), 91.

The integrated energy planning literature has arrived at certain evaluation criteria for planning documents as well. As seen in table 6-2, planning proponents at Oak Ridge National Laboratory emphasize for criteria: clarity of the plan, technical competence of the plan, adequacy of the short-term action plan, and fairness of the plan. These provide broad objectives that can be used in initiating integrated water resource planning. Planning mandates should make the objectives of the process explicit and participants in the planning processes should be prepared to state how these objectives are to be met.

Planning documents are essential decision tools. Equally important is the analytical framework set forth for making decisions. This too should be explicitly addressed in planning mandates. The National Water Commission emphasized that the method selected for decision analysis in water resource planning should meet certain criteria:[6]

- The approach should provide a level playing field in its treatment of supply-side and demand-side options.
- The method should be reasonably consistent with the corporate decisionmaking process.
- The method should minimize subjectivity and individual bias when calculating the value of externality adjustments and weighting factors.
- The method should foster giving the greatest attention to the most important externalities.

The integrated plan outline provided in appendix J of this report attempts a comprehensive approach to preparing an integrated water resource plan. Many of the leading evaluation methods are reflected in that outline, including those discussed below.

6 Ibid.

TABLE 6-2

CHECKLIST FOR A GOOD INTEGRATED RESOURCE PLAN

Clarity of the Plan

Does the plan adequately inform various groups about future resource needs, resource alternatives, and the utility's preferred strategy?

- Clear writing style
- Comprehensible to different groups
- Presentation of critical issues facing utility, its preferred plan, the basis for its selection, and key decisions to be made
- Logical report structure

Technical Competence of the Plan

Does the plan positively affect utility decisions on resource acquisitions and regulatory approval thereof?

- Comprehensive and multiple load forecasts
- Thorough consideration of demand-side options and programs
- Thorough consideration of supply options
- Consistent integration of demand and supply options
- Thoughtful uncertainty analysis
- Full explanation of preferred plan and its close competitors
- Use of appropriate time horizons

Adequacy of the Short-Term Action Plan

Does the plan provide enough information to document the utility's commitment to acquire resources in the long-term plan and to collect and analyze data to improve the planning process?

Fairness of the Plan

Does the plan provide information so that different interests can access the plan from their own perspectives?

- Adequate participation in plan development and review by various stakeholders
- Sufficient detail in report on effects of different plans

Source: Adapted from Eric Hirst, Martin Schweitzer, Evelin Yourstone, and Joseph Eto, *Assessing Integrated Resource Plans Prepared by Electric Utilities* (Oak Ridge, TN: Oak Ridge National Laboratory, 1990), vi.

Incremental Least-Cost Analysis[7]

One method for comparing the total costs associated with incremental additions to capacity (brought about by either supply management or demand management alternatives) is the estimation of marginal costs within a least-cost planning framework.[8] Proposed here is a method for calculating average incremental costs that builds substantially on previously developed techniques while incorporating certain practical solutions to some of the more troublesome conceptual and applied problems of marginal-cost pricing. The general steps in an incremental least-cost analysis are:

- Identification and feasibility analysis of incremental capacity alternatives.
- Estimation of capital and operation and maintenance costs for each incremental capacity alternative.
- Cost allocation to functional categories of water supply, off-peak and peak demand, and service classes.
- Calculation of total annualized incremental costs (TAIC) and average incremental costs (AIC).
- Identification of incremental least-cost (ILC) alternative.
- Use of estimates in rate design and planning.

The incremental least-cost method identifies the next increment of capacity in terms of least-cost planning criteria. The rationale is that cost allocation and rate design are an integral part of supply planning and such a methodology helps reinforce these relationships. A planning approach confines the number of capacity increment alternatives to those that meet a priori planning criteria within a specified planning time frame. Planning criteria need not be confined to least-cost

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[7] Adapted from Janice A. Beecher and Patrick C. Mann, *Cost Allocation and Rate Design for Water Utilities* (Columbus, OH: The National Regulatory Research Institute, 1990), chapter 4.

[8] In planning, marginal cost is sometimes used to represent avoided cost, by which is meant the savings associated with not implementing a particular supply strategy. The avoided cost of a supply option (such as an increment of new utility-owned capacity) is compared to the cost of other supply options (such as purchases) or demand management options (such as conservation).

principles or even to cost considerations. For example, most water supply plans would require systems to maintain basic engineering and health standards related to system reliability and water quality where cost is a subordinate consideration. As this report has emphasized, utility planning options also may be constrained by water resource plans and policies of various government agencies. The planning framework can span any length of time, and potential capacity increments can be either small or large and have either a short or long service life. One need not assume that the next capacity increment will be added within the next year or even in the next few years. Absent a highly technical analysis, water system engineers essentially can make an educated forecast about a select number of potential capacity sources.

Methodology

The first step in the incremental least-cost methodology is identifying appropriate supply alternatives (including changes in output levels using existing capacity as well as nontraditional supply options) consistent with relevant planning criteria. Each supply increment will involve different types of costs in the different functional areas of public water supply: source development (including raw water storage), pumping, transmission, treatment, and storage (for treated water). Some options, such as purchased water, require a separate functional category. Which cost categories are affected by each option depends on the system's existing capacity configuration. Some, for example, may entail additional incremental costs in only select areas without affecting costs in others.

For purposes of comparison, the incremental capital costs (k) associated with each supply alternative are operationalized as the annual payment over the useful service life of the capital expenditure necessary to pay interest and fully recover capital costs, as follows:[9]

$$k = \frac{Ci(1 + i)^n}{(1 + i)^n - 1}$$

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[9] Jack Hirshleifer, James C. Dehaven, and Jerome W. Milliman, *Water Supply: Economics, Technology, and Policy* (Chicago: University of Chicago Press, 1960).

where: k = annualized capital costs,
C = the total capital expenditure required,
n = the useful service life of the capital expenditure (a proxy for the consumer payback period), and
i = the appropriate interest (financing) rate.

For each capacity alternative, the analyst must also estimate operation and maintenance expenses (OM). A pragmatic approach is to use the projected annual OM for the first year that the capacity addition is expected to be operational. Knowing both k and OM for each option allows the calculation of total annualized incremental costs (TAIC) for each capacity option according to the general formula:

$$TAIC = k + OM.$$

Allocating costs to each of the identified functional areas of water supply yields the more detailed formula:

$$TAIC = (k+OM)_d + (k+OM)_p + (k+OM)_r + (k+OM)_t + (k+OM)_s + (k+OM)_o$$

where: k = annualized capital costs,
OM = additional annual operation and maintenance costs,
d = source development,
p = pumping,
r = transmission,
t = treatment,
s = storage, and
o = nontraditional supply.

This calculation of TAIC can be performed for unallocated additions to system capacity, for additions that meet off-peak or peak capacity needs, or for capacity requirements for different customer classes (which also may be divided into off-peak and peak needs). Analysts must develop allocation rules for cost assignment. Although in theory all costs can be allocated to a functional area of water supply, some analysts may choose to use a separate category for joint or common costs, such as general office expenses. The customer categories that apply depend on characteristics of the water service area. Cost allocation can be facilitated by use of a cost allocation matrix or spreadsheet program.[10]

The next step in the analysis is the choice of an appropriate denominator for comparing costs on a per-unit basis in terms of what is known as average incremental cost (AIC). Some of the available alternatives are summarized in table 6-3. As always, analyst judgment plays an important role. One approach is to calculate AIC by dividing simple annual costs (TAIC) by the amount of designed capacity added in millions of gallons per annum (mg):

$$AIC_{mg} = \frac{TAIC}{W_{mg}}$$

where: W = additional increment of water capacity, and
mg = million gallons per annum.

The problem with this formulation of AIC is that it does not take into account the difference between designed capacity and utilized capacity or the magnitude of water losses. As a result, AIC_{mg} may tend to underrepresent unit costs. An alternative denominator can be used to reflect the expected utilization of the capacity increment. A capacity utilization factor is the ratio of the average demand of a system to the installed capacity of the system. Thus, an alternative AIC calculation can be represented by:

$$AIC_{umg} = \frac{TAIC}{u * W_{mg}}$$

where: u = capacity utilization factor for the capacity increment.

There is another approach for dealing with the issue of water losses, water that is provided free-of-charge, or otherwise unaccounted-for water. Caused by a variety of conditions, "nonaccount water" is not billed and therefore generates no revenues for the utility. The greater the system water loss, the more AIC will

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10 For an example of an incremental least-cost matrix, see Beecher and Mann, *Cost Allocation,* table 4-6.

TABLE 6-3

NOTATION USED IN CALCULATING AVERAGE INCREMENTAL COSTS

Notation	Definition
k	Incremental capital costs (annualized).
OM	Incremental operation and maintenance costs (annualized).
$k+OM$	Total annualized incremental cost (TAIC).
$\frac{k+OM}{W_{mg}}$	Average incremental cost (AIC) per system design capacity.
$\frac{k+OM}{u * W_{mg}}$	Average incremental cost (AIC) per utilized capacity, where u = a capacity utilization factor for the capacity increment.
$\frac{k+OM}{W_{rpmg}}$	Average incremental cost (AIC) per revenue producing water.
$\frac{k}{W_{mg}} + \frac{OM}{u * W_{mg}}$	An average incremental cost (AIC) hybrid where unit capital costs are based on added design capacity and unit OM costs are based on output using a capacity utilization factor.

Source: Authors' construct.

underestimate the actual incremental cost of water. Although historical records can be used, care should be taken in estimating revenue producing water because water losses do not necessarily increase linearly with output. Given an estimate of expected annual revenue producing water (rpmg), another calculation of AIC can be made as follows:

$$AIC_{rpmg} = \frac{TAIC}{W_{rpmg}}$$

where: rpmg = revenue producing million gallons per annum.

It follows that the incremental cost of water losses can be estimated by calculating the difference between the incremental cost of the gross additional increment of capacity and the incremental cost of revenue producing capacity. Because mg is always greater than rpmg, this number will always be positive. Water system managers and their regulators will certainly take note of the magnitude of this amount. For some utilities, leak detection and repair itself may be a cost effective (if not least-cost) source of additional capacity. Indeed, the incremental least-cost method incorporates a variable (o) to address this potential source of supply. Other supply options, such as purchased water and conservation programs, also can be considered in the nontraditional category, as long as their cost impacts on other functional areas (such as transmission and distribution) also are identified.

Assuming that AIC is calculated for more than one potential source of additional capacity, incremental least cost (ILC) is simply the lowest value that results from the comparative analysis. The option identified should be reanalyzed in terms of feasibility and desirability. If the least-cost alternative is not preferable, it is incumbent on the analyst to explain why. Finally, the least-cost estimate should be compared with cost estimates using other methodologies, including traditional methods used to determine revenue requirements. The divergence between estimates should be evaluated with care, particularly if the analysis is to be used for pricing decisions.

Assumptions

It is important to clarify the several assumptions underlying the application of the incremental least-cost method described here.[11] First, it is assumed that operating and cost data on potential supply capacity increments (including changes in existing levels of output) are either readily available or can be easily estimated. Second, operating and cost data on nontraditional supply alternatives, such as wholesale purchases, source-of-supply leasing, leak detection and repair, conservation technology, and so on, can also be estimated. Third, service lives and financing rates associated with alternative capacity increments can be identified reliably. Fourth, reasonable estimates can be made of the amount of water capacity added to the water system as well as revenue producing water and unaccounted-for water. Fifth, the cost of incremental additions to the distribution system can be directly recovered and therefore is not properly included in a marginal-cost analysis. Sixth, it is assumed that the water utility experiences a positive growth rate in water output and usage along with increased costs of service during the planning period. This assumption precludes the generation of negative marginal-cost values that can occur under this and other cost calculation techniques.

Perhaps most importantly, similar to the average marginal-cost method, it is assumed that the use of the incremental least-cost method as described places more importance on the evaluation criteria of cost and rate stability, revenue adequacy, and administrative feasibility than on the criterion of economic efficiency. The method is principally a least-cost planning and general ratemaking tool, and one that should be used in conjunction with others available evaluation methods.

Discussion

Incremental least cost has analytical value as a reasonable proxy for marginal costs (or avoided costs) in an integrated planning framework, even though it departs significantly from the textbook definition with regard to economic efficiency. An important part of the incremental least-cost method is that incremental capital and operation costs are estimated for each potential capacity increment on an annualized

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[11] The use of certain assumptions is required in the application of other marginal-cost pricing methods as well. Application limitations can arise when the specified conditions cannot be assumed.

basis. Average incremental costs can be calculated by determining annualized costs and dividing by the amount of capacity added. Capital and operating costs can be estimated separately for each of the principal cost categories (that is, source development, storage, transmission, treatment, and so on) and, at the analyst's discretion, separately for capacity needed to meet off-peak and peak demand. The analysis can be taken a step further by estimating these costs for different customer classes. Still, the method does not require more data than most other cost allocation analyses.

The method, as described, allows analysts to consider alternative measures of average incremental cost based on the denominator of choice. For example, the method recognizes both the incremental cost of added capacity and the incremental cost of revenue-producing water.[12] The difference between the two is a reasonable estimate of the incremental cost of water loss on a per-unit basis. Water suppliers and regulators obviously have an interest in the amount of a system's unaccounted-for or nonaccount water and the incremental cost of these water losses. A reasonable estimate of this cost may induce some water supply managers to implement leak detection and repair programs essentially as a source of additional capacity. Finally, the method allows for the calculation of more than one average incremental-cost estimate, based on the existence of more than one capacity alternative. These can be used to identify the least-cost alternative for planning purposes. More complicated analyses can incorporate sensitivity tests using different technological and system growth assumptions.

The benefits of the incremental least-cost method, then, are that it establishes a principle for choosing the next capacity increment and eliminates many of the concerns related to time frame, simplifies the calculation of annualized costs, provides for the assessment of the incremental costs of revenue-producing water, and sets forth an array of alternatives from which to choose. One of the chief benefits is that the calculation of incremental least cost encourages the analysis of nontraditional capacity increments, such as purchased water, leasing, water loss reduction, and conservation, within a planning framework.

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[12] The importance of revenue producing water as the denominator in calculating per-unit costs was emphasized in Patrick C. Mann and Janice A. Beecher, *Cost Impact of Safe Drinking Water Act Compliance for Commission-Regulated Water Utilities* (Columbus, OH: The National Regulatory Research Institute, 1989).

Program Evaluation

The different conceptions of least cost lead to different evaluation standards, especially for demand-side management or conservation programs implemented under the auspices of integrated resource planning. An integrated planning process should establish both general performance criteria for demand-side programs as well as spell out specific means of measuring cost effectiveness. One can also add the consideration of regulatory costs. The experience in least-cost energy planning has shown that these issues can be highly contentious.

Performance Criteria

Demand-side management is a multidimensional tool and should be evaluated accordingly. Kentucky-American Water Company provided the following criteria for evaluating conservation programs under its least-cost mandate:[13]

- **Cost-effectiveness.** Each individual program must demonstrate favorable economics for the consumer and the utility on a present-value basis.
- **Equity.** Providing a carefully designed package of programs will allow all utility customers to participate in and benefit from at least some elements of the program package.
- **Ease of implementation.** Programs should be acceptable to the consumer and not require major changes in existing institutional and administrative structures.
- **Achievable savings.** The proposed water management programs should build on the successes of tried and proven conservation efforts elsewhere.
- **Targeted savings.** The proposed programs target specific water use sectors and end-users where significant benefits can be expected at the least cost to the consumer and the utility.

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[13] American Water Works Service Company, Inc., *Kentucky-American Water Company Least-Cost/Comprehensive Planning Study: Technical Appendix* (Haddon Heights, NJ: System Engineering, American Water Works Service Company, Inc., 1986), appendix C-2.

- **Measurability.** All programs adopted must be able to be monitored an evaluated to determine their overall effectiveness.

Recent studies have begun to identify some specific performance measures for utility conservation programs. Most of the measures devised for the electricity sector can easily be adapted to the case of water. Of particular use are measures that are readily quantifiable and that can be weighted according to the importance they are given by policymakers. Six such indicators are:[14]

- Participation rate (annual and cumulative) of eligible customers.
- Percentage savings in demand.
- Proportion of free riders.
- Ratio of indirect to direct program costs.
- Program cost per gallon of water saved.
- Ratio of measured savings to estimated savings.

This is not to say that these are the only appropriate indicators. As experience with demand-side management grows, so will the number of available tools for evaluating performance. As long as this area continues to evolve, the use of a combination of indicators is probably preferable to reliance on a single measure. In some instances, for example, the presence of free riders might be excused in the interest of the overall cost effectiveness of the program. The planning horizon is crucial to the analysis of costs.

Cost Effectiveness

By far, the most talked about evaluation criterion for demand management programs is cost effectiveness.[15] An important lesson learned from the application of least-cost planning to electric and gas utilities has been in understanding competing definitions of cost effectiveness. Such evaluations depend greatly on the

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[14] Adapted from Steven Nadel, "Use of Simple Performance Indices to Help Guide Review of DSM Program Performance," a paper presented at the NARUC Third National Conference on Integrated Resource Planning, April 8-10, Santa Fe, New Mexico.

[15] See Rau, et al., *Methods to Quantify Energy Savings.*

vantage point taken and the assignment of values to various options. Some of the principal cost effectiveness tests are the utility cost test, the total resource cost test, the ratepayer impact measure test, and the participant cost test.[16] The calculations involved appear in table 6-4.

The first three are methods applicable to a least-cost utility planning framework and can be compared readily with supply-side calculations.[17] Each begins with the gross benefits of demand-side management, measured in terms of the utility's avoided cost, and subtracts the costs associated with the program (such as overhead administrative costs). The utility cost test emphasizes the use of utility revenue requirements to test effectiveness. Using this test, demand-side options should be implemented only when the end result is to increase utility revenue requirements less than the increase in revenue requirements associated with various supply-side options. The total resource cost test emphasizes the total customer bill for utility services. The effect of conservation programs on utility rates is measured by the ratepayer impact test.

A fourth test, the participant cost test, is not a least-cost planning tool, nor is its result readily comparable to supply-side options. Its purpose is to evaluate whether customers are sufficiently motivated to participate in demand-side management programs by virtue of the net benefits of participation. A variation is the nonparticipant, or "no losers test," which emphasizes the distributional effects of demand-side management among participants as well as nonparticipants.

These perspectives on cost-effectiveness are not entirely independent, as the additivity of the formulas suggests.[18] A demand-side measure passing the ratepayer impact test can be presumed to pass the utility cost test. Further, the total resource cost test is essentially the sum of the ratepayer impact test and the participant test. The total resource cost and participant cost formulas can be modified to include indirect costs, such as the investment of time by participants. The ratepayer impact measure and participant cost formulas can be modified as well

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[16] Janice S. Berman and Douglas M. Logan, "A Comprehensive Cost-Effectiveness Methodology for Integrated Least-Cost Planning," a paper presented at a conference of the Electric Power Research Institute held in Milwaukee, Wisconsin, May 2-4, 1990.

[17] Ibid.

[18] Ibid., 5.9.

TABLE 6-4

COST-EFFECTIVENESS TESTS USED IN EVALUATING DEMAND-SIDE MANAGEMENT MEASURES

Utility Cost Test

Definition: The most basic of the four tests, it assumes that the utility's objective is to minimize revenue requirements. If a DSM program passes this test, then the utility's total revenue requirements will be lower with the program than without it.

Measurement: UC = AC - OC - I - UH

where:
UC = utility cost
AC = avoided cost (may include externalities)
OC = overhead program administrative cost
I = incentive or rebate from the utility to customers
UH = utility purchases of hardware or equipment

Total Resource Cost Test

Definition: This test recognizes that utilities sell services and evaluate the impact of DSM programs on the total customer bill for energy services, including both participants and nonparticipants. It is sometimes defined in terms of "most value."

Measurement: TRC = AC - OC - TH

where:
TRC = total resource cost
TH = total hardware cost, regardless of who pays

Ratepayer Impact Measure Test

Definition: A test designed to measure the impact of a DSM program on utility rates. It is sometimes known as the nonparticipants' test because of the effect of the potential for nonparticipants to subsidize participants through higher rates.

Measurement: RIM = AC - OC - I - UH - LR

where: LR = lost revenue to the utility from the reduction in sales to customers installing conservation measures

Participant Cost Test

Definition: This test views cost effectiveness from the participant perspective. It does not evaluate least-cost planning (a utility concern) but rather whether customers are sufficiently motivated to participate in DSM programs.

Measurement: P = I + LR - PH

where: PH = participant's purchased hardware and other costs

Modified Total Resource Cost and Participant Cost Reflecting Indirect Costs

Definition: Total resource cost (or participant cost) including an indirect cost term to reflect participant costs such as of information and time and changes in the form or function of service provided. Because it only applies to participants, and has not rate consequences, this term should not be used in calculating RIM.

Measurement: TRC = AC - OC - TH - IC

P = I + LR - PH - IC

where: IC = net of indirect participant costs and benefits created by utility sponsorship of the DSM program

Modified Ratepayer Impact Measure and Participant Cost Reflecting Shared Savings

Definition: Ratepayer impact measure (or participant cost) reflecting shared savings by dividing the incentive term into utility incentives and customer payments.

Measurement: RIM = AC - OC - UI - UH - LR + CP

P = UI + LR - PH - IC - CP

where: UI = the amount of upfront payment the utility makes to the participant

CP = the return payment by the participant to the utility over time

Supply-Side Cost

Definition: Utility-owned or purchased supply-side resources.

Measurement: SS = AC - OC - TH

where: SS = supply-side cost

Source: Adapted from Janice S. Berman and Douglas M. Logan, "A Comprehensive Cost-Effectiveness Methodology for Integrated Least-Cost Planning," a paper presented at a conference of the Electric Power Research Institute held in Milwaukee, Wisconsin, May 2-4, 1990.

to reflect shared savings (utility and participant). Finally, the cost-effectiveness for demand-side management measures can be compared with supply-side measures, as also shown in table 6-4.

Janice Berman and Douglas Logan suggest a comprehensive two-step approach to demand-side management evaluation.[19] The first step is to use total resource cost, reflecting both indirect participant costs and shared savings, for the purpose of integrated resource or least-cost planning. The second step is program design. Planners can use the ratepayer impact and participant cost tests to design successful programs in which customer will actually participate and benefits and costs will be fairly distributed. This approach has the advantage of consistency of criteria and clarity of method, both of which aid in decisionmaking and implementation.

Regulatory Cost

The cost of regulation is a particularly sensitive issue in the water sector supply because of the sometimes overwhelming nature of the Safe Drinking Water Act, especially the 1986 amendments. The term "regulatory cost" is associated with both administrative costs of regulatory agencies and the compliance costs incurred by regulated entities. Though not of the same scale as drinking water quality regulations (in terms of compliance and monitoring), integrated resource planning also imposes regulatory costs.

The administrative cost of integrated resource planning is not insignificant.[20] The planning process requires the dedication of utility resources to potentially extensive analytical and reporting requirements. In particular, utilities may be unaccustomed to developing and analyzing both supply-side and demand-side options for evaluation in an integrated framework. Planning requires regulatory resources for initiating the process, evaluating options, and monitoring program implementation. Commission resources may be inadequate for full-scale implementation of integrated water resource planning, especially demand-side management programs. The allocation of resources to planning may jeopardize or

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[19] Ibid., 5.14.

[20] Mary S. Hayes and Richard M. Scheer, "Least-Cost Planning: A National Perspective," *Public Utilities Fortnightly* 119 (19 March 1987): 13-18.

complicate other regulatory activities, such as ratemaking proceedings and programs addressing the viability of small water systems.

On any significant scale, planning thus requires either an increase in commission resources or a reallocation of resources away from other programs. Still, it is not out of the question that some water utilities may take the initiative to incorporate certain integrated resource planning principles in their existing planning processes without prodding by regulators. Certainly this would be the prudent course of action for utilities that want to avail themselves of the benefits associated with least-cost supply and demand options.

Social Acceptability[21]

Cost impacts aside, social acceptability also plays a prominent role in determining the effectiveness of integrated planning processes that incorporate utility conservation programs:

> A particular water conservation measure may be technically possible, effective, and economically efficient, and yet when proposed, be rejected. In an effort to understand why, an investigator might discover that the measure had been perceived by the public or by the city council or other community power as violating the rights of private property, or as unfairly placing the heaviest economic burden on those least able to pay, or as interfering with the prerogatives of local government, etc., etc. In realistically assessing the chances a given measure of conservation has of being implemented, it is but a short distance from the familiar concepts and methods of technical and economic considerations to the alien territories of values, beliefs, attitudes, and feelings--of what may be termed 'social ideologies.'[22]

Evaluating social acceptability may be difficult, but it is not impossible. One study recommends combining interviews with expert advisors and a survey questionnaire for the general public.[23] While this approach does not guarantee an accurate prediction of social acceptability, it should help enlighten the

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21 Adapted in part from Beecher and Laubach, *Compendium,* chapter 7.

22 Duane D. Baumann, et al., *Planning and Evaluating Water Conservation Measures* (Chicago, American Public Works Association, 1981), appendix A, 59.

23 Ibid.

decisionmaking process. With no assessment of acceptability, the risk of overestimating the potential effectiveness of conservation measures is greater.

When asked, many consumers express support for water conservation measures. A majority of consumers in northeastern Colorado supported installing toilet dams, limiting lawn sizes, imposing watering restrictions, and reusing water for irrigation. An overall majority supported metering, but the majority of flat-rate customers still preferred flat rates; a slight majority even supported higher prices to encourage conservation (those having higher incomes and more education were more likely to favor this strategy).

The only conservation method opposed by a majority of customers, not surprisingly, was reusing water for drinking purposes. Support for this measure likely will depend on substantially increasing the public's faith in the feasibility of treatment technologies that make reuse possible. The study's authors concluded that the survey is reasonably representative of Western states' water users, that water supply managers can expect public support for water conservation programs, and that water utilities can cultivate support for their programs by using an intensive public education program.[24]

A survey of customers in southern Texas produced similar results.[25] Eighty percent answered that they had reduced their overall water consumption. The results for specific consumption areas indicated that outdoor use frequently was the target of conservation efforts. Respondents also were found to be highly supportive of state-mandated conservation plans and city-mandated conservation measures for residential and industrial use. Like their Colorado counterparts, Texans were relatively supportive of rate increases for conservation purposes, but also were highly supportive of lifeline water rates.

Finally, a survey prepared for the Kentucky-American Water Company revealed that the public was both aware of the potential for future water shortages and

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24 J. Ernest Flack and Joanne Greenberg, "Public Attitudes Toward Water Conservation," *American Water Works Association Journal* 79 no. 3 (March 1987): 46-51.

25 Darryll Olsen and Allan L. Highstreet, "Socioeconomic Factors Affecting Water Conservation in Southern Texas," *American Water Works Association Journal* 79 no. 3 (March 1987): 59-68.

supportive of water conservation, at least to a degree.[26] A summary of the sometimes cynical attitudes of respondents favoring conservation regardless of cost implications appears in table 6-5. According to James Hougland, who conducted the survey, the appreciable level of support for conservation will make it easier to mobilize consumers in support of conservation as compared with new supply development. He suggests that, "Because of the political context in which public utilities operate, this potential for mobilization should not be ignored as new decisions about the provision of water are made."[27]

One area of uncertainty is whether customers willingly will make major and permanent lifestyle changes in the interest of water conservation. Studies indicate that how the public responds to conservation programs and activities depends a great deal on their perceptions. During drought periods, people have an empirical basis--persistent dry weather--for believing in the prospect of water scarcity and the need for conservation. This perception disappears during normal-weather periods. Thus implementing long-term conservation strategies may hinge on perceptions about whether a water crisis is imminent and conservation essential.

Special care should be taken in using survey results commissioned by a party with a vested interest in the outcome because of the potential for bias. A slight variation in the wording of a survey question can greatly affect results. Ideally, regulatory commissions, other government agencies, and universities would conduct independent survey analyses. Realistically, the resources available for doing so are limited. A large investment in survey research also assigns a special importance to public opinion in policymaking, which may or may not be desirable in fine tuning water resource planning decisions.

Although there are limits to the use of opinion surveys in policymaking, for reasons of validity, reliability, and desirability, public opinion does play a role in integrated planning that should not be ignored. Certainly, it is desirable to be responsive to public sentiments as well as cultivate public support for programs and policies. Public opinion leaders must walk a fine line between public information and scare tactics when it comes to water issues. Public information campaigns

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[26] James C. Hougland, Jr., "Public Reactions to Drought and Future Water Supply Needs: Results from Public Opinion Polls," presented at the annual Mid-America Regulatory Conference in Chicago, IL (July 26, 1989).

[27] Ibid., 12.

TABLE 6-5

SUMMARY OF FINDINGS IN THE KENTUCKY-AMERICAN ATTITUDINAL SURVEY

Summary of Characteristics of Respondents Favoring Conservation Regardless of Cost Implications

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Demographic/Personal Characteristics

- Lower average quarterly water bill

Perceptions and Attitudes

- More likely to believe that the quality of drinking water is getting worse.
- Less likely to agree that a water shortage can be avoided under normal weather conditions.
- More likely to agree that the water company did not tell the truth about the water shortage [during the] past summer.
- Less likely to agree that a water shortage can be avoided during a drought.
- More likely to agree that enforcement of mandatory restrictions during the drought was too lax.
- More likely to agree that businesses were not asked to restrict their water use as much as individual households during the water shortage.
- Less likely to agree that the water shortage was an unusual event and will probably not happen again in the next ten years.
- Less likely to agree that the water company was clear in its statements about the water short [during the] past summer.
- Less likely to favor charging more for water during peak periods in the summer.
- Less likely to consider newspapers an important source of information about water supplies and restrictions.
- Less likely to have seen Aqua-Duck on television.
- Less likely to have seen Aqua-Duck in brochures.

Source: James C. Hougland, Jr., "Public Reactions to Drought and Future Water Supply Needs: Results from Public Opinion Polls," presented at the annual Mid-America Regulatory Conference in Chicago, Illinois (July 26, 1989), table 6.

should provide consumers with the information they need to make wise-use decisions without "creating" a water crisis in the process.

Externalities and Environmental Impacts

Some analysts have argued that for least-cost planning to be effective, a narrow definition of cost should be employed.[28] The cost definition should not be broadened to incorporate more ambiguous factors such as economic development, costs incurred by ratepayer participation, and social costs.

Undoubtedly, a narrow definition may make least-cost planning easier to implement and evaluate because of ease in quantification. However, it also may preclude consideration of qualitative issues as well as externalities. In the case of water supply, substantial health, environmental, and natural resource considerations exist. In an integrated planning framework, social costs and benefits and other externalities can be explicitly addressed, if not quantified. The inability to quantify certain outcomes clearly should not preclude including them in a comprehensive analysis. As table 6-6 suggests, the planning sciences have long considered intangibles in the planning process. Moreover, the practice of regulation has long recognized the importance of the principle of the public interest, as determined by duly appointed public officials. The public interest is by nature a very broadly defined decisionmaking principle not easily reconciled with narrow definitions of public policy.

With the passage of the National Environmental Policy Act of 1969 (NEPA), the Environmental Protection Agency was established and along with it the mixture of art and science known as environmental impact assessment. An analysis of environmental impacts is required for many projects where federal funding is involved, including water projects related to water resource development. Different federal agencies approach the assessment process somewhat differently, affecting the resulting document. Many states conduct environmental assessments of major projects as well. Environmental impact statements (EISs) may not be the perfect

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28 Daniel J. Duann, "Alternative Searching and Maximum Benefit in Electric Least-Cost Planning," *Public Utilities Fortnightly* 124 (21 December 1989): 19-22.

TABLE 6-6

CONCEPTS USED IN THE EVALUATION OF INTANGIBLES

Concept	Description
Opportunity cost	The net present value of the most economical alternative use which is precluded when resources are allocated to a specific project.
Equity	The distribution or incidence of real income on selected social groups, e.g., the poor and the rich, and classifications, e.g., spatial, temporal, and racial.
Welfare economics	The area of economics that relates individual and collective social utility to monetary values (though noneconomic factors are assumed to be constant, social, political, and institutional aspects enter into the analysis).
Benefit-cost analysis	The net discounted value of net benefits from providing goods and services from a developmental alternative obtained from subtracting from the value of the goods and services, provided the value of those goods and services that could have been produce had the developmental alternative not been constructed; the criterion is to maximize the net discounted value of benefits, given that compensation is made to those who are made worse off by the developmental alternative, to ensure that no one is made worse off, at least someone is better off.
National economic development account	The monetary value of the change in goods and services provided, inclusive of the willingness-to-pay aggregated values and the costs incurred by reducing the utilization of existing projects.
Regional development account	Changes that occur at the regional level, e.g., employment, economic base, population distribution, and environmental quality; direct and indirect changes occurring from a developmental alternative on the region.
Environmental quality	Physical, biological, and ecological changes imputable to a project, characterized by indicators, e.g., historical, geological, recreational, and environmental
Social well-being account	Changes in the distribution of real income, the opportunity to partake in recreational activities, and other social changes affecting individuals.

TABLE 6-6 (continued)

Willingness to pay	The market expenditure made by the individual consumer, plus any additional amount which consumers can be induced to pay, to assure that they are not excluded from enjoying the output of the developmental alternative; the net willingness to pay is the monetary value of the
Demand curve	The quantities of a good or service the individual consumer is willing and able to buy at given prices are related through the demand curve; the determinants of demand are quantity demanded, price of the good or service, the price of available substitutes and complementary goods and services; the individuals income, taste, and preference characteristics of the demand curve.
Consumer surplus	The amount of money that an individual actually pays for a given quantity of a good or service resulting from subtracting the amount actually paid from the maximum amount he would be willing to pay; the definite integral of the area under the demand curve, up to the quantity demanded, measures the consumer's surplus and the actual expenditures made to enjoy the output from the project; the utility that the consumer derives, a nonproprietary right, diminishes as more of the quantity is provided to the consumer, diminishing marginal returns.
Willingness to sell	The measures of benefits lost by foreclosing options, e.g., flooding a habitat with consequent loss of a species, as the minimum compensation that the sellers would accept to relinquish their rights; such compensation is of such amount that would make the sellers neither better or worse off than they would have been without the project.
Social rate of interest	The rate of discount used to determine the present worth of future value expressing the preference of a society as a whole. Generally considered to be less than the opportunity cost of capital.

Source: American Society of Civil Engineers, *Urban Planning Guide* (New York: American Society of Civil Engineers, 1986), 39-40.

instruments of rational decisionmaking, but they are important tools of planning.[29] The general outline for an environmental impact statement is reported in table 6-7.

Many states have begun to take environmental externalities into account in utility planning processes.[30] A recent survey identified seventeen state commissions that have operational rules or regulations addressing externalities.[31] Several other states are developing approaches to this issue. The existing approaches include qualitative assessment, incorporation of externalities in the bidding system for new capacity or in the least-cost planning process, and adjustments to the utility's rate of return.

Least-cost planning analysts have begun to develop methods for incorporating environmental externalities in the planning process. Jennifer Fagan and Rodney Stevenson identify three tools that help accomplish this purpose: (1) listing (the environmental impact statement approach), (2) monetization (whereby the planner "costs out" externalities), and (3) qualitative scoring (which provides an overall index of resource options).[32] Furthermore, externalities can be incorporated into the decisionmaking process using such methods as fatal-flaw screening, benefit-cost evaluation, and multiattribute decision analysis.[33]

The debate over incorporating externalities in planning decisions is far from over in the electricity sector and has hardly begun in the water sector. As water

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[29] Paul J. Culhane, H. Paul Friesema, and Janice A. Beecher, *Forecasts and Environmental Decisionmaking: The Content and Predictive Accuracy of Environmental Impact Statements* (Boulder, CO: Westview Press, 1987).

[30] S. D. Cohen, J. H. Eto, C. A. Goldman, J. Beldock, and G. Crandall, *Survey of State PUC Activities to Incorporate Environmental Externalities into Electric Utility Planning and Regulation* (Washington, DC: National Association of Regulatory Utility Commissioners, 1990).

[31] Arizona, California, Colorado, Connecticut, Idaho, Kansas, Massachusetts, Minnesota, Nevada, New Jersey, New York, Ohio, Oregon, Pennsylvania, Texas, Vermont, and Wisconsin.

[32] Jennifer Fagan and Rodney Stevenson, "Incorporation of Environmental Externalities into Integrated Resource Planning," a paper presented at the NARUC Third National Conference on Integrated Resource Planning, April 8-10, 1991, Santa Fe, New Mexico.

[33] Ibid. See also, Mark Hanson, Stephen Kidwell, Dennis Ray, and Rodney Stevenson, "Electric Utility Least-Cost Planning," *Journal of the American Planning Association* 57 no. 1, Winter 1991 (Chicago, IL: American Planning Association, Winter 1991).

TABLE 6-7

OUTLINE OF AN ENVIRONMENTAL IMPACT STATEMENT

I. Describe present conditions.

II. Describe alternative actions.

- Continue current action
- Engineering alternatives
- Design alternatives
- Location alternatives
- Institutional alternatives

III. Describe expected future conditions, and determine the changes from present conditions to yield impacts.

- Adverse, beneficial
- Short-term versus long-term
- Irreversible or irretrievable

IV. Identify alternatives chosen (proposed action), and indicate means of evaluation.

V. Describe probable impacts of chosen action in detail, including unavoidable impacts that remain.

VI. Describe techniques to be employed to minimize harm.

VII. Disseminate a draft report for comment and review by other government agencies and interested parties, including members of the public.

VIII. Prepare a final report that includes a detailed response to comments received on the draft report.

Source: Adapted from Lewis Hopkins, et al., *Environmental Impact Statements: A Handbook for Writers and Reviewers* (Chicago: Institute for Environmental Quality, 1973). The last two stages were added here for completeness.

is a natural resource, however, it will be virtually impossible to ignore the environmental consequences of future water resource planning decisions at all levels, including public water utilities and the commissions that regulate them. Indeed, it is arguable that the purpose of integrated resource planning in the first place is to provide a forum for considering these very issues.

APPENDIX A

FEDERAL WATER PLANNING AND DEVELOPMENT

This appendix, containing descriptions of federal agencies affecting water resources, was adapted from "Federal Water Planning and Development," which is Section 16 of the **Utah State Water Plan** (Salt Lake City: Division of Water Resources, Department of Natural Resources, January 1990). Descriptions of the federal agencies and their programs were prepared by federal agency representatives. While most of the information is relevant nationally, there are some items specific to the state of Utah that do not necessarily apply to other states or regions.

Agricultural Stabilization and Conservation Service

Background

The Agricultural Stabilization and Conservation Service (ASCS) administers farm commodity, conservation, environmental protection, and emergency programs.

State and county ASC committees are made up of members actively engaged in farming. They administer the programs and activities of ASCS. These committees were established under the Soil Conservation and Domestic Allotment Act of 1935, as amended. The Agricultural Adjustment Act of 1938 mandated use of elected farmer committees as they were considered most capable of making decisions regarding the administration of farm programs. State committees are appointed by the secretary of Agriculture.

These programs provide: (1) Commodity loans and price support payments to farmers; (2) commodity purchases from farmers and processors; (3) acreage reduction; (4) cropland set-aside and other means of production adjustment; and (5) conservation cost sharing and emergency assistance.

ASCS maintains a headquarters office in Washington, D.C., headed by an administrator; offices in each state headed by a state executive director; and offices in most counties headed by a county executive director. There is an aerial photography field office in Salt Lack City, Utah.

Programs

Agricultural Conservation Program (ACP) -- The ACP is designed to help reduce soil erosion and water pollution, protect and improve productive farm and ranch land, conserve water use in agriculture, preserve and develop wildlife habitat, and encourage energy conservation measures.

Only those practices that significantly contribute to these objectives and are not required as a condition of receiving assistance through other federal programs are eligible for cost-share assistance. Production-oriented practices or those resulting in significant economic benefits are not eligible.

The ACP is administered by state and county committees working under the general direction of the Agricultural Stabilization and Conservation Service. The Soil Conservation Service, Forest Service, and Utah Division of State Lands and Forestry are responsible for providing technical program guidance. The County Cooperative Extension Service provides educational support.

To assure effective solutions to local conservation problems, the County Agricultural Stabilization and Conservation (ASC) Committee periodically meets with the County Program Development Group to identify the problems and develop conservation practices to solve them. The county committee encourages adoption of the most needed practices and assigns priorities. Cost sharing is available through annual agreements or long-term agreements.

Emergency Conservation Program (ECP) -- The ECP provides emergency cost-share funds to rehabilitate farmland damaged by wind erosion, floods, hurricanes, or other natural disasters and for carrying out emergency water conservation measures during periods of severe drought. The natural disaster must create new conservation problems, which, if not treated, would: (1) Impair or endanger the land; (2) materially affect the productive capacity of the land; (3) represent unusual damage which, except for wind erosion, is not the type likely to recur frequently in the same area; and (4) be so costly to repair that federal assistance is or will be required to return the land to productive agricultural use.

The ASC County Committee, in consultation with the ASC State Committee, is authorized to implement the ECP for all disasters except drought. Drought determination will be made by the Washington office.

Colorado River Salinity Control (CRSC) -- The CRSC program applies to an eligible project area identified in a published U.S. Department of Agriculture salinity control report. The program is considered approved when a project implementation plan has been funded based on the USDA Salinity Control coordinating Committee's recommendation. Eligible lands can be privately owned or controlled, Indian tribal land, irrigation district or company land, and state and local government land.

Practices reduce onfarm and off-farm salt contributions by reducing deep percolation of water and controlling erosion. Mitigation measures protect, restore, or develop permanent cover or food to replenish wildlife and develop or restore shallow water areas to replace the associated wildlife resources.

Conservation Reserve Program (CRP) -- The CRP was created in the Food Security Act. This program provides for removing highly erodible lands from production so they can be protected. It also promotes maintaining wetlands for wildlife habitat and water quality.

Bureau of Indian Affairs

Background

The overall organization of the Bureau of Indian Affairs consists of a headquarters in Washington, D.C., area offices, and subordinate field installations throughout the country. The commissioner of Indian Affairs is chief executive of the bureau. Each area office is supervised by an area director who also supervises field installations within that area. Utah is in the Phoenix area. There are field offices in Fort Duchesne, Cedar City, and Blanding.

Functions regarding protection of rights are performed in the Office of the Director of Trust Responsibilities. These encompass, among other things, all matters involving water rights, land titles, hunting and fishing rights, the right to regulate hunting and fishing, zoning and other land use.

Programs

The Bureau of Indian Affairs, under the trusteeship exercised by the secretary of the Interior, works cooperatively with the Indian people and their tribal leaders toward assuring the most effective and productive use and development of their resources. Accordingly, the bureau is vitally interested in development of water resources and the adjacent and tributary territories to the full extent that such development affects the current and prospective economic and social opportunities of the Indian people.

The Office of Tribal Resources Development provides staff support to the commissioner of Indian Affairs in the development and management of bureau programs. It provides technical and financial assistance to enhance the economic development of Indian reservations and people.

The Office of Trust Responsibilities provides staff support to the commissioner to develop and manage programs relative to the bureau's trust and legal responsibilities.

Bureau of Land Management

Background

The Bureau of Land Management (BLM) came into being as a result of the Taylor Grazing Act of 1934 when the Grazing Service was created to manage public lands. In 1946, the Grazing Service was combined with the General Land Office to create the present BLM.

The Federal Land Policy and Management Act of October 21, 1976, as amended, established the legislative base for the BLM. Section 102 of the act requires "the public lands be managed in a manner that will protect the quality of scientific, scenic, historical, ecological, environmental, air and atmospheric, water resource, and archaeological values."

Section 201 of the act requires "an inventory of all public lands and their resources and other values be prepared and maintained on a continuing basis. The extent and intensiveness of the inventory has not been established. For water resources, it is envisioned to be as extensive as required commensurate with the importance of water quality and quantity on wildland watersheds.

Section 202 of the act requires development of land use plans that are in compliance with applicable federal and state laws.

The BLM in Utah is a three-tier organization with a state office which oversees all responsibilities. There are five district offices which provide policy guidance, overview, and operational programs. Sixteen resource offices make up the primary field organization and carry out the bureau programs.

Programs

The Federal Land Policy and Management Act gives the Bureau of Land Management (BLM) authority for inventory and comprehensive planning for all public lands and resources under its jurisdiction. This includes water quality considerations, with the mandate to comply with applicable laws.

Water resources, both quantity and quality, are key factors in managing all terrestrial and aquatic resources on public lands. Water resources are rapidly becoming a major determinant of resource management alternatives, particularly those associated with energy development. BLM in Utah manages riparian habitats of streams, lakes, reservoirs, and ponds to provide high-quality water resources for beneficial downstream uses for human consumption, fish and wildlife, livestock, wild horses, recreation, and aesthetics.

Collection of water resources and water quality data is a must for all resource programs. Water quality is related to soil and watersheds, energy and minerals, wildlife habitat, livestock grazing, and recreation programs. The BLM is also responsible for planning the use of these resources on the public lands. Coordination with the state and other agencies is a mandatory element of these plans.

Bureau of Reclamation

Background

The Reclamation Act of June 17, 1902, authorized the secretary of the Interior to locate, construct, operate, and maintain works for the storage, diversion, and development of waters for the reclamation of arid and semi-arid lands in the Western states. To perform these functions, the secretary approved an organization plan for a Reclamation Service in the Geological Survey in July 1902. In March 1907, the Reclamation Service was removed from the Geological Survey and a director was appointed. In June 1923, the secretary created the position of commissioner of Reclamation and changed the name Reclamation Service to Bureau of Reclamation. Public Law 99-662, November 17, 1986, Water Resources Development Act of 1986, provides "The Secretary shall not initiate any feasibility study for a water resources project... until appropriate nonfederal interests agree... to contribute 50 percent of the cost for such study during the period of such study."

Over the years, the purposes have been amplified and extended through special legislation and numerous changes in and additions to what has become known as reclamation law. The Bureau of Reclamation is now becoming more of a technical service agency.

Reclamation's involvement in Utah began in 1903 with the planning and construction of Strawberry Dam and Reservoir and other features of the Strawberry Valley project. To date, Reclamation has developed 15 separate water supply projects and a water quality improvement program. Twenty-six storage reservoirs have been constructed along with numerous tunnels; diversion dams; miles of canals, laterals, and pipelines; and hydroelectric plants.

The Bureau of Reclamation is directed by the commissioner of Reclamation. The majority of Utah is served by the Upper Colorado Region. The balance is in the Lower Colorado and Northwest regions. Each region is administered by a regional director with appropriate staff and operating offices. Additional technical assistance is available in the Engineering and Research Center in Denver, Colorado.

Programs

Bureau of Reclamation programs for water resources can be placed into four broad categories: investigations, research, loans, and service. All require close cooperation with the concerned entities.

Investigations Programs -- General investigations, including an environmental assessment, are conducted for both specific and multipurpose water resource projects. These investigations determine the feasibility of constructing new or replacing old features to provide water storage and conveyance. Purposes include irrigation water service, municipal and industrial water supply, hydroelectric power generation, water quality improvement, navigation, and river regulation and control. Frequently, water resource development projects provide opportunities for enhancing fish and wildlife benefits and recreation and occasionally are significant enough to warrant a project specifically designed for such purposes.

Feasible projects are submitted to Congress for construction authorization. Once funding has been secured, Reclamation prepares designs and specifications and contracts construction. Some project features may be operated and maintained by Reclamation, but usually this is turned over to a responsible entity. All dams are regularly inspected to assure safety.

Water quality improvement programs (Public Law 93-320) are special investigations to control salinity levels in the Colorado River. The criteria for determining feasibility are set by the Colorado River Basin Salinity Control Forum, a committee composed of state representatives.

Research Programs -- Reclamation conducts research on water-related design; construction; materials; atmospheric management; and wind, geothermal, and solar power. Most programs are conducted in cooperation with other entities in areas where opportunities exist for demonstrating future feasibility.

Loan Programs -- These loan programs provide federal loans and assistance to qualified organizations wishing to construct or improve smaller and generally less complex water resource developments. The purposes can be any of those listed for general investigations. The applicant is responsible for planning, constructing, operating, and maintaining the project. If it is impossible to obtain the necessary specialized services from private industry, Reclamation or another federal agency can provide the services.

There are three types of loans made by Reclamation: distribution system, small reclamation, and rehabilitation and betterment loans. Funding programs are shown in Section 8, Table 8-1 [of the *Utah State Water Plan*].

Service Programs -- Intergovernmental service programs are specialized technical service programs designed to provide data, technical knowledge, and expertise to states and local government agencies to help avoid duplication of special service functions. Local governments pay for requested services.

Services to the Non-Federal Entities program is primarily work performed with funds advanced to Reclamation in accordance with the act of March 4, 1921 (41 State. 1404) for "investigations, surveys, construction work, or any other development work similar to those provided for by Reclamation law." Use of Reclamation laboratory facilities by members of the scientific community is included.

The Technical Assistance to States Program provides data, technical knowledge, and expertise to the state to aid in the allocation and management of water resources. In some cases, the task is simply to provide available data to the states; but in others, the complex interrelationships of surface water and groundwater, various user demands, and instream flow require specialized hydrologic and economic analyses. Entire project investigations will not be performed for the state, nor will specific investigations be conducted for state-licensed agencies such as irrigation districts. This program is administered under general reclamation laws and is funded through the general Bureau of Reclamation budget subject to the availability of funds.

Corps of Engineers

Background

The limited peacetime army which existed at the time of Presidents Washington and Adams included few technically qualified officers. To remedy this deficiency, President Jefferson encouraged Congress to establish the Corps of Engineers through an act which he signed on March 16, 1802. The Corps was to be stationed at the old Hudson fortress of West Point and establish a military academy.

A half-dozen officers were added to the Corps in 1816 as topographical engineers, but they were not limited to mapping. These engineers began the first surveys in the interior of the country.

In 1820, Congress authorized and appropriated $5,000 for the first Corps of Engineers survey. The survey covered the Ohio and Mississippi rivers between Louisville and New Orleans to determine the most practicable means of improving their navigation. Obstructions to steamboat navigation were the chief concerns, and most of the work involved what was to become the traditional "clearing and snagging."

The big breakthrough came in 1822 when Congress appropriated $22,700 for the Corps' river and harbor work. No appropriation was made in 1823, but $115,000 was voted in 1824 and regular appropriations were made annually thereafter. Eventually this became known as the rivers and harbors appropriation.

Utah is served by the South Pacific Division located in San Francisco, California. The Los Angeles District covers the Virgin River area. The balance of Utah is under the Sacramento District with the Colorado and Great Basin Branch office in Salt Lake City.

Programs

If local interests are unable to cope with a water resources problem, they may petition their representatives in Congress for assistance. This allows the Corps of Engineers (Corps) to investigate the economic and technical feasibility and environmental and social acceptability of remedial measures. When the directive covers an entire river basin, it is studied as a unit and a comprehensive plan is developed. Close coordination is maintained with local interests, the state, and other federal agencies.

Civil Works - These responsibilities are carried out through the Survey and Construction Program. Studies are conducted in the following areas: flood control, navigation, hydroelectric power, water supply, and recreation including environmental, social, economic, and energy-related issues.

Flood control work is accomplished by structural and nonstructural measures. Navigation improvement considers water-borne commerce and recreational boating. The Corps is only the constructing agent for hydroelectric power projects. The secretary of the Army is authorized to contract with states, municipalities, private concerns, or individuals for domestic and industrial uses of surplus water that may be available at Corps multipurpose reservoirs. Outdoor recreation opportunities are considered on the same basis as other uses of water resources.

Special Study Programs - The Urban Studies program utilizes Corps knowledge and expertise, in partnership with local and state governments, to develop realistic 50-year plans to help solve a wide range of water- and land-related problems in certain urban regions such as the National Hydroelectric Power Resources Study.

Continuing Authorities Program - The Continuing Authorities program (also known as the Small Projects program) allows the Corps to respond more quickly to study and construct certain water resources development projects. The program is comprised of seven different types of projects, each with its own project authority and strict limit on federal funds. As studies progress, certain project costs must be shared with the local agency. Small flood control work provides for local protection from flooding by the construction or improvement of flood control works. Nonstructural alternatives also are considered. Emergency streambank and shoreline protection work is intended to prevent erosion damages to nonprofit public facilities. Snagging and clearing for flood control work provide for channel clearing and excavation. Small beach erosion control project work provides for protection or restoration of public shorelines. Snagging and clearing for navigation work provide for emergency measures to clear and remove obstructions to navigation. The other two projects relate to ocean shorelines and ocean harbors.

Technical Assistance Programs - The Corps provides technical assistance for other federal, state, and local government agencies and the general public. In some cases, this work is reimbursable.

The Flood Plain Management Services program provides technical expertise in flood plain management. Section 206 of the Flood Insurance Studies was enacted to inform communities about flood dangers, provide reasonable protection by flood plain management, and protect residents against financial losses. The Flood Insurance

Study is conducted by the Corps of other federal or state agencies or private engineering firms at the request of the Federal Emergency Management Agency.

The Planning Assistance to States program enables states to use Corps planning expertise in the preparation of comprehensive plans for the development, utilization, and conservation of water and related land resources. Planning assistance is provided at state request.

The Corps can provide technical and engineering assistance to nonfederal public interests to develop structural and nonstructural methods for preventing damages from shoreline and streambank erosion. All assistance is provided at no charge.

Emergency Activities - The Corps of Engineers is authorized to engage in flood fighting and rescue operations, to repair or restore flood control works threatened or damaged by floods, to construct emergency flood protection works, and to assist state and local governments in alleviating damage, hardship, and suffering caused by major disasters.

Permit Program - The Corps of Engineers performs extensive civil functions which include: (1) Construction, operation, maintenance, and control of river and harbor and flood control improvements authorized by law; and (2) administration of certain laws enacted by Congress to protect and preserve navigation and navigable waters.

Section 10 (River and Harbor Act of March 3, 1899) prohibits the unauthorized obstruction or alteration of any navigable water. Activities requiring a permit include the construction of any structure or other work in or over any navigable water of the United States.

Section 404 (Clean Water Act of 1977) regulates the discharge of dredged or fill material in all waters and their adjacent wetlands.

Environmental Protection Agency

Background

The Environmental Protection Agency (EPA) regulates environmental standards in the areas of air and water pollution control, public water supply, solid waste management, radiation, and pesticides. The agency was created in December 1970. Its formation brought together the above functions from the Departments of the Interior, Health, Education and Welfare; Agriculture; and the Atomic Energy Commission.

The Federal Safe Drinking Water Act and the Clean Water Act provide EPA with statutory authority for assuring that water resources are of satisfactory quality for beneficial uses including public water supply; recreation; agriculture; industry; propagation of fish, aquatic life, and wildlife; and other purposes.

The EPA is directed by an administrator in Washington, D.C. Utah is in Region VIII whose regional administrator is in Denver, Colorado.

Programs

Major Environmental Protection Agency (EPA) programs dealing with water resources are the safe drinking water program under the Federal Safe Drinking Water Act (SDWA) and the water pollution control program under the Clean Water Act (CWA).

The SDWA provides for adoption and enforcement of a set of national drinking water standards. Included are interim primary standards for contaminants affecting health and secondary standards affecting aesthetics such as taste, odor, and appearance. The act also provides for regulation of wells used for injection of contaminated water or other hazardous wastes that pose a threat to underground supplies of drinking water.

The Federal Safe Drinking Water Act, 1974, as amended in 1986, substantially increased the number of regulated drinking water contaminants, added new required treatment methods, and made other revisions. The act does not contain any provisions for financial assistance for drinking water systems.

There are several aspects of the Clean Water Act, including:

National Pollutant Discharge Elimination System (NPDES) - the NPDES program (CWA, Section 402) regulates the discharge of point sources of pollutants to waters of the United States by means of discharge permits issued to municipal and industrial sources of pollution.

Construction Grants - This program under CWA, Section 201, provides grant funds for construction of needed municipal wastewater treatment facilities. This program will be phased out by 1990 and replaced with a revolving loan fund managed by the state.

Water Quality Management Planning and Nonpoint Source Pollution Control - Section 205(j) of the CWA provides funds to states to carry out water quality management planning including, but not limited to: (1) Identification of cost-effective nonpoint control measures to meet and maintain water quality standards, and (2) determining the nature, extent, and causes of water quality problems in various areas of the state.

Section 319 of the CWA authorizes funding for implementation of nonpoint source pollution control measures under state leadership.

Water Quality Standards - States are required to develop water quality standards under Section 303 of the CWA. In developing standards, a state is required to take into consideration: (1) Use and value of water for public water supplies; (2) protection and propagation of fish, shellfish and wildlife; (3) recreation in and on the water, and (4) agricultural, industrial, and other purposes including navigation. EPA approves state-adopted water quality standards.

In Utah, the safe drinking water and water pollution control programs are administered by the Bureau of Drinking Water/Sanitation and the Bureau of Water Pollution Control, respectively, with oversights by EPA.

Federal Emergency Management Agency

Background

By Executive Order 12148 (1980), the president delegated the primary responsibility for administering the Disaster Relief Act of 1974 (Public Law 93-288) to the director of the Federal Emergency Management Agency (FEMA). This act was formerly administered within the Department of Housing and Urban Development. The executive order also transferred the functions of civil defense to FEMA.

Disaster activities are coordinated by the associate director for State and Local Programs at the national level and the Disaster Assistance Programs Division at the regional level. Utah is Region VIII with headquarters in Denver, Colorado.

Programs

Programs administered by the Federal Emergency Management Agency (FEMA) are related to disaster preparedness, assistance, and mitigation. They can provide technical assistance, loans, and grants.

Presidential Declared Disaster - After a presidential declaration of a major disaster, usually after a state request, grants are available to state and local governments for: (1) Debris and timber removal; (2) emergency protective measures; (3) food, water, shelter, temporary housing, and transportation; (4) fire suppression; (5) individuals and families; and (6) repair or replacement of public and nonprofit private facilities. Technical assistance is available for crisis counseling, legal services, and hazard mitigation. Community disaster loans are available when the disaster results in substantial tax revenue loss.

Assistance Grants - FEMA can provide grants on a matching basis to help the state develop and improve disaster preparedness plans and to develop effective state and local emergency management organizations. Also, grants are available to develop earthquake and hurricane preparedness capabilities.

Flood Plain Management - FEMA provides technical assistance to reduce potential flood losses through flood plain management. This includes flood hazard studies to delineate flood plains, advisory services to prepare and administer flood plain management ordinances, and assistance in enrolling in the National Insurance Program. FEMA can also assist with the acquisition of structures subject to continual flooding.

Fish and Wildlife Service

Background

The Fish and Wildlife Service (F&WS) is rarely responsible for conventional water development except in waterfowl refuges. Its role is usually to participate in water project planning to minimize damages.

The primary legal basis for much of the service's involvement in water projects is the Fish and Wildlife Service Act. This act requires consultation with the F&WS

and the wildlife agency of any state wherein streams or other water bodies are proposed or authorized to be impounded, diverted, channelized, or otherwise controlled or modified by any federal or nonfederal entity under federal permit or license, with a view to the conservation of wildlife resources.

The F&WS has legal mandates to protect endangered species and migratory wildlife. Many species in these categories are associated with aquatic, riparian, or wetlands habitat and are often affected by water development.

The Fish and Wildlife Service in Utah is under the direction of a state supervisor located in Salt Lake City. Other staff are maintained at Jones Hole, Fish Springs, Bear River, and Ouray.

Programs

The Fish and Wildlife Service administers some facilities in Utah which have significant water requirements, and for which the Fish and Wildlife Service holds water rights. These installation are Jones Hole National Fish Hatchery, Fish Springs National Wildlife Refuge, Bear River Migratory Bird Refuge, and Ouray National Wildlife Refuge. In addition, Brown's Park National Wildlife Refuge in Colorado and Bear Lake National Wildlife Refuge in Idaho could be affected by uses of water in Utah.

Forest Service

Background

The Forest Service is responsible for managing national forest lands in Utah. National forests have their beginnings in forest reserves authorized by the Organic Act of 1897 "to improve and protect the forest within the reservation for the purpose of securing favorable conditions of water flows, and to furnish a continuous supply of timber." The specific intent was that forest reserves be established for watershed management. Utah's first reserve was the Uinta which was withdrawn from public entry on February 22, 1987, by President Cleveland. Forest reserves were managed by the Bureau of Forestry, which became the Forest Service in 1905. In 1907, the reserves were renamed national forests.

During this same period, Utahans were beginning to realize that the natural resource base upon which they depended was becoming seriously depleted. By 1890, it was evident that timber depletion and overgrazing had disturbed the balance by which nature maintains mountain watersheds. In addition, drought from 1899 to 1902 emphasized the growing shortage of irrigation water.

Albert Potter, a grazing expert with the Bureau of Forestry, undertook a survey that carried him from one end of Utah to the other. He found much of the area seriously depleted. A large number of Utah reserves were established as a result of Potter's 1902 report.

The establishment of national forests in Utah resulted in the regulation of grazing and halted the rapid growth of the migratory sheep industry. Similarly, timber harvest has been regulated for watershed protection.

Range and timber management changes were gradual, and watershed damage was slow to heal. From the turn of the century to the 1930s, summer thunderstorms caused increasingly frequent, damaging floods and debris flows from Bountiful to Brigham City. Local citizens organized a flood control committee in 1930 and called upon the governor for help. A commission was appointed which recommended a program of fire protection, restricted grazing, and watershed restoration measures. The committee's recommendations were carried out by the Forest Service using Civilian Conservation Corps labor.

The purpose of national forests was reaffirmed by Congress in 1960 by the Multiple Use-Sustained Yield Act which stated that forests shall be administered for watershed, wildlife, fish, recreation, range, and timber. The Forest Service role in Utah's water resource development and planning is to manage the mountain watersheds to provide high-quality water while reducing the threat of damaging floods.

The organizational structure of the Forest Service is that of line and staff. National forests are divided into districts. A district ranger with support staff, is the line officer responsible for district management and administration. The forest supervisor, with staff, is the responsible line officer for a national forest. The national forests are administratively grouped into regions headed by regional foresters. All forests in Utah are in the Intermountain Region with offices in Ogden. At the top of the organization structure is the chief of the Forest Service in Washington, D.C. The Forest Service is a strongly decentralized organization. Authority for resource decisions rests with local district rangers and forest supervisors.

Programs

Water-related programs of the Forest Service include watershed management; special use authorization for water development projects; and coordination with local, state, and federal agencies.

Watershed Management - Watershed protection insures that activities do not cause undue soil erosion and stream sedimentation, reduce soil productivity, or otherwise degrade water quality. Some municipal watersheds have further restrictions such as closure to grazing to protect water quality. Watershed improvement work includes gully plugs, contour trenches, and other structural methods in combination with seeding or planting to reestablish a protective vegetative cover.

Water yields may be affected primarily through snowpack management as a result of timber harvest using well-planned layout and design. Potential increases in Utah may approach one-half acre foot per acre for some treated areas, but multiple-use considerations and specific on-site conditions may limit actual increases.

Special Use Authorization - Construction and operation of reservoirs, transmission ditches, hydropower developments, and other water resources developments require special use authorization and usually require an annual fee. Authorization contains conditions necessary to protect all other resource uses. The impacts are analyzed using National Environmental Policy Act criteria. The proposal also will be responsive to other legislation and the management direction established in forest plans.

If the use is approved, the permit holder may need to provide plans and specifications developed by a licensed architect or professional engineer and may also be required to provide a bond. The Forest Service inspects all special uses on a periodic basis. Regulations for certain proposals require that an applicant enter into a memorandum of understanding and cost reimbursement agreement.

Coordination - Water developments by others require communication early in the planning process to guarantee environmental concerns are addressed. Project planning must be coordinated with the Corps of Engineers and the Utah Division of Water Rights where stream channels are impacted, and with the Environmental Protection Agency for wetlands. The Utah Bureau of Water Pollution Control and local water quality agencies must be involved where there is potential to degrade water quality. The Utah Division of Wildlife Resources needs to address projects that impact fish or wildlife habitat.

Geological Survey

Background

The Geological Survey's Federal-State Cooperative Water Resources program has served the nation since 1895. As the largest major component of the survey's total water resources investigations program, it represents a working partnership with state and local interests.

Program details are negotiated at state or local levels. Implementation of the work is principally by survey personnel, but there is an accountability for performance to the state and local partners. The nation's ability to cope with the challenges of water management rests largely on data and information provided by the cooperative program. The need for hydrologic data, investigations, and research clearly will continue to be great. The cooperative program is one proven way to develop water resources information so federal and state interests are equally represented.

The Utah District office is located in Salt Lake City. There is a subdistrict office in Cedar City and field offices in Salt Lake City and Moab.

Programs

The Geological Survey, through its Water Resources Division (WRD), investigates the occurrence, quantity, distribution, and movement of surface water and groundwater and coordinates federal water data acquisition activities. This is accomplished through programs supported by the Geological Survey independent of, or in cooperation with, other federal and nonfederal agencies. These programs involve:

1. Collecting, on a systematic basis, data needed for the continuing determination and evaluation of the quantity, quality, and use of the nation's water resources.

2. Conducting analytical and interpretive water resource appraisals of the occurrence, availability, and the physical, chemical, and biological characteristics of surface water and groundwater.

3. Conducting basic program-oriented research in hydrology to improve the scientific basis for investigations and measurement techniques and to predict quantitatively the response of hydrologic systems to stress.

4. Disseminating water data and the results of investigations and research through reports, maps, computerized information services, and other forms of public releases.

5. Coordinating the activities of federal agencies in the acquisition of water data for streams, lakes, reservoirs, estuaries, and groundwater.

6. Providing scientific and technical assistance in hydrologic fields to other federal, state, and local agencies; to licensees of the Federal Energy Regulatory Commission; and to international agencies on behalf of the State Department.

7. Administering the provisions of the Water Resources Research Act of 1984, which includes the State Water Resources Research Institute Program and the National Water Resources Research Grant Program.

8. Acquiring information useful in predicting and delineating water-related natural hazards from flooding, volcanoes, mudflows, and land subsidence.

The Utah District WRD collects streamflow and reservoir data at about 210 sites, water-level data in about 1,100 wells, and water-quality and fluvial-sediment data for approximately 200 surface water and 200 well sites. Various characteristics of the Great Salt Lake are also monitored. In addition, interpretive water resources investigations in selected parts of Utah are always underway by Geological Survey personnel in cooperation with state and other federal agencies.

Soil Conservation Service

Background

Soil erosion as a menace to agriculture in the United States received national recognition when Congress adopted the Buchanan Amendment to the Agricultural Appropriations Bill in 1930. The amendment provided $160,000 to the secretary of Agriculture to conduct soil erosion investigations. In the same year, regional soil erosion experiment stations were established by the Bureau of Chemistry and Soils in cooperation with the Bureau of Agriculture Engineering.

On September 19, 1933, the Soil Erosion Service (SES) was established as a temporary agency of the Department of the Interior. Its purpose was to carry out the provisions of the National Industrial Recovery Act to administer Public Works Administration allocations related to preventing soil erosion.

Twenty-two emergency conservation work camps began work under the technical direction of the Soil Erosion Service on April 1, 1934. The SES was transferred to the Department of Agriculture by an administrative order on March 25, 1935.

The Soil Conservation and Domestic Allotment Act of 1935 (Public Law 74-46), as amended, established the Soil Conservation Service (successor of the Soil Erosion Service) for the development and prosecution of a continuing program of soil and water conservation. Subsequent legislation and executive actions added responsibilities for soil and snow surveys; inventorying and monitoring the nation's soil, water, and related resources; flood prevention; and river basin activities. This law is the basic authority for the Soil Conservation Service. It contains broad language to carry out the Conservation Operations program. Primary beneficiaries of the program are individuals and informal groups of farmers and ranchers. They receive technical assistance for soil and water conservation through local soil conservation districts.

The Soil Conservation Service is directed by a state conservationist located in Salt Lake City. Field operations are carried out through seven district offices and 18 sub-offices around the state.

Programs

Soil Conservation Service authorities and programs are provided in the Soil Conservation and Domestic Allotment Act of 1935. This act calls for the development and prosecution of a continuing program of soil and water conservation on all lands, regardless of ownership, when so requested. Over the years, additional programs have been added.

The soil survey program provides for studies and reports necessary for the classification and interpretation of kinds of soils. These are carried out through cooperative arrangements with state or other public entities.

The snow survey program makes and coordinates surveys and prepares forecasts of seasonal water supplies. This is a cooperative program with state and other federal agencies for the benefit of water users.

The Resources Conservation Act of 1977 requires a continuing appraisal of soil, water, and related resources of the nation.

The Watershed Protection and Flood Prevention Act (Public Law 83-566), as amended, gives primary responsibility for small, upstream watershed activities. This law authorizes cost sharing with local sponsors at varying rates, to preserve, protect, and improve the land and water resources by reducing erosion, floodwater, and sediment damages. It also provides for irrigation, drainage, recreation, and wildlife measures. Section 6 of the act provides for cooperative river basin studies with state, local, and other federal agencies.

The Resource Conservation and Development program began with the Food and Agriculture Act of 1962 (Public Law 87-703), as amended. It provided assistance to government and nonprofit organizations in multiple-jurisdictional areas. Cost sharing and loans are available to carry out water and related land conservation and development measures.

The Soil Conservation Service also provides technical assistance for the Colorado River Basin Salinity Control program, Flood Insurance program, Rural Clean Water program, Flood Hazard Studies program, and Rural Abandoned Mine program. Some of these are cost shared with local entities under other agency programs.

Other Federal Agency Programs

There are several federal agencies with water-related roles. These are briefly described below.

The Economic Development Administration (EDA) was established under the Public Works and Economic Development Act of 1965. The assistant secretary for Economic Development heads EDA. The primary function of EDA is long-range economic development and programming for areas and regions of substantial and persistent unemployment, underemployment, and low family income. It does this by creating new employment opportunities by developing new and expanding existing facilities and resources. EDA administers public works grants and loans, fixed asset and working capital loans, and loan guarantees for industrial or commercial facilities. It also provides technical planning, and research assistance.

The Farmers Home Administration is authorized to provide financial assistance for water and waste disposal facilities in rural areas and town of up to 10,000 people. Public entities such as municipalities, counties, special purpose districts, Indian tribes, and corporations not operated for profit may receive assistance. Priority is given to public entities in areas of less than 5,500 population to restore deteriorating water supplies, or to improve, enlarge, or modify water facilities or inadequate water facilities. Preference is also given to requests which involve merging small facilities and those serving low-income communities.

In order for water or waste disposal systems to be eligible for loan and grant funds, plans must be consistent with any applicable state, multijurisdictional area, county, or municipal goals. All facilities must comply with federal, state, and local laws, including those concerned with zoning regulations, health and sanitation standards, and the control of water pollution.

The Federal Energy Regulatory Commission (FERC) inherited virtually all of the Federal Power Commission's regulatory functions and was given several additional responsibilities. A significant new authority given the commission was the conformation and approval of federal hydroelectric rates for power marketed by the Bureau of Reclamation.

The Federal Power Commission was created by the Federal Water Power Act of 1920. In 1977, it was replaced by the Department of Energy which incorporated the independent regulatory agency known as the FERC.

Under provisions of the Federal Power Act and related acts, FERC is assigned statutory responsibilities for planning, constructing, and operating water resources projects, particularly those which develop power. The commission investigates use of the water resources of any region to be developed and cooperates in such investigations with other federal and state agencies. The commission is specifically charges with making recommendations to the secretary of the Army regarding installation of penstocks or similar facilities adapted to the development of power at projects constructed by the Department of the Army.

The Department of Housing and Urban Development (HUD) administers major federal programs which provide assistance for housing and the development of the nation's communities. Sound community development effects and is affected by water supply, flood and runoff control, water quality, and the quality of life involving water and related open space. Consequently, HUD is interested in investigations, surveys, and planning assistance provided by other departments and agencies for water and related land resources programs and projects which may be responsive to the needs and desires of the nation's communities. The department assists in the planning of such programs through financial assistance to state, areawide, or other local comprehensive planning agencies, and the development of water resource projects, at local option, through the Community Development Block Grant program.

The National Oceanic and Atmosphere Administration (NOAA) was organized in October 1970 within the U.S. Department of Commerce. It applies a unified approach to the problems of the oceans, the atmosphere, and the third major component of our environment - the solid earth. NOAA brings together functions of the Environmental Science Services Administration with those of the Department of the Interior; Department of the Navy; National Science Foundation; and the Department of the Army, Corps of Engineers.

The National Weather Service (NWS) within NOAA, observes and reports the weather of the United States and its possessions. It issues forecasts and warnings of weather and river and flood conditions that affect natural safety, welfare, and the general economy. In providing river and flood forecasts and warnings, the NWS conducts necessary research which includes analyses and studies of hydrometeorological data for broad application to water resources planning, design, and operational problems.

Periodic and special publications present data, analysis and interpretations. Forecasts, both meteorological and hydrological, are given wide and instantaneous distribution by radio, television, press, telephone, and telegraph. Routine coordination and exchange of information for operational purposes are conducted by local NWS offices and appropriate field offices of federal and state agencies concerned with disaster relief, water control, and management.

Because of this responsibility to provide nationwide river and flood forecasts and warning services, the NWS is interested in comprehensive water and related land planning studies and project reports, including future plans and their anticipated implementation. Also of interest is the application of meteorological and hydrometeorological data and analyses in project planning and in future requirements for basic data and analyses.

APPENDIX B

SELECTED STATE STATUTES CONCERNING WATER RESOURCE PLANNING

ARKANSAS

Arkansas Code of 1987 Annotated
Including Acts of 1989 General Assembly

15-22-201. Declaration of Policy.

(a) In recognition of the fact that there is rainfall over the State of Arkansas in rainy reasons more than ample to provide sufficient surface water for the use of persons in this State during those seasons, that most of this surplus water is now wasted and completely lost, and does damage to fertile soil while being wastefully lost, and that during other periods the supply of surface water has been and may be inadequate for needed use, it is declared to be the policy of the Stat of Arkansas to encourage and provide methods for conserving surplus surface water for future use.

(b) To that end it is declared to be the purpose of this subchapter to permit and regulate the construction of facilities to store surplus surface water for future use, to protect the rights of all persons equitably and reasonably interested in the use and disposition of surface water to maintain the normal flow of all streams and preserve the fish therein, to prevent harmful overflows and flooding, and conserve the natural resources of the State of Arkansas.

History. Acts 1957, No. 81 S 1; A.S.A.
1947, S 21-1301.

[text continues]

15-22-217. Allocation during shortages.

(a) Whenever a shortage or water in any stream, or part thereof, exists to the extent that there is not sufficient water therein to meet the requirements of all water needs, the Commission, on its own initiative or on the petition of any person affected by such shortage of water, after notice and hearing, may allocate the available water therefrom among the uses of water affected by the shortage of water in a manner that each of them may obtain an equitable portion of the available water.

(b) In allocating water in such as case, the Commission may consider the use that each person involved is to make of the water allocated to that person.

(c) In making such allocations of water, reasonable preferences shall be given to different uses in the following order of preference:

(1) Sustaining life;
(2) Maintaining health; and
(3) Increasing wealth/

(d) Water needs shall include domestic and municipal water supply needs, agricultural and industrial water needs, and navigational, recreational, fish and wildlife, and other ecological needs.

(e) The following priorities shall be reserved prior to allocation:

(1) Domestic and municipal domestic;
(2) Minimum streamflow;
(3) Federal water rights.

History. Acts 1957, No. 81, S 8; A.S.A
1947, S 21-1308; Acts 1989, No. 469, S 2.

15-22-503. Arkansas Water Plan.

(a) Under such rules and regulations as it may adopt, the [Arkansas Soil and Water Conservation] Commission is charge with the duty of preparing, developing, formulating, and engaging in a comprehensive program for the orderly development and management of the State's water and related land resources, to be referred to as the Arkansas Water Plan.

(b) The Commission shall be governed in its preparation of the plan by a regard for the public interest of the entire State. It shall direct its efforts to project the water resources of the State, including boundary waters, against unwarranted encroachments by other States and the United States upon its sovereignty with respect thereto. Any attempt to transport or export any of such water against the best interests of the State of Arkansas and its inhabitants shall be strongly opposed.

(c) The Arkansas Water Plan shall give due consideration to existing water rights of the State and its inhabitants and shall take into account modes and procedures for the equitable adjustment of individual water rights affected by the implementation of the plan. The Arkansas Water Plan shall be the State policy for the development of water and related land resources in this State and shall, from time to time, be altered, amended, or repealed to the extent necessary for the proper administration of the State's water resources.

(d) All State agencies, Commissions, and political subdivisions shall take Arkansas Water Plan into consideration in all matters pertaining to the discharge of their respective duties and responsibilities as they may affect the comprehensive Arkansas Water Plan, but nothing in the Arkansas Water Plan shall be construed as to impair any water right existing under the laws of this State.

(e) No political subdivision nor agency of the State shall spend any State funds on or engage in any water development project, excluding any project in which game protection funds or federal or State outdoor recreation assistance grant funds are to be spent provided such project will not diminish the benefits of any existing water development project, until a preliminary survey and report therefor, which sets forth the purpose of the project, the benefits to be expected, the general nature of the works of improvement, the necessity, feasibility and the estimated cost thereof, is filed with the Commission and is approved by the Commission to be in compliance with the Arkansas Water Plan. Upon approval of the report, no political subdivision nor agency board or Commission thereof filing the report, or designated by the Commission as having responsibility for constructing, operating, managing and maintaining the improvement, shall be dissolved, merged, abolished, or otherwise changed during the life of the water development project without prior approval of the Commission.

History. Acts 1969, No. 217, s 2.
1973, No. 584, S 2; A.S.A.
1947, S 21-1318; Acts 1989.
No. 469, S 3.

15-22-504. Publication and availability of plan.

(a) In accordance with SS 15-22-207, 15-22-204, and 15-22-501, the Arkansas Soil and Water Conservation Commission shall publish a "State Water Plan," which shall from time to time be revised, updated, and amended as new information, projects, and developments shall occur.

(b) The State Water Plan shall be made available to all interested State agencies, departments, Commissions, and individuals in order to insure that the provisions of this subchapter are complied with, concerning water resources planning and development.

History. Acts 1975, No. 555, S 2.
A.S.A. 1947, S 21-1332.

HAWAII

Chapter 174C, State Water Code

S174C-31 Hawaii water plan. (a) The Hawaii water plan shall consist of four parts: (1) a water resource protection plan which shall be prepared by the water resources commission; (2) water use and development plans for each county which shall be prepared by each separate county and adopted by ordinance, setting forth the allocation of water to land use in that county; (3) a state water project plan which shall be prepared by the agency which has jurisdiction over such projects in conjunction with other state agencies; and (4) a water quality plan which shall be prepared by the department of health.

(b) All water use and development plans shall be prepared in a manner consistent with the following conditions:
(1) Each water use and development plan and the state water projects plan shall be consistent with the water resource protection plan and quality plan.
(2) Each water use and development plan shall be consistent with the respective county land use plans and policies including general plan and zoning as determined by each respective county.
(3) The water use and development plan for each county shall also be consistent with the state land use classification and policies.
(4) The cost to develop the initial water use and development plan for each county shall be funded by the State in an amount not exceeding $150,000 per county.
(5) The cost of maintaining the water use and development plan shall be borne by the counties; state water capital improvement funds appropriated to the counties shall be deemed to satisfy Article VIII, section 5 of the State Constitution.
(6) Each county in order to be eligible for state appropriations for county water projects must have developed an acceptable water use and development plan within the time frame established by this chapter.

(c) To prepare the water resources protection and quality plan, the commission shall:
(1) Study and inventory the existing water resources of the State and the means and methods of conserving and augmenting such water resources;
(2) Review existing and contemplated needs and uses of water including state and county land use plans and policies and study their effect on the environment, procreation of fish and wildlife, and water quality;
(3) Study the quantity and quality of water needed for existing and contemplated uses, including irrigation, power development, geothermal power, and municipal uses;
(4) Identify rivers or streams, or a portion of a river or stream, which appropriately may be placed within a wild and scenic river system, to be preserved and protected as part of the public trust. For the purposes of this paragraph, the term "wild and scenic rivers" means rivers or streams, or a portion of a river or stream, of high natural quality or that possess significant scenic value, including but not limited to, rivers or streams which are within the natural area reserves system. The commission shall report its findings to the legislature twenty days prior to the convening of each regular legislative session; and
(5) Study such other related matters as drainage, reclamation, flood hazards, floodplain zoning, dam safety, and selection of reservoir sites, as they relate to the protection, conservation, quality, and quality of water.

The water resource protection play shall include, but not be limited to:
(1) Nature and occurrence of water resources in the State;
(2) Hydrologic units and their characteristics, including the quality and quality of available resource, requirements for beneficial instream uses and environment protection, desirable uses worthy of preservation by permit, and undesirable uses for which permits may be denied;
(3) Existing and contemplated uses of water, as identified in the water use and development plans of the Sate and the counties, their impact on the resource, and their consistency with objectives and policies established in the water resource protection quality plan;
(4) Programs to conserve, augment, and protection the water resource; and
(5) Other elements necessary or desirable for inclusion in the plan.

Thereafter, the commission in coordination with the counties and the department of health shall formulate an integrated coordinated program for the protection, conservation, and management of the waters in each county based on the above studies. This program, with such amendments, supplements, and additions as may be necessary, shall be known as the water resource protection and quality plan.

Thereafter, each county shall prepare a water use and development plan and the appropriate state agency shall prepare the state water projects plan. Each county water use and development plan shall include but not be limited to:

(1) Status of water and related land development including an inventory of existing water uses for domestic, municipal, and industrial users, agriculture, aquaculture, hydropower development, drainage, reuse, reclamation, recharge, and resulting problems and constraints;

(2) Future land uses and related water needs; and

(3) Regional plans for water developments including recommended and alternative plans, costs, adequacy of plans, and relationship to water resource protection and quality plan.

(d) The Hawaii water plan shall be directed toward the achievement of the following objectives:

(1) The attainment of maximum reasonable-beneficial use of water for such purposes as those referred to in subsection (a);

(2) The proper conservation and development of the waters of the State;

(3) The control of the waters of the State for such public purposes as navigation, drainage, sanitation, and flood control;

(4) The attainment of adequate water quality as expressed in the state water protection and quality plan; and

(5) The implementation of the water resources policies expressed in section 174C-2.

(e) The Hawaii water plan shall divide each county into sections which shall each conform as nearly as practicable to a hydrologic unit. The board shall describe and inventory:

(1) All water resources and systems in each hydrologic unit;

(2) All presently exercised uses;

(3) The quantity of water not presently used within that hydrologic unit; and

(4) Potential threats to water resources, both current and future.

(f) Within each hydrologic unit the commission shall establish the following:

(1) An instream use and protection program for the surface watercourses in the area.

(2) Sustainable yield. The sustainable yield shall be determined by the commission using the best information available and shall be reviewed periodically. Where appropriate the sustainable yield may be determined to reflect seasonal variation.

(g) The commission shall condition permits under part IV of this chapter in such a manner as to protect instream flows and maintain sustainable yields of groundwater established under this section.

(h) The commission shall give careful consideration to the requirements of public recreation, the protection of the environment, and the procreation of fish and wildlife. The commission may prohibit or restrict other future uses on certain designated streams which may prohibit or restrict other future uses on certain designated streams which may be inconsistent with these objectives.

(i) The commission may designate certain uses in connection with a particular source of supply which, because of the nature of the activity or the amount of water required, would constitute an undesirable use of which the commission may deny a permit under the provisions of part IV.

(j) The commission may also designate certain uses in connection with a particular source of supply which, because of the nature of the activity or amount of water required, would result in an enhancement or improvement of the water resources of the area. Such uses shall be preferred over other uses in any action pursuant to sections 174C-50(h) and 174C-54.

(k) The commission may add to the Hawaii water plan any other information, directions, or objectives it feels necessary or desirable for the guidance of the counties in the administration and enforcement of this chapter.

(l) In formulating or revising the plans, each county and the commission shall consult with and carefully evaluate the recommendations of concerned federal, state, and county agencies.

(m) The commission shall not adopt, approve, or modify any portion of the Hawaii water plan which affects a county or any portion thereof without first holding a public hearing on the matter on the island on which the water resources are located. At least ninety days in advance of such hearing, the commission shall notify the affected county and shall give notice of such hearing by publication within the affected region and statewide.

Each county shall update and modify its water use and development plans as necessary to maintain consistency with its zoning and land use policies. [L 1987. c 45, pt of S.2; am 1 1988, c 276, S.1]

S174C-32 Coordination. (a) Respective portions of the water resource protection and quality plan, and the water use and development plans of each county, shall be developed together to achieve maximum coordination.

(b) The development of the Hawaii water plan or any portion thereof shall proceed in coordination with and with attention to the Hawaii state plan described in chapter 226.

(c) The Hawaii water plan and its constituent parts, except for the water quality plan, shall be adopted by the commission not later than three years from July 1, 1987. The commission shall receive the water quality plan from the department of health and incorporate this part in the Hawaii water plan. [l 1987, c 45, pt of S.2]

Revision note.

"July 1, 1987" substituted for "the effective date of this chapter".

INDIANA

INDIANA CODE 13-2-6.1
WATER RESOURCE MANAGEMENT

SECTION 3. The [natural resources] commission shall: (1) Conduct a continuing assessment of the availability of the water resource; (2) Take and Maintain an inventory of significant uses of water withdrawn from the surface or ground; and (3) Plan for the development, conservation, and utilization of the water resource for beneficial uses.

SECTION 4. The commission may: (1) Collect and disseminate information relating to the water resources; (2) Consult with and advise all users of the water resource as to availability of the water resource and the most practical method of water withdrawal, development conservation, and utilization; (3) Make the necessary investigations and inspections for proper administration of this chapter; (4) Enter at reasonable times with proper notice upon any property other than a dwelling place for the purpose of inspecting and investigating significant water withdrawal facilities or enforcing the provisions of this chapter; (5) Establish, by rule, the criteria for the determination of minimum stream flows and minimum ground water levels; (6) When necessary for the proper administration and enforcement of this chapter, require the metering or other reasonable measurement of water withdrawals from significant water withdrawal facilities and the reporting thereof to the commission; (7) Cooperate with other state and local agencies, other states and their state agencies, and agencies of the United States in water resource development, conservation, and utilization; (8) Accept and administer funds from any source to aid in carrying out the provisions of this chapter; and (9) Exercise such additional authority as may be necessary to carry out the provisions of this chapter.

SECTION 5. (a) The commission shall make and maintain an inventory of the water resources of the state. The inventory shall include an assessment of: (1) The capabilities of streams to support instream and withdrawal uses and of aquifers to support withdrawal uses; (2) Low stream flow characteristics; (3) Existing uses and projections of beneficial use requirements; (4) The potential in watersheds for managing flood water for beneficial uses; (5) Potential sources, and amounts of, surplus water available for transfers, and (6) Such other assessment and information as may be deemed necessary to properly define water resource availability. (b) The commission shall maintain, on a continuing basis and with opportunity for participation and consultation with all interested persons, plans a recommendations for the development, conservation, and utilization of the water resource to best serve the needs of the people of Indiana for beneficial uses.

KENTUCKY

HB 419

AN ACT relating to water supply planning.

Be it enacted by the General Assembly of the Commonwealth of Kentucky:

SECTION 1. KRS 151.110 is amended to read as follows:

The conservation, development and proper use of the water resources of the Commonwealth of Kentucky have become of vital importance as a result of population expansion and concentration, industrial growth, technological advances and an ever increasing demand for water for varied domestic, industrial, municipal and recreational uses. It is recognized by the General Assembly that excessive rainfall during certain seasons of the year causes damage from overflowing streams. However, prolonged droughts at other seasons curtail industrial, municipal, agricultural and recreational uses of water and seriously threaten the continued growth and economic wellbeing of the Commonwealth. The advancement of the safety, happiness and welfare of the people and the protection of property require that the power inherent in the people be utilized to promote and to regulate the conservation, development and most beneficial use of the water resources. It is hereby declared that the general welfare requires that the water resources of the Commonwealth be put to the beneficial use to the fullest extent of which they are capable, that the waste or nonbeneficial use of water be prevented, and that the conservation and beneficial use of water be exercised in the interest of the people. Therefore, it is declared the policy of the Commonwealth to actively encourage and to provide financial, technical or other support for projects that will control and store our water resources in order that the continued growth and development of the Commonwealth might be assured. To that end, it is declared to be the purpose of KRS Chapters 146, 149, 151, 224, 262 and KRS 350.029 and 433.750 to 433.757 for the Commonwealth to permit, regulated, and participate in the construction or financing of facilities to store surplus surface water for future use; to conserve and develop the ground water resources of the Commonwealth; to require local communities to develop long range water supply plans; to protect the rights of all persons equitably and reasonably interested in the use and availability of water; to prohibit the pollution of water resources and to maintain the normal flow of all streams so that the proper quantity and quality of water will be available at all times to the people of the Commonwealth; to provide for the adequate disposition of water among the people of the Commonwealth entitled to its use during severe droughts or times of emergency; to prevent harmful overflows and flooding; to regulate the construction, maintenance and operation of all dams and other barriers of streams; to prevent the obstruction of streams and floodways by the dumping of substances therein; to keep accurate records on the amount of water withdrawals from streams and watercourses and reasonably regulate the amount of withdrawal of public water; and to engage in other activities as may be necessary to conserve and develop the water resources of the Commonwealth of Kentucky, and to ensure adequate supply of water for domestic, agricultural, recreational and economic development uses.

SECTION 2. A new section of KRS Chapter 151 is created to read as follows:

(1) The cabinet shall administer a program for the purpose of developing long range water supply plans for each county and its municipalities and public water systems or for a region composed of more than one (1) county. the plans to be developed shall include an assessment of the existing public and private water resources, both surface and groundwater, of the study area, an examination of present water use in the area, projections of future water requirements, and a determination of possible alternative approaches that can be taken in order to meet future water supply needs.

(2) The plans may be developed by area development districts in conjunction with the counties and its municipalities and public water systems within each district. A county and its municipalities and public water systems may require that the plan be developed for its jurisdictional area only or, if there is agreement between two (2) or more counties, that the plan be developed jointly with other counties.

(3) The plans shall be subject to approval by the cabinet. The cabinet is authorized to approve any water supply plan developed outside of this program which meets the guidelines set out in this Act and the criteria established by cabinet regulations.

SECTION 3. A new section of KRS Chapter 1151 is created to read as follows:

The cabinet shall promulgate regulations to carry out the program and shall consult with the Economic Development Cabinet in developing those regulations. The regulations shall set out the details which are to be included in the water supply plans, the procedure for counties and their municipalities and public water systems to apply for financial assistance to pay for the plans, and the criteria and process by which the cabinet will approve plans. The cabinet shall assemble all information in a uniform data base available to all agencies and concerned entities.

SECTION 4. A new section of KRS Chapter 1151 is created to read as follows:

(1) The cabinet, in conjunction with a county and its municipalities and public water systems, shall finance the development of the water supply plans and encourage multi-county cooperation. The county and its municipalities and public water systems shall pay up to twenty (20) percent of the total cost of plan development. A county and its municipalities and public water systems shall be given credit toward its share of the plan's cost for in-kind services performed.

(2) The financial assistance of the cabinet shall be available until July 15, 1996.

(3) After July 15, 1996, the full cost of water supply plan development will be the responsibility of any county and its municipalities and public water systems which has not had a plan approved by the cabinet.

(4) After July 15, 1998, the cabinet shall not endorse projects that impact water under the Kentucky intergovernmental review process for any county and its municipalities and public water systems which does not have an approved water supply plan.

Approved April 10, 1990

NEW HAMPSHIRE

LAWS OF 1983

AN ACT PROVIDED FOR A METHOD OF PROTECTION OF THE GROUNDWATER OF THE STATE AND ESTABLISHING A WATER RESOURCES MANAGEMENT PROGRAM.

Be it Enacted by the Senate and House of Representative in General Court convened:

402:1 Declaration of Purpose.

I. The general court finds that an adequate water supply is indispensable to the health, welfare and safety of the people of the state and is essential to the ecological balance of the natural environment of the state and that the water resources of the stat are subject to an ever-increasing demand for new and competing uses; that, therefore, the general court declares and determines that the waters of New Hampshire whether occurring above or below ground constitute a precious, finite and invaluable public resource which should be protected, conserved and managed in the interest of present and future generations.

II. It is the intent of the general court by this act to establish a comprehensive water resources management program that shall be consistent with the scientific realities of the hydrologic cycle and shall recognize that ground water and surface water are interrelated parts of that cycle and must be considered conjunctival.

III. The water resource board is hereby directed to develop under the oversight of the joint house of representatives resources, recreation and development committee, and the senate development, recreation and environment committee, with assistance of the appropriate state agencies, and to recommend to the general court policies and a plan to determine priority water uses and allocation and to guide the general steps that the water resources board and the stat shall take to conserve, distribute and otherwise manage for the public good the water resources of the state.

IV. The water resources board shall submit its recommendations to the general court by January 1, 1984.

V. The implementation of a water allocation system authorized under RSA 481:3, I shall not take effect until the general court has adopted water resources management policies and plan. However, authority to investigate and ascertain the uses of the state's water resources, as authorized under RSA 481:3, I, including registering and reporting by water users, shall take effect immediately upon the effective date of this act.

CHAPTER 481

STATE DAMS, RESERVOIRS AND OTHER WATER CONSERVATION PROJECTS

481:1 Declaration of Policy. The general court finds that an adequate supply of water is indispensable to the health, welfare and safety of the people of the state and is essential to the balance of the natural environment of the state. Further, the water resources of the state are subject to an ever-increasing demand for new and competing uses. The general court declares and determines that the water of New Hampshire whether located above or below ground constitutes a limited, and therefore, precious and invaluable public resource which should be protected, conserved and managed in the interest of present and future generations. The state as trustee of this resource for the public benefit declares that it has the authority and responsibility to provide careful stewardship over all the waters lying within its boundaries. The maximum public benefit shall be sought, including the assurance of health and safety, the enhancement of ecological and aesthetic values, and the overall economic, recreational and social well-being of the people of the state. All levels of government within the state. all departments, agencies, boards and commissions, and all other entities, public or private, having authority over the use, disposition or diversion of water resources of the state, shall comply with this policy and with the state's comprehensive plan and program for water resources management and protection.

*Source. 1935, 121:1. 1937, 118:1. RL 266:1. RSA 481:1. 1981, 505:1. 1985, 400: 6, eff. June 26, 1985.

NEW JERSEY

SENATE, NOS. 1611 AND 1613
Adopted June 15, 1981

An Act Concerning the management of water and the diversion of any surface or ground water anywhere in the State, and revising and repealing parts of the statutory law relating thereto.

Be in enacted by the Senate and General Assembly of the State of New Jersey:

1. This act shall be known and may be cited as the "Water Supply Management Act."

2. The Legislature finds and declares that the water resources of the State are public assets of the State held in trust for its citizens and are essential to the health, safety, economic welfare, recreational and aesthetic enjoyment, and general welfare, of the people of New Jersey; that ownership of these assets is in the State as trustee of the people; that because some areas within the State do not have enough water to meet their current needs and provide an adequate margin of safety, the water resources of the State and any water brought into the State must be planned for and managed as a common resource from which the requirements of the several regions and localities in the State shall be met; that the present regulatory system for these water resources is ineffective and counter-productive; that it is necessary to insure that within each basin there exists adequate water supplies to accommodate present and future needs that to ensure an adequate supply and quality of water for citizens of the State, both present and future, and to protect the natural environment of the waterways of the State, it is necessary that the State, through its Department of Environmental Protection, have the power to manage the water supply by adopting a uniform water diversion permit system and fee schedule, a monitoring, inspection and enforcement program, a program to study and manage the State's water resources and play for emergencies and future water needs, and regulations to manage the waters of the State during water supply and water quality emergencies.

[text continues]

4. a. Upon a finding by the commissioner that there exists or impends a water supply shortage of a dimension which endangers the public health, safety, or welfare in all or any part of the State, the Governor is authorized to proclaim by executive order a state of water emergency. The Governor may limit the applicability of any state of emergency to specific categories of water supplies or to specific areas of the State in which a shortage exists or impends.

b. The department shall, within 180 days of the effective date of this act, adopt an Emergency Water Supply Allocation Plan as a rule and regulation. This plan shall be utilized as the basis for imposing water usage restrictions during a declared state of water emergency and shall include a priority system for the order in which restrictions would be imposed upon the various categories of water usage.

c. During the duration of a state of water emergency the commissioner, to the extent not in conflict with applicable Federal law or regulation but notwithstanding any State or local law or contractual agreement, shall be empowered to:

(1) Order any person to reduce by a specified amount the use of any water supply; to make use of an alternate water supply where possible; to make emergency interconnections between systems; to transfer water from any public or private system; or to cease the use of any water supply;

(2) Order any person engaged in the distribution of any water supply to reduct [sic] or increase by a specified amount or to cease the distribution of that water supply; to distribution a specified amount of water to certain users as specified by the commissioner; or to share any water supply with other distributors thereof;

(3) Establish priorities for the distribution of any water supply;

(4) Adopt rules and regulations as are necessary and proper to carry out the purpose of this section; and

(5) Direct andy person engaged in the retail distribution of water to impose and collect a surcharge on the cost of that water as a penalty for the violation of any order to reduce water usage issued pursuant to this subsection. The disposition of all sums collected pursuant to this subsection shall be as provided by law; and

(6) Otherwise implement the Emergency Water Supply Allocation Plan adopted pursuant to subsection b. of this section.

Any order issued by the commissioner pursuant to this subsection shall be based upon fair compensation, reasonable rate relief and just and equitable terms, to be determined after notice and hearing which may occur subsequent to the order and compliance therewith.

d. During the existence of a state of water emergency, the Governor may order the suspension of any laws, rules, regulations, or orders of any department or agency in State Government or within any political subdivision which deal with or affect water and which impede his ability to alleviate or terminate a state of water emergency.

e. Any aggrieved person, upon application to the commissioner, shall be granted a review of whether the continuance of any order issued by the commissioner pursuant to this section is unreasonable in light of then prevailing conditions of emergency,

f. During a state of water emergency the commission may require any other department of other agency within State Government to provide information, assistance, resources, and personnel as shall be necessary to discharge his functions and responsibilities under this act, rules and regulations adopted hereunder, or applicable Federal law and regulations.

g. The powers granted to the Governor and the commissioner under this section shall be in addition to and not in limitation of any emergency powers now or hereafter vested in the Governor, the commissioner, or any other State department or agency pursuant to any other laws; except that, upon declaring a state of energy emergency, the Governor may supersede any other emergency powers.

h. The state of water emergency declared by the governor pursuant to this section shall remain in effect until the Governor declares by a subsequent executive order that the state or water emergency has terminated.

5. The commissioner shall have the power to adopt, enforce, amend or repeal, pursuant to the "Administrative Procedure Act," P. L. 1968, c. 410 (C:52:14B-1) et seq.) rules and regulations to control, conserve, and manage the water supply of the State and the diversions of that water supply to assure the citizens of the State an adequate supply of water under a variety of conditions and to carry out the intent of this act. These rules and regulations may apply throughout the state or in any region thereof and shall provide for the allocation or the reallocation of the waters of the State in such a manner as to provide an adequate quantity and quality of water for the needs of the citizens of the State in the present and in the future and may include, but shall not be limited to" . . . . [text continues]

6. a. The department in developing the permit system established by this act shall: . . . . [text continues]

7. a. Except as provided by section 6 of this act, no person may divert more than 100,000 gallons per day of any waters of the State or construct any building or structure which may require a diversion of water unless he obtains a diversion permit. Prior to issuing these permits, the department shall afford the general public with reasonable notice of permit applications, and with the opportunity to be heard thereon at a public hearing held by the department.

b. Every permit issued pursuant to this section and every water usage certification approved pursuant to section 6 of this act shall be renewed by the department upon the expiration thereof, with any conditions deemed appropriate by the department, for the same quantity of water, except that the department may, after notice and hearing, limit that quantity to the amount currently diverted, subject to contract, or reasonably required for a demonstrated future need.

8. Every permit issued pursuant to this act shall include provisions: [text continues]

9. The Board of Public Utilities shall fix just and reasonable rates for any public water supply system subject to its jurisdiction, as may be necessary for that system to comply with an order issued by the department or the terms and conditions of a permit issued pursuant to this act.

[text continues]

12. No person supplying or proposing to supply water to any other person shall have the power to condemn lands, water or water privileges for any new or additional source of ground or surface water until that person has first submitted to the department an application for approval to divert the source of the water and the department has approved the application subject to such conditions as it may determine to be necessary to protect the public health and welfare.

13. a. Within 180 days of the effective date of this act, the department shall prepare and adopt the New Jersey Statewide Water Supply Plan, which plan shall be revised and updated at least once every 5 years.

b. The plan shall include, but need not be limited to, the following:

(1) An identification of existing Statewide and regional ground and surface water supply sources, both interstate an intrastate, and the current usage thereof;

(2) Projections of Statewide and regional water supply demand for the duration of the plan;

(3) Recommendations for improvements to existing State water supply facilities, the construction of additional State water supply facilities, and for the interconnection or consolidation of existing water supply systems; and

(4) Recommendations for legislative and administrative actions to provide for the maintenance and protection of watershed areas.

c. Prior to adopting this plan, the department shall:

(1) Prepare and make available to all interested persons a proposed plan;

(2) Conduct public meetings in the several geographical areas of the State on the proposed plan; and

(3) Consider the comments made at these meetings, make any revisions to the proposed plan as it deems necessary, and adopt the plan.

14. a. When the department determines that the developed water supply available to a water purveyor is inadequate to service its users with an adequate supply of water under a variety of conditions, the department may order the water purveyor to develop or acquire, within a reasonable period of time, additional water supplies sufficient to provide the service. . . . [text continues]

15. The department may:

a. Perform any and all acts and issue such orders as are necessary to carry out the purposes and requirements of this act;

b. Administer and enforce the provisions of this act and rules, regulations, and orders promulgated, issued or effective hereunder;

c. Present proper identification and then enter upon any land or water for the purpose of making any investigation, examination, or survey contemplated by this act;

d. Subpena and require the attendance of witnesses and the production by them of books and papers pertinent to the investigations and inquiries the department is authorized to make under this act, and examine them and such public records as shall be required in relation thereto;

e. Order the interconnection of public water supply systems, whether in public or private ownership, whenever the department determines that the public interest requires that this interconnection be made, and require the furnishing of water by means of that system to another system, but no order shall be issued before comments have been solicited at a public hearing, notice of which has been published at least 30 days before the hearing, in one newspaper circulating generally in the area served by each involved public water supply system, called for the purpose of soliciting comments on the proposed action;

f. Order any person diverting water to improve or repair its water supply facilities so that water loss is eliminated so far as practicable, safe yield is maintained and the drinking water quality standards adopted pursuant to the "Safe Drinking Water Act," P. L. 1977, c. 224 (C.58:12A-1 et seq.) are met;

g. Enter into agreements, contracts, or cooperative arrangements under such terms and conditions as the department deems appropriate with other states, other State agencies, Federal agencies, municipalities, counties, education institutions, investor owned water companies, municipal utilities authorities, or other organizations or persons;

h. Receive financial and technical assistance from the Federal Government and other public or private agencies.

i. Participate in related programs of the Federal Government, other states, interstate agencies, or other public or private agencies or organizations;

j. Establish adequate fiscal controls and accounting procedures to assure proper disbursement of and accounting for funds appropriated or otherwise provided for the purpose of carrying out the provisions of this act;

k. Delegate those responsibilities and duties to personnel of the department as deemed appropriate for the purpose of administering the requirements of this act;

l. Combine permits issued pursuant to this act with permits issued pursuant to any other act whatsoever that action would improve the administration of both acts;

m. Evaluate and determine the adequacy of ground and surface water supplies and develop methods to prevent aquifer recharge areas.

16. If any person violates any of the provisions of this act or any rule, regulation or order adopted or issued pursuant to the provisions of this act, the department may institute a civil action in a court of competent jurisdiction for injunctive relief to enforce said provisions and to prohibit and prevent that violation and the court may proceed in the action in a summary manner. . . . [text continues]

17. All of the powers, duties and functions of the Water Policy and Supply Council are transferred to the Department of Environmental Protection. Whenever the term "Water Policy and Supply Council" occurs or any reference is made thereto in any law, contract or document, administrative or judicial determination, or otherwise, it shall be deemed to mean or refer to the Department of Environmental Protection.

18. a. There is established in the department a Water Supply Advisory Council which shall consist of seven members appointed by the Governor with the advice and consent of the Senate. . . . [text continues]

19. The council shall:

a. Advise the department concerning the preparation, adoption and revision of the New Jersey Statewide Water Supply Plan;

b. Advise the department concerning the implementation of the permit program required by this act;

c. Advise the New Jersey Water Supply Authority concerning the construction, maintenance and operation of State water supply facilities and projects; and

d. Advise the department concerning the preparation and implementation of the Emergency Water Supply Allocation Plan.

20. The council may:

a. Review any matter relating to water supply and to transmit such recommendations thereon to the department or to the New Jersey Water Supply Authority as it may deem appropriate;

b. Hold public meetings or hearings within this State on any matter related to water supply; and

c. Call to its assistance and avail itself of the services of such employees of any State, county or municipal department, board, commission or agency as may be required and made available for such purposes.

[text continues]

25. Any rules and regulations promulgated pursuant to any statutes repealed by this act shall remain in effect until superseded by rules and regulations promulgated pursuant to this act. However, all such rules and regulations shall be reviewed and revised where necessary by the department within 2 years of the enactment of this act.

26. The following are repealed: [text continues]

27. This act shall take effect immediately.

NEW YORK

1984 Session Laws, Chapter 509
Environment--Water Resources Management Strategy

An ACT to amend the environmental conservation law, in relation to providing for a water resources management strategy.

Approved and effective July 24, 1984.

The people of the State of New York, represented in Senate and Assembly, do enact as follows:

Section 1. Article fifteen of the environmental conservation law is S 1 amended by adding a new title twenty-nine to read as follows:

TITLE 29

WATER RESOURCES MANAGEMENT STRATEGY

S15-2901. Water resources planning council; organization.

There is hereby established within the department of environmental conservation a water resources planning council. It shall consist of fifteen members, including the commissioners of agriculture and markets commerce, energy, environmental conservation, health, transportation, the chairman of the public service commission, secretary of state and seven members to be appointed by the governor including at least one member who shall have expertise in the science of water resources planning and at least one member selected from a list proposed by public interest or environmental citizens organizations. these seven members shall serve terms of four years each. Two of the members shall be appointed upon the recommendation of the majority leader of the senate and two of the members shall be appointed upon the recommendation of the speaker of the assembly. The governor shall select a chairman from among the members. Meetings of the council shall be called by the chairman. Members shall receive reimbursement for expenses.

[text continues]

S15-2907. Water resources management strategy.

Not later than January first, nineteen hundred eighty-seven, the department of environmental conservation, with the participation of the department of health and whenever possible, regional planning and development boards, shall develop and submit a complete statewide water resources management strategy to the water resources planning council for its review and adoption. This strategy shall be composed of substate water resources management strategies which recognize the natural boundaries of the water resource basins, watersheds, and aquifers and existing significant deficiencies of water supply, and which organize these in the most practical and manageable manner. Each substate management strategy shall analyze the present and future demographic, natural resource, economic development, water quality, and conservation requirements of public and private water systems and develop regional management strategies to meet the water resources requirements of residential, agricultural, industrial and commercial users as well as assure the highest possible quality and quantity of these resources.

PENNSYLVANIA

Section 1904-A. Waters.

Section 1904-a. Waters.--The Department of Environmental Resources shall have the power and its duty shall be:

(1) To study, consider, and determine upon a public policy with regard to the conservation, marketing, and equitable distribution of the water and power to be derived from the utilization of the water resources of the Commonwealth, to the restoration, development, and improvement of transportation by water, to the supply of water and power for municipal, domestic, and industrial use, and to the conservation of water resources by the aid of forestation;

(2) To investigate or examine dams, walls, wing walls, wharves, embankments, abutments, projections, bridges, and other water obstructions. . . . [text continues]

(3) To collect such information relative to the existing conditions of the water resources of the State as, in the opinion of the department, shall be necessary for the utilization of waters, and for the conservation, purification, development, and equitable distribution of water and water power resources, and in particular, for the use of such citizens and communities as may be in need of extended facilities for these purposes;

(4) To establish and maintain gauging stations on rivers and their tributaries;

(5) To issue bulletins, during freshet and flood conditions, forecasting gauge heights, and the times thereof;

(6) To maintain a complete inventory of all the water resources of the Commonwealth; collect all pertinent data, facts, and information in connection therewith; classify, tabulate, record, and preserve the same; and, upon the basis thereof, determine, the points at which storage reservoirs may be constructed for flood control, municipal and domestic supply, hydraulic and hydroelectric power, steam raising, steam condensation, navigation, and other utilization; and generally to devise all possible ways and means to conserve and develop the water supply and water resources of the Commonwealth for the use of the people thereof;

(7) To construct, maintain, and operate works for water storage, flood control, channel improvement, or other hydraulic purposes;

(8) To acquire by purchase, lease, gift or condemnation, with the approval of the Governor, such land, buildings and appurtenances thereto, as in the judgment of the department, may be necessary for the construction, maintenance, improvement or development of any port or harbor in this Commonwealth.

(9) To promulgate rules and regulations to protect, manage and regulate the recreational use of designated whitewater zones; license whitewater outfitters operating within designated whitewater zones; and establish fees, royalties and charges for licenses and for using public lands, waters and facilities.

[text continues]

((9) added July 11, 1985, P.L.232, No. 57)
(1994-A added Dec. 3, 1070, P.L.834, No. 275)

APPENDIX C

TOTAL WATER WITHDRAWLS AND PUBLIC SUPPLY WITHDRAWALS BY STATE

State	Total water withdrawals (mgd*)	State rank	Withdrawals for public supply		State rank
			Amount (mgd*)	Percent (%)	
Alabama	8,590	14	615	7%	19
Alaska	406	48	76	19	49
Arizona	6,420	21	618	10	18
Arkansas	5,910	26	257	4	36
California	37,400	1	5,310	14	1
Colorado	13,500	6	737	5	14
Connecticut	1,200	42	362	30	30
Delaware	139	50	77	55	48
Florida	6,280	22	1,680	27	5
Georgia	5,370	29	836	16	11
Hawaii	1,270	41	204	16	40
Idaho	22,300	2	212	1	39
Illinois	14,400	4	1,780	12	4
Indiana	9,360	11	575	6	22
Iowa	2,760	36	350	13	32
Kansas	5,670	27	316	6	33
Kentucky	4,200	31	404	10	28
Louisiana	9,900	10	628	6	16
Maine	849	44	108	13	44
Maryland**	1,540	39	771	50	12
Massachusetts	6,260	23	767	12	13
Michigan	11,400	8	1,250	11	8
Minnesota	2,840	35	473	17	25
Mississippi	2,320	37	312	13	34
Missouri	6,110	25	645	11	15
Montana	8,650	13	158	2	41
Nebraska	10,000	9	248	2	37
Nevada	3,740	33	288	8	35
New Hampshire	687	45	89	13	46
New Jersey	2,230	38	961	43	9
New Mexico	3,290	34	226	7	38
New York	9,050	12	2,860	32	3
North Carolina	7,880	16	595	8	20
North Dakota	1,170	43	69	6	50
Ohio	12,700	7	1,420	11	7

State	Total water withdrawals (mgd*)	State rank	Withdrawals for public supply Amount (mgd*)	Percent (%)	State rank
Oklahoma	1,280	40	521	41	24
Oregon	6,540	20	416	6	27
Pennsylvania	14,300	5	1,600	11	6
Rhode Island	147	49	116	79	43
South Carolina	6,810	18	359	5	31
South Dakota	674	46	80	12	47
Tennessee	8,450	15	627	7	17
Texas	20,100	3	2,990	15	2
Utah	4,180	32	447	11	26
Vermont	126	51	53	42	51
Virginia	4,870	30	579	12	21
Washington	7,000	17	955	14	10
West Virginia	5,440	28	151	3	42
Wisconsin	6,740	19	576	9	23
Wyoming	6,200	24	98	2	45
Puerto Rico	598	47	391	65	29
Virgin Islands	7	52	5	63	52
Total	338,000	--	36,500	--	--

Source: Jerry E. Carr, Edith B. Chase, Richard W. Paulson, and David W. Moody, Compilers *National Water Summary 1987--Hydrologic Events and Water Supply and Use* (Washington, DC: U.S. Geological Survey, Water-Supply Paper 2350, 1990), 126-27.

* Million gallons per day.
** Includes District of Columbia.

APPENDIX D

WATER RESOURCE MANAGEMENT AND PLANNING ISSUES BY STATE

State	Availability	Water Quality	Hydrologic Hazards/Land-use	Institutional/Management
Alabama	ground	point and nonpoint sources of pollution(s), hazardous waste (s&g), saline-water intrusion(g)	sinkholes	none specified
Alaska	surface ground	pollution(s), landfills and septic systems(g), chemical constituents(g), eutrophica-tion, acidic precipitation	volcanoes, ice-jam and glacial-outburst flooding, erosion and sedimentation, resource development (hydroelectric power and mineral extraction)	water laws water allocation
Arizona	surface ground	Colorado River salinity(s) bacteria(s&g), nonpoint sources of pollution(g), hazardous-waste sites and landfills(g), natural constituents(g)	subsidence, storm-water management, resource development (metal mining), safety of dams, flooding	water allocation, water resources manage-ment (s&g), water laws, treaties and compacts
Arkansas	surface ground	point and nonpoint sources of pollution(s), pesticides(s), saline-water intrusion(g), hazardous-waste sites and landfills(g)	resource development (coal mining), flooding, wetlands	water laws
California	surface ground	irrigation return water(s&g), saline-water intrusion(g), hazardous-waste sites(g), pesticides(g)	flooding, subsidence, wet-lands and estuaries	water laws, interbasin transfers, treaties and compacts
Colorado	ground	Colorado River salinity(s), hazardous-waste sites(s&g), landfills(g), national defense facilities(g), eutrophication	resource development (mineral extraction and processing, oil shale), flooding	water allocation, treaties and compacts
Connecticut	surface ground	point and nonpoint sources of pollution(s), public and domestic supplies(s&g), land disposal of wastes(g), eutrophication, acidic precipitation	flooding	interbasin transfers, improved coordination of water-resources planning and management
Delaware	ground	hazardous waste sites and landfills(g), saline-water intrusion(g), nitrate(g), eutrophication	flooding	water laws

State	Availability	Water Quality	Hydrologic Hazards/Land-use	Institutional/Management
Florida	ground surface	point and nonpoint sources of pollution(s), saline-water intrusion(s&g), bacteria(g), hazardous-waste sites(g), wastewater(g), landfills(g), pesticides(g), acidic precipitation	sinkholes, resource development (phosphate mining), wetlands and estuaries	river-system management
Georgia	surface ground	point and nonpoint sources of pollution(s), saline-water intrusion(g), pesticides(g), natural substances(g), eutrophication, bottom sediments	sinkholes, coastal-zone utilization, flooding	interbasin transfers, interstate ground-water issues, river system management, water laws and water allocation
Hawaii	surface ground	point and nonpoint sources of pollution(s&g), saline-water intrusion(g), wastewater injection(g)	flooding	water laws
Idaho	surface ground	point and nonpoint sources of pollution(s&g), hazardous -waste sites(g)	flooding, landslides, wet soils and drainage	water laws, water-resources management(g)
Illinois	surface ground	point and nonpoint sources of pollution(s&g), hazardous waste sites(g), lakes(s), public supplies(g)	flooding, rising groundwater levels, erosion and sedimentation, wetlands	development of policy and management structure flood-plain management, water-quality standards
Indiana	surface ground	point sources of pollution (s), hazardous-waste sites (g), eutrophication, acidic precipitation	flooding (streams and lakes), resource development (coal mining)	water laws
Iowa	surface ground	hazardous-waste sites(s&g), point sources of pollution (g), nonpoint sources of pollution(s&g), nitrate(s&g), radium(g)	none specified	water laws, water allocation, river-system management
Kansas	surface ground	Nonpoint sources of pollution (s), saline-water intrusion (s&g), hazardous-waste sites(s&g), trihalomethane(s)	resource development (lead-zinc mining, coal mining), flooding, erosion and sedimentation	treaties and compacts, water allocation, financing the infrastructure, river-system management

State	Availability	Water Quality	Hydrologic Hazards/Land-use	Institutional/Management
Kentucky	surface	radioactive-waste site(g), point and nonpoint sources of pollution(s), viruses(g), landfills(g), hazardous-waste sites(g), acidic precipitation	sinkholes, rising groundwater levels, resource development (mineral production), flooding, landslides	none specified
Louisiana	surface ground	point and nonpoint sources of pollution(s), saline-water intrusion (s&g), hazardous waste sites and landfills(g), potential radioactive wastes(g)	resource development (lignite mining, flooding, erosion and sedimentation (coastal zone)	river-system management, locks and dams, treaties and compacts
Maine	surface ground	hazardous-waste sites(s&g), point and nonpoint sources of pollution(g), radon(g), acidic precipitation	resource development (mining, hydroelectric power) flooding, erosion and sedimentation	water laws
Maryland and District of Columbia	ground	point and nonpoint sources of pollution, Chesapeake Bay(s), hazardous-waste sites and landfills(g), nitrate(g), acidic precipitation	erosion and sedimentation (coastal zone), resource development (coal mining)	water laws, river-system management
Massachusetts	surface ground	municipal sewage(s), hazardous-waste sites(s&g), highway deicing salts(s&g), point sources of pollution (g), saline-water intrusion (g), bottom sediments, acidic precipitation	rising groundwater levels	interbasin transfers, water laws, river-system management
Michigan	surface ground	hazardous waste(s), point and nonpoint sources of pollution (s&g), nitrate(g), eutrophication, bottom sediments	flooding, erosion and sedimentation (coastal zone)	none specified
Minnesota	ground	municipal sewage(s), natural salinity(g), hazardous-waste sites and landfills(g), nitrate(g) eutrophication(g), acidic precipitation	flooding (streams and lakes), erosion and sedimentation, resource development (peat mining)	agency coordination
Mississippi	surface ground	saline-water intrusion(g), radioactive wastes(g), point and nonpoint sources of pollution(g), acidic precipitation	flooding	river-system management, water laws, water allocation

State	Availability	Water Quality	Hydrologic Hazards/Land-use	Institutional/Management
Missouri	surface ground	dioxin(s&g), saline-water intrusion(g), natural radio-activity(g), septic systems (s&g), point and nonpoint sources of pollution(s), temperature(s), hazardous-waste sites(g)	sinkholes, erosion and sedimentation, resource development (coal mining, lead-zinc mining), flooding, safety of dams	river-system management
Montana	surface ground	hazardous-waste sites(g), settling ponds(g), land-fills(g)	erosion and sedimentation, resource development (coal mining, metal mining, oil field brines, hydroelectric power), saline seeps	water allocation, treaties and compacts, river-system management, water-resources manage-ment(g), water-use information
Nebraska	surface ground	point and nonpoint sources of pollution(g)	flooding, erosion, wetlands, erosion and sedimentation	water laws, water allocation
Nevada	surface ground	point and nonpoint sources of pollution(s), radioactive wastes and chemicals(g)	subsidence, flooding and debris flows	water allocation, treaties and compacts
New Hampshire	surface ground	hazardous-waste sites(s&g), surface water quality (lakes and streams), acidic preci-pitation, radon and arsenic(g)	resource development (hydro-electric power)	water allocation
New Jersey	surface ground	point and nonpoint sources of pollution(s), estuaries(s), saline-water intrusion(g), acidic precipitation, hazardous-waste sites(s&g)	flooding, safety of dams	water laws, water allocation, financing the infrastructure, river-system management
New Mexico	surface ground	hazardous-waste sites(g), nitrate(g), radioactive wastes(g)	none specified	water-resources management, treaties and compacts, Indian water rights
New York	surface ground	bacteria(s), saline-water intrusion(g), radioactive-waste sites(g), eutrophica-tion acidic precipitation, point and nonpoint sources of pollution(s&g), petroleum leaks and spills(g), hazardous waste sites(g)	rising groundwater levels, wetlands, resource development (salt mining), flooding	treaties and compacts, water allocation, financing the infra-structure

State	Availability	Water Quality	Hydrologic Hazards/Land-use	Institutional/Management
North Carolina	surface ground	point and nonpoint sources of pollution(s), saline-water intrusion(g), eutrophication, hazardous waste sites and landfills(g), acidic precipitation	resource development (non-metal mining), coastal zone utilization, flooding, erosion and sedimentation	interbasin transfers
North Dakota	surface ground	point sources of pollution (s), arsenic(g), eutrophication, natural salinity(s&g), acidic precipitation	flooding, wetlands, resource development (lignite mining, oil and gas production, uranium mining)	water allocation, treaties and compacts
Ohio	surface ground	hazardous-waste sites(g), municipal sewage(s), public and domestic supplies (s&g), acidic precipitation	erosion and sedimentation, resource development (coal mining, oil and gas production), flooding	none specified
Oklahoma	surface ground	point and nonpoint sources of pollution(s), natural salinity(s), sulfate(s), hazardous waste site(g)	resource development (lead-zinc mining, coal mining, oil and gas production), flooding	interbasin transfers, financing the infrastructure
Oregon	surface ground	aquatic-habitat degradation (s), estuaries(s), hazardous-waste sites(g), nitrate(g), acidic precipitation, landfills and lagoons(g), natural salinity(g)	volcanoes (including mudflows), flooding (debris flows, streams)	none specified
Pennsylvania	none specified	agricultural runoff(s&g), hazardous-waste sites(g), industrial wastes(g), acidic precipitation	storm-water management, resource development (coal mining, oil and gas production)	river-system management, water-resources management(g)
Puerto Rico and U.S. Virgin Islands	surface ground	point sources of pollution (s&g), nonpoint sources of pollution(s), saline-water intrusion(s&g)	flooding, sinkholes, erosion and sedimentation (coastal zone, reservoirs), wetlands	water laws, water allocation, financing the infrastructure, river-system management
Rhode Island	surface ground	point and nonpoint sources of pollution(s), hazardous-waste sites(s&g), nitrate(g)	none specified	river-system management, water-resources management(g)

State	Availability	Water Quality	Hydrologic Hazards/Land-use	Institutional/Management
South Carolina	surface ground	hazardous-waste sites(s), point and nonpoint sources of pollution(s&g), saline-water intrusion(g), natural constituents(g), radioactive-waste sites(g)	coastal-zone utilization, sinkholes, aquatic weeds	water laws
South Dakota	surface ground	eutrophication, acidic precipitation, point and non-point sources of pollution (s), landfills(g), natural constituents and gasoline(g)	resource development (metal mining), flooding, erosion and sedimentation, wetlands	water allocation, water-resources planning and management, water laws, river-system management
Tennessee	surface	point and nonpoint sources of pollution(s), radioactive-waste sites(s&g), hazardous-waste sites(g), Tennessee Valley reservoirs	sinkholes, resource development (coal mining), flooding	none specified
Texas	surface ground	point and nonpoint sources of pollution (s&g), natural salinity(s), saline-water intrusion(g), hazardous waste sites(g), eutrophication	subsidence, resource development (lignite mining, oil and gas production), flooding	treaties and compacts, water allocation, water-quality protection
Utah	surface ground	point and nonpoint sources of pollution(s), Colorado River salinity(s), hazardous-waste sites(g), acidic precipitation	flooding, landslides, resource development (energy minerals)	treaties and compacts, water allocation
Vermont	none specified	hazardous waste sites and landfills (s&g), eutrophication, water quality(s&g), acidic precipitation	flooding, resource development (hydroelectric power, Uplands water withdrawals)	water allocation
Virginia	surface ground	Chesapeake Bay(s), hazardous waste sites(s&g), bacteria and chemical constituents(g), radioactivity(g), eutrophication, bottom sediments	flooding, resource development (coal mining), safety of dams	water allocation, river-system management

State	Availability	Water Quality	Hydrologic Hazards/Land-use	Institutional/Management
Washington	surface ground	saline-water intrusion(g), radioactive wastes(g), hazardous waste sites(g), nitrate(g), natural salinity (g), bottom sediments, acidic precipitation, landfills(g), eutrophication	flooding, volcanoes, resource development (fisheries)	river-system management, treaties and compacts,
West Virginia	surface	point and nonpoint sources of pollution(s), hazardous-waste sites(s&g), acidic precipitation, fecal coliform bacteria(s)	safety of dams, resource development (coal mining), flooding	hydroelectric power,
Wisconsin	ground	point and nonpoint sources of pollution(s&g), acidic precipitation, hazardous waste sites(g)	wetlands, erosion and sedimentation, flooding	water laws, inland lake management and protection
Wyoming	surface	Upper Colorado River salinity (s), eutrophication, acidic precipitation, point and nonpoint sources of pollution(g)	flooding, wet soils, drainage and wetlands, resource development (energy minerals development),	Indian water rights, water-resources management(g), water-resources management (municipal supplies), water allocation, treaties and compacts, river-system management

Source: Authors' construct from U.S. Geological Survey, National Water Summary 1983--Hydrologic Events and Issues (Washington, DC: U.S. Geological Survey, 1984). Although the analysis was prepared in 1983, contacts at the Geological Survey indicated that it remains representative of contemporary water issues in the states.

s = surface water.
g = groundwater.

APPENDIX E

1991 NRRI SURVEY ON STATE WATER RESOURCE PLANNING

Alabama

Water planning is coordinated by the Department of Economic and Community Affairs. Regional commissions prepare studies and the state participates in federal water resource planning. There has been a heightened awareness of water issues in response to recent drought conditions. In late 1990, a water resources study commission, aided by a technical advisory committee representing fifteen state agencies, submitted a policy report to the governor. Among other issues, it addresses the need for county planning coordination and cost-based ratemaking at the local level. A legislative package may include state comprehensive water planning.

Contact: Bob Grasser, Water Resources Coordinator, Planning and Economic Development Division, Alabama Department of Economic and Community Affairs, (205) 284-8735.

Alaska*

Water resource planning in Alaska is neither comprehensive nor well coordinated. Much of the responsibility for water resource planning and administration rests with the departments of Natural Resources (DNR) and Environmental Conservation (DEC). Although there is no statewide plan, water resources are affected by state policies and planning in other areas, such as land use. A number of programs prepare and analyze water supply and quality data. Recent water quality planning programs address groundwater quality protection and nonpoint source pollution control assessment.

Contact: Mary Lu Harle, Water Resources Manager, Alaska Department of Natural Resources, Division of Land and Water Management, (907) 762-2680.

Arizona*

Water planning is conducted by the Department of Water Resources. The state has conducted water resource planning since the 1940s. The last state water plan was conducted in the late 1970s. Arizona's Groundwater Management Code, passed in 1980, provides a comprehensive basis for statewide water management and planning. Regional plans are prepared for four areas. A statewide water resource planning initiative is underway, guided by a detailed scope of work and with public review expected in 1991.

Contact: Steven L. Olson, Project Manager, Arizona State Water Resources Planning, Department of Water Resources, (602) 542-1546.

Arkansas

Comprehensive water supply planning is conducted by the state Soil and Water Conservation Commission, pursuant to Arkansas Act 217 of 1969, as amended. The current state plan was a result of the Commission's 1986 revisions pursuant to Arkansas Act 1051 of 1985. The current Arkansas Water Plan is prepared on a basin approach, inclusive of eight basin reports covering the entire state. The reports inventory the water resources of the basins, identify current and future water problems within the basins, and recommend actions regarding problem areas and improvements.

Contact: Randy Young, Director, Arkansas Soil and Water Conservation Commission, (501) 682-1611.

California*

California has long been active in water resource planning, marked by 1947 legislation initiating a statewide water resources investigation, the preparation of the *California Water Plan* in 1957, and periodic planning updates and bulletins since. In 1988, the Department of Water Resources published *California Water: Looking to the Future,* including a statistical appendix. It reports on water conditions, uses, and policies. The state's evolving and increasingly complex water policy could be dramatically affected by implementation of a "public use doctrine," by which historic water rights decisions could be revised by regulatory bodies and the courts in light of new conditions.

Contact: Warren J. Cole, Principal Engineer, W.R., Department of Water Resources, Division of Planning, (916) 445-9965.

Colorado*

Colorado does not have a state water plan, which many view as the antithesis to the state's reliance on the prior appropriation doctrine. The state relies on a system of constitutional and statutory law, policies, and programs and leaves decisions concerning the use, development, and allocation of water to individual appropriators and the marketplace. The state's seven divisions based on river systems prepare annual reports and hold water court. A state engineering office is responsible for administering state water law, including issuance of well permits.

Contact: David W. Walker Deputy Director, Colorado Conservation Board, (303) 866-3441 or Division of Water Resources, Colorado Department of Natural Resources, (303) 866-3581.

Connecticut

Water resources planning is not conducted formally on a statewide basis in Connecticut. By law, water utilities are required to develop and submit to the state, for approval, their own water supply plans. Further, state law requires water utilities to form Regional Cooperation Authorities by which coordinated water management planning is to be conducted within specified water management regions.

Contact: Carolyn Hughes, Supervising Environmental Analyst, Department of Environmental Protection, (203) 566-5125.

Delaware

The Department of Natural Resources and Environmental Control (DNREC) is responsible for Delaware's Comprehensive Water Resources Management Planning Program. The DNREC was charged with this responsibility by Executive Order 97 of 1981. The same Executive Order established the Comprehensive Water Resources Management Committee to advise the DNREC in developing water management recommendations. The most recent water supply plan was completed in 1983, after a two-year planning process. The planning process was carried forward by the advisory Water Resources Management Committee in conjunction with the DNREC. Water conservation and water allocation management are important components of the comprehensive plan. The water management program is conducted pursuant to the DNREC's general authority to oversee the utilization of natural resources in the state of Delaware.

Contact: Stewart Lovell, Water Supply Branch, Department of Natural Resources and Environmental Control, (302) 739-4793.

Florida

Pursuant to the State Water Use Plan Law of 1986, the Department of Environmental Regulation (DER) is charged with the authority to draft the state water resource plan. Rather than write such a plan, the DER - by regulation - has shifted the planning focus to overseeing the development of regional water resources plans within five Regional Water Management Districts. These regional districts are responsible for allocation of water through the assignment of consumptive use permits. Further, the regional districts are required to designate areas that have water supply problems which have become critical or are anticipated to become critical within the next twenty years, and integrate this information into their district water plan. The regional districts were required to begin their respective planning processes in 1989, and must complete the regional plans by 1994. The regional districts are required to submit proposed plans to the DER for review. The DER has supervisory authority to review any regional rules as to their consistency with state water policy.

Contact: Bart Bibbler, Assistant Bureau Chief, Bureau of Surface Water Management, Department of Environmental Regulation, (904) 488-6221.

Georgia

The Georgia Water Resources Management Strategy is administered and implemented by the Environmental Protection Division of the Department of Natural Resources. The statewide five-year plan includes sections regarding water conservation, drought management, water use permitting, and basin-wide water availability and use reports. Altogether, planning was initiated with the first five-year plan in 1986. The most recent plan was completed in 1989.

Contact: Napoleon Caldwell, Environmental Protection Division, Department of Natural Resources, (404) 656-3094.

Hawaii*

Hawaii enacted a State Water Code in 1987 resulting in a comprehensive seven-volume state water resource plan completed in June 1990. The Water Code, along with detailed administrative rules, has several major provisions: the creation of a central administrative authority to manage water resources, the statewide registration of all water sources and the certification and reporting of all water uses, the selective state regulation of water development and use, the preparation of resource protection and development plans, the establishment of an instream use protection program, and the development of a mechanism to resolve water disputes.

Contact: William W. Pay, Commission on Water Resources Management, Department of Land and Natural Resources, (808) 548-6550.

Idaho*

The first version of the Idaho State Water Plan was adopted in 1976 following an elaborate effort to provide for public involvement. The plan is a policy document that has been updated and readopted in 1982 and 1986. In 1988 the state legislature provided new direction and authorities. A comprehensive state water plan based on river basins or other geographic areas is to be developed that must examine a lengthy list of river and other water resources related activities. Provisions for a state protected rivers system are also incorporated in the 1988 legislation. Some basin plans have been completed, with more underway on a priority basis.

Contact: Wayne T. Haas, Administrator, Planning and Policy Division, Idaho Department of Water Resource, (208) 327-7910.

Illinois

Water resource planning is conducted by the state Department of Transportation. The state EPA also monitors and conducts assessments of systems. State water plans were prepared in 1967 and 1984. The 1984 *Illinois State Water Plan* is the product of an interagency task force and emphasizes problem identification and general policy recommendations. Today, the state does not rely on a single planning document. Recent studies are more empirical in nature and have focused on projections of future demand and an assessment of surface water supply adequacy for specific public supply systems.

Contact: Gary R. Clark, P.E., Chief of Planning and Research, Division of Water Resources, Illinois Department of Transportation, (217) 782-3488.

Indiana

Comprehensive water resource planning is not conducted on a statewide or regional basis in the state of Indiana. Currently, the Department of Natural Resources (DNR) is working on a water resource assessment and availability study for twelve Water Resource Management Basins.

Contact: Jim Hebenstreit, Assistant Director, Division of Water, Department of Natural Resources, (317) 232-4163.

Iowa

Iowa has a state water supply plan and a state groundwater quality plan. Supply planning was initiated pursuant to state law in 1983 and the most recent plan was completed in 1985. Plans are to be completed every five years. The Department of Natural Resources (DNR) is responsible for conducting statewide planning. The state plan developed by the DNR is by law reviewed and approved by the state Environmental Protection Commission and the state legislature.

Contact: Dennis Alt, Supervisor, Water Supply Section, Department of Natural Resources, (515) 281-8998.

Kansas*

The Kansas Water Office formulates a comprehensive water plan on an ongoing basis. The purpose of *Kansas Water Plan* is to make recommendations on water policy and state programs affecting each of the state's twelve major river basins. Since the beginning of this process, in 1985, most policy recommendations in the plan have been implemented. In 1989, Kansas established a State Water Plan Fund that will generate approximately $16 million annually to implement the state water plan. The state plans continue to fully utilize the water planning process.

Contact: Clark Duffy, Assistant Director, Kansas Water Office, (913) 296-3185.

Kentucky

Historically, water supply planning in Kentucky took place at the local level through very active area development districts. Under 1990 Water Supply Planning legislation (HB419; KRS 151.110 et seq.) long-range water supply planning is mandated for counties or groups of counties. Detailed administrative regulations for implementing the law are currently under review and the state plans to prepare a planning guidebook. All water suppliers, regardless of ownership structure, will be affected. The state also has developed a Water Shortage Response Plan, which emphasizes local responsibilities.

Contact: Pamla A. Woods, Supervisor, Water Quantity Management, Division of Water, Kentucky Department for Environmental Protection, (502) 564-3410.

Louisiana

A separate and comprehensive water policy does not exist in Louisiana. Water policy statements are found primarily in the Constitution and in the Revised Statutes where policy statements often precede the description of powers and duties of the various water resources agencies and programs. The Louisiana Water

Resources Study Commission has been charged with studying the water policy of Louisiana and recommending changes or revisions. Before arriving at water policy recommendations, an evaluation was made of the purpose of water policy, the existing water policy in Louisiana, water policies of other states, and needed water policies based on water resources concerns expressed by the various agencies and interests represented on the Water Resources Study Commission.

Contact: Bo Lourchi, Chief, Water Resources Section, Department of Transportation and Development, (504) 379-1478.

Maine

Comprehensive water supply planning is not conducted on a statewide or regional basis in Maine.

Contact: David Rocque, State Soil Scientist, Soil and Water Conservation Commission, Department of Agriculture, Food, and Rural Resources, (207) 289-2666.

Maryland

Water supply planning is performed on a county basis through County Comprehensive Plans. The plans entail forecasting future water needs and supplies by each county, and are reviewed by the state Department of Environment. Moreover, new system construction is required to be included in the county water plans.

Contact: Shantini Senanayake, Engineer, Department of Environment, (301) 631-3792.

Massachusetts

Water supply planning is conducted by the Massachusetts Water Resources Commission, pursuant to the commission's enabling legislation. The most recent planning process began in 1979 according to regulations promulgated by the Commission. The regulations provide for a state river basin planning process and a local planning process which feeds into the state planning process. The Office of Water Resources, Department of Environmental Management acts as the staff of the Water Resources Commission integrating the separate river basin plans.

Contact: William Bones, Water Resources Planner, Office of Water Resources, Department of Environmental Management, (617) 727-3267, Ext. 523.

Michigan

Comprehensive water supply planning is not conducted on a statewide or regional basis in Michigan.

Contact: Tim Benton, District Engineer, Water Supply Division, Department of Health, (517) 335-9216.

Minnesota

The Minnesota Environmental Quality Board, which includes citizen members and the heads of various other state agencies, was charged with the responsibility of developing the Minnesota Water Plan by Minnesota Statutes, Section 103B.151. This most recent plan was to be completed by November 1990. The previous plan was developed by the Minnesota Water Planning Board in 1979. Plan recommendations focus on integrating water management within the state, resource protection and conservation, and management of water's interconnections with land use decisions and other aspects of the environment.

Contact: Jim Japs, State Coordinator, Water Appropriation Program, Division of Waters, (612) 296-4800.

Mississippi

The Mississippi Water Planning Task Force, which operates in conjunction with the Department of Environmental Quality (DEQ), is in the process of completing the first phase of a statewide water resource plan. Water resource planning was mandated by HB 762 of 1985. This law directed the DEQ to prepare a State Water Management Plan and establish the mechanisms to create a state water data base. The Water Planning Task Force (appointed by the Governor) was established by Executive Order 600 of 1988, to conduct the water management planning process. As a result of funding availability, the planning process did not begin until 1990. The planning process will occur in six phases. The first phase is to include a set of planning guidelines, and will be completed during 1991. Subsequent phases will include evaluations of the present status of water resources, present utilization of water, and projections of future water resource availability and water usage.

Contact: Keith Harkins, Task Force Administrator, Mississippi Water Resources Planning Task Force, Department of Environmental Quality, (601) 961-5260.

Missouri

A comprehensive statewide water supply plan is currently not in place, though a water supply plan is in the early stages of development. Pursuant to the Missouri Water Resource Law of 1989, the Department of Natural Resources (DNR) is responsible for the development and maintenance of a long range statewide program for the use of surface water and groundwater resources in the state of Missouri. The planning process will also include establishing an interagency task force to work on the water resource plan in conjunction with the DNR.

Contact: Jerry Vineyard, Director, State Water Plan, Department of Natural Resources, (314) 364-1752.

Montana

The state is attempting to shift from litigation to collaboration and consensus building. The mission of the state water planning process begun in 1988 is to solve statewide and basin-specific water management issues in a cost-effective and efficient manner. The water plan itself uses the three-ring-binder approach with sections addressing specific problems, policies, and recommendations that can be updated as needed. The Department of Natural Resources and Conservation is the lead planning agency and has adopted a two-year planning cycle to facilitate analysis.

Contact: Richard Moy, Chief, Water Management Bureau, Water Resource Division, Department of Natural Resources and Conservation, (406) 443-5435.

Nebraska*

Natural Resources Districts at the river-basin level prepare one-year and ten-year plans and the state's Natural Resources Commission is responsible for statewide planning. The first comprehensive planning effort was an inventory prepared by the State Planning Board in 1936. A state water plan was mandated by the legislature and completed in 1971. The current State Water Planning and Review Process grew out of agency recommendations and was statutorily approved in 1981. It is an ongoing interagency process that is not directed toward the development of a final planning document. The analysis of water policy issues as they arise is emphasized.

Contact: Terrence L. Kubicek, Deputy Director/Chief, Planning Division, Nebraska Natural Resources Commission, (402) 471-3945.

Nevada*

Nevada's arid climate, limited water resources, and growing water demand have intensified the competition for water as well as the state's interest in effective water-use management. The state's ground and surface water resources are managed by the State Engineer under the Department of Conservation and Natural Resources. Various entities in the state have an interest in water planning and the integration initiative now underway is the first of its kind. In 1991, the Division of Water Planning issued a draft of a statewide drought plan and a statewide water resource plan was expected later in the year.

Contact: Everett A. Jesse, P.E., State Water Planner, Division of Water Planning, (702) 687-4380.

New Hampshire

Water planning is conducted by the Water Resources Division, Department of Environmental Services, pursuant to a 1983 state law. The statewide plan was completed in 1984. Since the statewide plan was completed, a groundwater strategy and other various program documents have been developed but not fully integrated into the statewide water resources plan.

Contact: Ken Stern, Administrator, Water Management Bureau, Department of Environmental Services, (603) 271-3406.

New Jersey

Water resource planning and management in New Jersey is comprehensive with regard to both long-term and emergency issues. The Water Supply Management Act of 1981 provided for preparation of a Statewide Water Supply Master Plan and set forth the planning responsibilities of the Department of Environmental Protection. Unaccounted-for water, conservation, system rehabilitation, system pressure and storage, interconnections, and critical supply areas are addressed in detail in the administrative rules implementing the act. The state also has a Drought Emergency plan and documentation of drought responses is extensive. The Delaware River Basin Commission is an important regional force in planning and consensus building.

Contact: Paul Schorr, Division of Water Resources, New Jersey Department of Environmental Protection, (609) 292-5550.

New Mexico*

New Mexico manages its scarce water resources by accounting for virtually every drop of water in the state. The Prior Appropriation Doctrine is enunciated in Article XVI of the New Mexico Constitution. All of the state's surface water and most of its groundwater is appropriated. Among other things, the State Engineer's Office and the Interstate Stream Commission are responsible for water rights administration, water resource investigations, water resource planning, and water research and conservation projects. There is some water resource planning, including assessment and projections, at the regional level.

Contact: Paul Saavedra, Water Rights Bureau, New Mexico State Engineer Office, (505) 827-6120.

New York

Preparation of a water resources management strategy was mandated by the Water Resources Management Strategy Act of 1984. The law directs the Department of Environmental Conservation (DEC), in conjunction with the Department of Health (DOH) and the regional planning and development boards, to begin the development of the water resources management strategy with a statewide inventory of significant deficiencies in water systems and an assessment of local funding capabilities. Pursuant to the 1984 Act, the statewide management strategy is required to be composed of thirteen substate water resources management strategies, all of which address present water supply problems and future water supply needs. Further, the law establishes the Water Resources Planning Council (WRPC) within the DEC, with staffing provided by the DEC. All substate strategies and the statewide strategy is required to be reviewed and approved by the WRPC, and subsequently adopted by the DEC and DOH. The strategies are to be reviewed and, if necessary, revised every two years. The most recent water resources management strategy was published in 1989.

Contact: Warren Lavery, Executive Secretary, New York Water Resources Planning Council, Department of Environmental Conservation, (518) 457-1625.

North Carolina

Water supply planning is conducted on a statewide basis by the Division of Water Resources of the Department of Environment, Health and Natural Resources (DEHNR), pursuant to the State Water Plan Amendment of 1989. The DEHNR is responsible for overseeing the development of local water supply plans by each local government unit that provides, or plans to provide public water supply services. Local plans must include present and projected population and water use, and present and future water supplies. Such plans must be updated at least every five years. The DEHNR is also required to develop a state water supply plan summarizing present and projected water use and present and future water supply sources, using information from the local water supply plans. Further, the state plan is required to include a summary of technical assistance needs indicated by local plans, an evaluation of the compatibility of the local plans, and identification of ways in which local water supply programs could be better coordinated.

Contact: John Morris, Director, Division of Water Resources, Department of Environment, Health, and Natural Resources, (919) 753-4064.

North Dakota*

North Dakota published its first comprehensive, long-range water plan in 1968, though it was preceded by statewide plans that focused on problems of the day. The 1968 plan reflected a broader, more integrated planning process. That process, overseen by the State Water Commission, continues to emphasize water development and water supply projects and programs within a framework of active public involvement. The product is a planning document and a state water plan computer base that is updated monthly and readily available for information retrieval.

Contact: Gene Krenz, Director, Division of Planning, North Dakota State Water Commission, (701) 224-4964.

Ohio

The Department of Natural Resources has responsibility for water planning in cooperation with the state Environmental Protection Agency. Five comprehensive long-range regional plans were prepared between 1967 and 1978, with detailed data on public systems organized according to river basins. The plans address land and soil conservation, water recreation, flood control, water quality control, and public, industrial, and agricultural water supply. Water demand projections are included as well as cost estimates for anticipated supply and treatment projects. Although there is no statewide planning document, planning occurs on an ongoing basis and recent updates have focused on public water supply development and costs.

Contact: Leonard P. Black, Planner, Water Planning Unit, Division of Water, Ohio Department of Natural Resources, (614) 265-6758.

Oklahoma*

Oklahoma enjoys abundant, though unevenly distributed, water resources. This problem, coupled with growing demand, led to legislation in 1974 requiring the Oklahoma Water Resources Board to design a statewide plan to meet current and long-range water needs. The Oklahoma Comprehensive Water Plan was subsequently developed to provide for the orderly control, protection, conservation, and development and utilization of the state's water resources. The Board has emphasized conservation and augmentation of water supplies, regional planning, and state financial assistance for water and sewer improvements and related purposes.

Contact: Michael R. Melton, Assistant Director, Oklahoma Water Resources Board, (405) 271-2551.

Oregon*

Oregon water law was first enacted in 1909. Major revisions in 1955 initiated the state's water resources planning activities. Since 1983, interagency coordination and cooperation in natural resources management has been expanded. The state's new planning process is designed to facilitate the involvement of agencies in other agencies' decisionmaking processes and ensure that resource management activities are complementary. A Strategic Water Management Group facilitates interagency coordination. Two major products of the planning process are the Biennial Water Program and the State Water Management Program.

Contact: Rebecca A. Kraeg, Administrator, Resource Management Division, Oregon Water Resources Department, (503) 378-3671.

Pennsylvania

Water supply planning is conducted by the Bureau of Water Resources Management (BWRM) of the Department of Environmental Resources. Data collection efforts on local water sources were initiated in 1966, with a comprehensive planning process initiated in 1972. The planning process was conducted in conjunction with twelve regional advisory organizations. The most recent water supply plan was completed in 1976 and published in 1980. The plan continues to be updated by the BWRM, and new policies and programs continue to be initiated as a result of this process. Water usage data contained in the water supply plan is updated annually so that it can be used for permitting purposes.

Contact: John E. McSparran, Director, Bureau of Water Resources Management, Department of Environmental Resources, (717) 541-7800.

Rhode Island

The principal statewide water supply planning agency is the Water Resources Board (WRB) which paid for and prepared the current water supply plan, begun in 1989 and completed in 1980. The plan was drafted pursuant to an Executive Order after a request for such action by the Water Resources Coordinating Council in 1988. The planning process involved a series of tasks relating to determination of current resources and usage, projection of future resources and needs, and preparation of demand and supply management studies. Recommendations were also issued concerning means for conducting an ongoing process of planning and review of new proposals, and revision of the current plan.

Contact: Bill Falcone, Staff Director, Water Resources Board, (401) 277-2217.

South Carolina

Comprehensive water supply planning is not conducted on a statewide or regional basis in South Carolina.

Contact: Danny Johnson, Director, Surface Water Division, Water Resources Commission, (803) 737-0800.

South Dakota

Water planning in South Dakota is necessitated by the semi-arid, rural nature of the state and the uneven distribution of water supplies. In 1972, the legislature established, for the first time, a comprehensive State Water Planning Process. In 1980, a more functional approach was adopted. The planning process identifies large, expensive water resource projects and includes them as a portion of the legislatively approved State Water Resources Management System. The Board of Water and Natural Resources recommends smaller projects for the State Water Facilities Plan and uses its discretionary authority to provide project financing.

Contact: Mark E. Steichen, Director, Division of Water Resources Management, South Dakota Department of Water and Natural Resources, (605) 773-4216.

Tennessee

Comprehensive water supply planning is not conducted on a statewide or regional basis in Tennessee.

Contact: John McClurkan, Environmental Engineer, Safe Dams and Water Resources Section, Department of Conservation, (615) 741-2281.

Texas*

In 1957, statewide water planning was formally mandated by the Texas Water Planning Act. The planning process is intended to be a guide to statewide water development and its success is attributed to its flexibility, the incorporation of independently implemented local plans, and provisions for state financial assistance. The state's fourth and most recent plan was published in early 1991 and emphasizes integration of state planning activities, integration of water resource management programs, and the selection of project alternatives that maximize water management system efficiency and flexibility.

Contact: T. James Fries, Chief of the Water Uses, Protection, and Conservation Section, Texas Water Development Board, (512) 463-7847.

Utah*

Utah published its first comprehensive state water resource plan in 1990, using a three-ring-binder, "living document" format that allows for updates of its twenty topical sections as needed. A public review draft was provided prior to finalization of the plan. The plan's coverage is very broad in scope and includes a section on federal water planning and development. It is the product of a time-consuming four-year process involving many different government agencies with private input as well. The general state plan will be supplemented by ten river basin plans that are more specific but follow the same format.

Contact: D. Larry Anderson, Director, Division of Water Resources, Department of Natural Resources, (801) 538-7230.

Vermont

Comprehensive water supply planning is not conducted on a statewide or regional basis in Vermont.

Contact: David Butterfield, Ground Water Management Chief, Department of Environmental Conservation, (802) 244-1562.

Virginia

Water supply planning is conducted by the State Water Control Board (SWCB). In 1981, the state legislature (HB 1607) directed the SWCB to prepare advisory plans and programs for the management of the water resources for each river basin in Virginia. The SWCB's water management responsibilities include (1) preparing water supply plans for each river basin, (2) quantifying water withdrawals and uses and projecting future water demand, (3) identifying and evaluating strategies and alternatives to address the supply and management problems some water system may have, (4) providing, upon request, water supply planning assistance to localities, and (5) establishing advisory committees to assist in the formulation of plans, programs and recommendations.

Contact: Erlinda Patron, Environmental Engineer, Virginia Water Control Board, (804) 367-6422.

Washington*

The State Water Code of 1917 established a centralized, state administered water rights system for surface water. The Water Resources Act of 1971 established basic water resource allocation and planning policy for the state. It directed the Department of Ecology to develop a statewide water resources program addressing all beneficial uses including instream flows. Legislation enacted in 1989 encouraged water use efficiency and water conservation, though these policies are not integrated within an overall planning program. Water resource planning in Washington continues to be in a sensitive period of revision and clarification.

Contact: Jerry Parker, Environmental Planner, Water Resources Program, Washington State Department of Ecology, (206) 438-7113.

West Virginia

Comprehensive water supply planning is not conducted on a statewide or regional basis in West Virginia.

Contact: Bill Brannon, Assistant Chief, Water Resources Division, Division of Natural Resources, (304) 348-2107.

Wisconsin

The Department of Natural Resources (DNR) conducts comprehensive water resource planning by means of an overall plan for management of surface water and groundwater developed from twenty-two separate river basin management plans, and a statewide water quantity management plan for both surface water and groundwater. Pursuant to Act 60 of 1985, the DNR is required to (1) develop a water withdrawal registration system, (2) administer a water loss approval program, (3) develop a statewide water quantity resources management plan, and (4) participate in regional water quantity resources management activities. The law was enacted to fulfill Wisconsin's commitments under the Great Lakes Charter of 1985. The water supply planning process began during 1985 and 1986. The most recent plan was completed and submitted to the legislature for approval in 1988. In particular, the Water Quantity Resources Plan is required to describe the state's system of allocating water resources, identify existing water use and estimate future trends in water use, and provide recommendations for use, management and protection of water resources.

Contact: Charles Ledine, Chief of Water Resource Planning and Policy, Department of Natural Resources, (608) 266-1956.

Wyoming*

The Wyoming Water Development Program was established in 1975. Since 1982, it has served three primary functions: development of new water supply projects, rehabilitation of existing water supply systems, and water planning. The Wyoming Water Development Commission is the state's water development planning agency. Planning activities including the development of basin wide plans and master plans for municipalities and other public entities, feasibility and environmental studies related to federal funding, research and data collection, and coordination with federal and state policies affecting water use, development, and management.

Contact: Mike Purcell, Administrator, Wyoming Water Development Commission, (307) 777-7627.

Source: 1991 NRRI Survey of State Water Resource Planning Agencies and state water planning documents of the individual states.

* Indicates that information was adopted in part from Western States Water Council, *State Water Plans: Water Management Symposium* (proceedings of a conference held in Reno, Nevada, September 7-8, 1989), updated where possible.

APPENDIX F

CALIFORNIA MEMORANDUM OF UNDERSTANDING

MEMORANDUM OF UNDERSTANDING

Department of Health Services and Public Utilities Commission On Maintaining Safe and Reliable Water Supplies For Regulated Water Companies in California

The Department of Health Services (DHS) and the Public Utilities Commission (PUC) recognize that it is their joint goal to ensure that California water companies regulated by PUC are economically maintaining safe and reliable water supplies. This Memorandum of Understanding (MOU) sets forth those policies and procedures to which DHS and PUC commit themselves towards achievement of that goal.

Objectives

The common objectives of the program, as they relate to public water systems subject to regulation by PUC and DHS, are as follows:

1. To monitor the systems to assure that safe and reliable water supplies are being maintained in accordance with applicable drinking water standards.

2. To identify contaminants and determine system improvements, including alternatives, necessary to provide safe and reliable water supplies.

3. To assure that system improvement projects, necessary to upgrade supplies to meet standards, are selected on the basis of priority and only after reasonable alternatives have been defined and cost-effective analyses performed to arrive at a cost-effective solution.

4. To establish mutually agreed upon priorities for necessary system improvements.

Principles of Agreement

For the purpose of this agreement, DHS and PUC agree that their staffs shall abide by the following principles:

1. To the extent its resources permit, DHS shall be responsible for evaluating and determining all technical aspects of monitoring water quality and identifying contaminants, and for identifying the various potential improvements necessary to provide safe and reliable water supplies. DHS will also recommend its preferred solution. PUC shall be responsible for evaluating fire flow requirements and for making recommendations on the financial and rate making aspects associated with implementing the improvements identified by DHS to provide safe and reliable water supplies.

2. The staffs of the two agencies shall endeavor to keep each other fully informed of their respective activities and to assist each agency in carrying out its responsibilities.

3. Both agencies shall exchange all information available regarding water companies that are experiencing water quality and/or water availability problems. The information about the problems should include, but is not limited to:

a. All communications with utilities;
b. Orders;
c. Decisions;
d. Regulations and Policies;
e. Proposed new water systems;
f. Permits; and
g. Reports, investigations, etc.

4. The PUC will notify DHS of all requests for rate increases from public water systems and shall routinely provide DHS with schedules of hearings. DHS will provide technical input to PUC as necessary and appropriate in PUC proceedings. This may include testimony before the PUC.

5. Identified system improvements necessary to provide safe and reliable water supplies should consider:

   a. Protection of public health;
   b. Short and long term benefits;
   c. Cost effectiveness;
   d. Cost to consumers; and
   e. Ability of customers to pay.

6. Each agency shall endeavor to provide appropriate assistance in necessary enforcement actions taken against individual water systems.

Agency Responsibilities

The intent of this MOU is to identify the separate and distinct responsibilities of DHS and PUC. the following represents a general description of the roles and responsibilities of each of the respective agencies relating to water companies under PUC jurisdiction. Each agency agrees to adopt and implement policies and procedures necessary to administer its respective duties. These policies and procedures shall be coordinated between the agencies.

1. DHS shall be responsible for the following:

   a. Evaluation of public water systems to identify public health deficiencies and determine compliance with the Safe Drinking Water Act.

   b. Identification of alternative cost effective corrective actions necessary to upgrade water supplies to meet standards, and recommendation of its preferred solution.

   c. Review and approval of plans and specifications and issuance of domestic water supply permits for improvements.

   d. Inspection of water quality improvement projects both during and after construction, and sharing project status reports with PUC.

   e. Participation at appropriate PUC public meetings with customers and/or evidentiary hearings where water quality matters raised by DHS or any other person are to be discussed.

2. PUC shall be responsible for the following:

   a. Determination of the type of rate relief needed to finance necessary system improvement projects for other than Safe Drinking Water Bond Act loan projects, which by existing policy are required to be paid off by a surcharge on customer bills.

   b. Arrange public meetings with customers and/or evidentiary hearings to ensure that customers are made aware of the need for system improvement projects and the impacts the projects will have on rates.

   c. Promptly inform DHS of PUC public meetings with customers and/or evidentiary hearings where water quality problems will be discussed so that DHS may prepare and participate.

   d. Provide analyses of the financial impacts, if any, of system improvement projects on both customers and water companies.

Project Coordination

1. DHS and PUC will designate project managers for their respective agencies when water quality and/or water availability problems exist and an improvement project is necessary. The project managers will be the principal contact persons for their agencies on a particular project.

2. Whenever a potential conflict regarding a specific project is identified, each agency will examine the alternative solutions available for upgrading water supplies and then meet to thoroughly discuss the issues involved and attempt to come to an agreement before announcing a position. If an agreement cannot be reached after consultation between the Chief of the Sanitary Engineering Branch of DHS and the Chief of the Water Utilities Branch of PUC, DHS and PUC staff may advocate separate positions. Notwithstanding such disagreements, this MOU shall remain in effect.

3. There should be a complete exchange of information between DHS and PUC through the project managers. Each agency will set forth where and to whom material shall be sent. Copies of all correspondence between an agency and other parties concerning a water system improvement project shall be sent to the project manager of each agency until project completion.

4. The Chief of the Sanitary Engineering Branch of DHS and the Chief of the Water Utilities Branch of PUC, with designated members of their staff, shall meet as necessary but at least semi-annually to review progress of the water quality improvement effort in California and resolve any issues which that been identified by staff.

Amendments

This MOU may be amended by mutual agreement of DHS and PUC. It shall remain in effect until DHS and/or PUC decide otherwise.

Approved:
(Signature)
Director
Department of Health Services
Date: February 9, 1987

Approved:
(Signature)
Executive Director
Public Utilities Commission
Date: December 9, 1986

APPENDIX G

STATE WATER MANAGEMENT AND PLANNING AGENCIES

State	Drinking Water (a)	Water Quality (b)	Groundwater Protection (c)	Water Resources (d)
Alabama	Joe A. Power, Chief Water Supply Branch Department of Environ- mental Management 1751 Congressional W.L. Dickinson Drive Montgomery, AL 36130 (205) 271-7773	Charles R. Horn Acting Director Water Quality Environmental Manage- ment Department 1751 Federal Dr. Montgomery, AL 36109 (205) 271-7823	—	James J. Plaster Executive Secretary Soil & Water Conser- vation Committee 1445 Federal Dr. P.O. Box 3336 Montgomery, AL 36193 (205) 242-2620
Alaska	Charlene Denys Manager Alaska Drinking Water Program Wastewater and Water Treatment Section Department of Environ- mental Conservation P.O. Box O Juneau, AK 99811-1800 (907) 465-2654	Doug Redburn, Chief Water Quality Management Department of Environ- mental Conservation P.O. Box O Juneau, AK 99811 (907) 465-2634	Doug Redburn, Chief Water Quality Management Department of Environ- mental Conservation P.O. Box O Juneau, AK 99811 (907) 465-2634	Robert L. Grogan Director Division of Governmental Coordination Office of the Governor P.O. Box AW Juneau, AK 99811 (907) 762-4355
Arizona	Robert L. Munari Manager, Field Services Section Office of Water Quality 2655 East Magnolia St. Phoenix, AZ 85034 (602) 392-4002	Randolph Wood Director Department of Environ- mental Quality 2005 N. Central, Room 701 Phoenix, AZ 85004 (602) 257-6917	William Plummer Director Department of Water Resources 15 S. 15th Ave. Phoenix, AZ 85007 (602) 542-1540	William Plummer Director Department of Water Resources 15 S. 15th Ave. Phoenix, AZ 85004 (602) 542-1540
Arkansas	Harold Seifert Director Division of Engineer- ing Department of Health 4815 W. Markham St. Little Rock, AR 72205-3867 (501) 661-2623	Randall Mathis Director Department of Pollution Control & Ecology 8001 National Dr. Little Rock, AR 72209 (501) 562-7444	Randy Young Director Soil & Water Conservation Comm. #1 Capitol Mall Suite 2D Little Rock, AR 72201 (501) 682-1611	Randy Young Director Soil & Water Conservation Comm. #1 Capitol Mall Suite 2D Little Rock, AR 72201 (501) 682-1611

State	Drinking Water (a)	Water Quality (b)	Groundwater Protection (c)	Water Resources (d)
California	Peter A. Rogers, Chief Office of Drinking Water Department of Health Services 714 P St., Room 692 Sacramento, CA 95814 (916) 323-1382	Jess Diaz, Chief Division of Water Quality Water Resources Control Board 901 P St., 2nd Floor Sacramento, CA 95814 (916) 445-9552	Ed Huntly, Chief Planning Division Department of Water Resources 1416 Ninth St. Sacramento, CA 95814 (916) 445-9610	David Kennedy Director Department of Water Resources 1416 Ninth St. Sacramento, CA 95814 (916) 445-6582
Colorado	Jerry C. Biberstine Manager Drinking Water Program Department of Health 4210 East 11th Ave. Denver, CO 80220 (303) 331-4546	Dave Holm, Director Water Quality Division Department of Health 4210 E. 11th Ave. Denver, CO 80230 (303) 331-4530	—	Jeris Danielson Director Water Conservation Board Department of Natural Resources 1313 Sherman St., Room 615 Denver, CO 80203 (303) 866-3441
Connecticut	Gerald R. Iwan Chief Department of Health Services Water Supplies Section 150 Washington St. Hartford, CT 06106 (203) 566-1251	Richard Barlow Director Water Compliance Unit Department of Environmental Protection 122 Washington St. Hartford, CT 06106 (203) 566-3245	Richard Barlow Director Water Compliance Unit Department of Environmental Protection 122 Washington St. Hartford, CT 06106 (203) 566-3245	David Cunningham Acting Director Water Resources Unit Environmental Protection Department 165 Capitol Ave. Hartford, CT 06106 (203) 566-7220
D.C.	James R. Collier Chief Water Hygiene Branch Department of Consumer & Regulatory Affairs 5010 Overlook Ave., SW Washington, DC 20032 (202) 767-7370	James Collier, Chief Water Hygiene Branch Housing & Environmental Regulations Department of Admin. 5010 Overlook Ave., SW Washington, DC 20032 (202) 767-7370	James Collier, Chief Water Hygiene Branch Housing & Environmental Regulations Department of Admin. 5010 Overlook Ave., SW Washington, DC 20032 (202) 767-7370	James Collier, Chief Water Hygiene Branch Housing & Environmental Regulations Department of Admn. 5010 Overlook Ave., SW Washington, DC 20032 (202) 767-7370
Delaware	Richard B. Howell, III Program Director Office of Sanitary Engineering Division of Public Health Cooper Building P.O. Box 637 Dover, DE 19903 (302) 736-5410	John A. Hughes Director Soil & Water Conservation Division Natural Resources & Environmental Control 89 Kings Highway Box 1401 Dover, DE 19903 (302) 736-4764	Allan J. Farling Manager Ground Water Management Section Division of Water Resources 89 Kings Highway Dover, DE 19901 (302) 736-5722	Gerald L. Esposito Director Division of Water Resources Natural Resources & Environmental Control 89 Kings Highway Box 1401 Dover, DE 19903 (302) 736-4411

State	Drinking Water (a)	Water Quality (b)	Groundwater Protection (c)	Water Resources (d)
Florida	J. Kent Kimes Administrator Drinking Water Section Environmental Regulation Department 2600 Blair Stone Rd. Tallashasee, FL 32399-2400 (904) 487-1762	Roxane Dow, Chief Surface Water Management Environmental Regulation Department 2600 Blair Stone Rd. Tallahassee, FL 32399-2400 (904) 488-6221	Chuck Aller, Chief Bureau of Groundwater Protection Environmental Regulation Department 2600 Blair Stone Rd. Tallahassee, FL 32399-2400 (904) 488-3601	Frank Walper Special Assistant Water Management District Environmental Regulation Department 2600 Blair Stone Rd. Tallahassee, FL 32399-2400 (904) 488-4805
Georgia	Fred Lehman Program Manager Drinking Water Program Environmental Protection Division Floyd Towers East Rm. 1066 205 Butler St., SE Atlanta, GA 30334 (404) 656-5660	Jack Dozier Branch Chief Water Protection Branch Department of Natural Resources 205 Butler St., SW E. Tower Atlanta, GA 30334 (404) 656-4708	John Fernstrom Manager State Groundwater Program Department of Natural Resources 205 Butler St., SW Atlanta, GA 30334-1703 (404) 656-5660	David Word Branch Chief Water Resources Management Branch Department of Natural Resources 205 Butler St., SW Atlanta, GA 30334 (404) 656-3094
Hawaii	Thomas E. Arizumi Chief, Safe Drinking Water Branch Environmental Management Division P.O. Box 3378 Honolulu, HI 96801-9984 (808) 543-8258	Bruce Anderson Deputy Director Environmental Protection & Health Services Department of Health 1250 Punchbowl St. Honolulu, HI 96813 (808) 548-4139	Manabu Tagomori Deputy Director Water & Land Development Division Department of Land & Natural Resources 1151 Punchbowl St. Honolulu, HI 96813 (808) 548-7533	Manabu Tagomori Deputy Director Water & Land Development Division Department of Land & Natural Resources 1151 Punchbowl St. Honolulu, HI 96813 (808) 548-7533
Idaho	Alfred E. Murrey Chief, Bureau of Water Quality Division of Environmental Quality Department of Health & Welfare Boise, ID 83720 (208) 334-5860	Alfred E. Murrey Chief, Bureau of Water Quality Department of Health & Welfare 450 W. State St. Boise, ID 83720 (208) 334-4250	Norman Young Administrator Water Management Division Department of Water Resources 1301 N. Orchard St. Boise, ID 83720 (208) 327-7902	R. Keith Higginson Director Department of Water Resources 1301 N. Orchard St. Boise, ID 83720 (208) 334-7901

State	Drinking Water (a)	Water Quality (b)	Groundwater Protection (c)	Water Resources (d)
Illinois	Roger D. Selburg Manager, Division of Water Supplies Environmental Protection Agency 2200 Churchill Road P.O. Box 19276 Springfield, IL 62706-9276 (217) 785-8653	Bernie Killian Director Environmental Protection Agency 2200 Churchill Rd. Springfield, IL 62708 (217) 782-3397	Bernie Killian Director Environmental Protection Agency 2200 Churchill Rd. Springfield, IL 62708 (217) 782-3397	Donald R. Vonnahme Director Division of Water Resources Department of Transportation 300 DOT Admn. Bldg. Springfield, IL 62764 (217) 782-0690
Indiana	Robert Hilton, Chief Drinking Water Branch Office of Water Management Department of Environment Management 105 South Meridian P.O. Box 6015 Indianapolis, IN 46206 (317) 233-4240	John L. Winters Jr. Branch Chief Water Quality Branch 105 S. Meridian St. Box 6015 Indianapolis, IN 46206 (317) 243-5028	Thomas Rarick Deputy Commissioner Department of Environmental Management 105 S. Meridian St. Indianapolis, IN 46206 (317) 232-8595 Richard Gordon Deputy Commissioner Department of Environmental Management 105 S. Meridian St. Indianapolis, IN 46206 (317) 232-8595	John Simpson, Director Water Division Department of Natural Resources 2475 Director's Row Indianapolis, IN 46241 (317) 232-4160
Iowa	Darrell McAllister Bureau Chief Surface & Groundwater Protection Bureau Department of Natural Resources Wallace State Office Building 900 East Grand Street Des Moines, IA 50319 (515) 281-8998	Rick McGeough, Chief Division of Law Enforcement Department of Natural Resources Wallace State Office Building Des Moines, IA 50319 (515) 281-5385	Rick McGeough, Chief Division of Law Enforcement Department of Natural Resources Wallace State Office Building Des Moines, IA 50319 (515) 281-5385	Rick McGeough, Chief Division of Law Enforcement Department of Natural Resources Wallace State Office Building Des Moines, IA 50319 (515) 281-5385

State	Drinking Water (a)	Water Quality (b)	Groundwater Protection (c)	Water Resources (d)
Kansas	David F. Waldo, Chief Public Water Supply Section Bureau of Water Department of Health & Environment Forbes Field #740 Topeka, KS 66620 (913) 296-5503	James A. Power Director Division of Environment Department of Health & Environment Forbes Field Topeka, KS 66620 (913) 296-1535	—	Joseph Harkins Director Kansas Water Office 109 SW Ninth Topeka, KS 66612 (913) 296-3185
Kentucky	John T. Smither, Mgr. Drinking Water Branch Natural Resources & Environmental Protection 18 Reilly Rd. Frankfort, KY 40601 (502) 564-3410 ext.543	Jack Wilson, Director Division of Water Natural Resources & Environmental Protection 18 Reilly Rd. Frankfort, KY 40601 (502) 564-3410	Carl H. Bradley Secretary Natural Resources & Environmental Protection Capital Plz. 5th Floor Frankfort, KY 40601 (502) 564-3350	Jack Wilson, Director Division of Water Natural Resources & Environmental Protection 18 Reilly Rd. Frankfort, KY 40601 (502) 564-3410
Louisiana	T. Jay Ray Administrator Office of Public Health & Hospitals P.O. Box 60630 New Orleans, LA 70160 (504) 568-5105	Maureen O'Neill Assistant Secretary Office of Environmental Quality P.O. Box 44091 Baton Rouge, LA 70804-4066 (504) 342-6363	Maureen O'Neill Assistant Secretary Office of Environmental Quality P.O. Box 44091 Baton Rouge, LA 70804-4066 (504) 342-6363	Maureen O'Neill Assistant Secretary Office of Environmental Quality P.O. Box 44091 Baton Rouge, LA 70804-4066 (504) 342-6363
Maine	Jeffrey Jenks Program Manager Drinking Water Program Division of Health Engineering Department of Human Services Augusta, ME 04333 (207) 289-5685	Dean C. Marriott Commissioner Department of Environmental Protection State House Sta. #17 Augusta, ME 04333 (207) 289-2811	Dean C. Marriott Commissioner Department of Environmental Protection State House Sta. #17 Augusta, ME 04333 (207) 289-2811	Frank W. Ricker Executive Director Soil & Water Conservation Commission Agriculture, Food & Rural Resources State House Station #28 Augusta, ME 04333 (207) 289-2666

State	Drinking Water (a)	Water Quality (b)	Groundwater Protection (c)	Water Resources (d)
Maryland	William F. Parrish Program Administrator Water Supply Program Department of the Environment Point Breeze Building 40, Room 8L 2500 Broening Highway Dundalk, MD 21224 (301) 631-3702	Richard Sellars Director Water Management Administration Health & Mental Hygiene Department 201 W. Preston St., 5th Floor Baltimore, MD 21201 (301) 225-6300	Robert D. Miller Division Director Water Supply Division Department of Natural Resources 580 Taylor Ave. Annapolis, MD 21401 (301) 974-3675	James W. Peck, Director Water Resources Administration Department of Natural Resources Tawes State Office Bldg. Annapolis, MD 21401 (301) 974-3048
Massachusetts	David Terry Acting Director Division of Water Supply Department of Environmental Protection One Winter St. Boston, MA 02108 (617) 292-5529	Cornelius O'Leary Acting Director Water Pollution Department of Environmental Quality Engineering One Winter St. Boston, MA 02108 (617) 292-5636	Richard Thibedeau Director Water Resources Department of Environmental Management 100 Cambridge St. Boston, MA 02202 (617) 727-3267	Elizabeth Cline Director Water Resources Executive Office of Environmental Affairs 100 Cambridge St. Boston, MA 02202 (617) 727-9800 Paul Levy, Director Water Resources Authority 100 First Ave. Charleston Navy Yard Boston, MA 02129 (617) 242-6000
Michigan	Jim K. Cleland, Chief Division of Water Supply Department of Public Health P.O. Box 30195 Lansing, MI 48909 (517) 335-8326	David Hales, Director Department of Natural Resources Mason Building P.O. Box 30028 Lansing, MI 48909 (517) 373-2329	---	David Hales, Director Department of Natural Resources Mason Building P.O. Box 30028 Lansing, MI 48909 (517) 373-2329
Minnesota	Gary L. Englund, Chief Section of Water Supply and Well Management Department of Health 925 SE Delaware St. P.O. Box 59040 Minneapolis, MN 55459 (612) 627-5133	Ron Nargang, Director Water Division Department of Natural Resources 500 Lafayette Rd. St. Paul, MN 55155-4001 (612) 296-4800	Brian Rongitsch Ground Water Division Environmental Resources 500 Lafayette Rd. St. Paul, MN 55155-4032 (612) 296-0436	Jim Birkholz Executive Director Water Resources Board 500 Lafayette Rd., Box 34 St. Paul, MN 55101 (612) 296-3767

State	Drinking Water (a)	Water Quality (b)	Groundwater Protection (c)	Water Resources (d)
Mississippi	James C. McDonald Director Division of Water Supply State Board of Health P.O. Box 1700 Jackson, MS 39215-1700 (601) 960-7518	Charles Chisolm Director Pollution Control Bureau Commission on Environmental Quality Southport Mall Jackson, MS 39209 (601) 961-5100	---	Gale Martin Executive Director Soil & Water Conservation Commission 410 Robert E. Lee Building Jackson, MS 39201 (601) 359-1281
Missouri	Jerry L. Lane Director Public Drinking Water Program Division of Environmental Quality P.O. Box 176 Jefferson City, MO 65102 (314) 751-5331	Charles Stiefferman Director Water Pollution Control Program Division of Environmental Quality P.O. Box 176 Jefferson City, MO 65102 (314) 751-1300	James Williams Director & State Geologist Division of Geology and Land Survey Department of Natural Resources P.O. Box 250 Rolla, MO 65401 (314) 364-1752	Donald Miller Program Director Water Resources Planning Program Division of Geology and Land Survey P.O. Box 250 Rolla, MO 65401 (314) 364-4185
Montana	Dan L. Fraser Water Quality Bureau Health & Environmental Sciences Cogswell Bldg. Rm. A206 Helena, Montana 59620 (406) 444-2406	Steven L. Pilcher Chief Water Quality Bureau Health & Environmental Sciences Capitol Station Helena, MT 59620 (406) 444-2406	Karen Barclay Director Department of Natural Resources & Conservation State Capitol Helena, MT 59620 (406) 444-6699	Gary Fritz Administrator Water Resources Division Department of Natural Resources & Conservation 32 S. Ewing Helena, MT 59601 (406) 444-6601
Nebraska	Jack Daniel, Director Drinking Water & Environmental Sanitation Department of Health P.O. Box 95007 Lincoln, NE 65809 (402) 471-2541	Dennis Grams, Director Department of Environmental Control 301 Centennial Mall S. P.O. Box 94877 Lincoln, NE 68509-4877 (402) 471-2186	J. Michael Jess, Dir. Department of Water Resources 301 Centennial Mall S. P.O. Box 94676 Lincoln, NE 65809-4676 (402) 471-2363	J. Michael Jess, Director Department of Water Resources 301 Centennail Mall S. P.O. Box 94676 Lincoln, NE 65809-4676 (402) 471-2363
		Jack Daniel, Director Environmental Health & Housing Surveillance Department of Health P.O. Box 95007 Lincoln, NE 65809 (402) 471-2674		Dayle Williamson, Director Natural Resources Comm. 301 Centennial Mall S. P.O. Box 94876 Lincoln, NE 65809-4876 (402) 471-2081

State	Drinking Water (a)	Water Quality (b)	Groundwater Protection (c)	Water Resources (d)
Nevada	Jeffrey Fontaine Supervisor Public Health Engin-eering Department of Human Resources Consumer Health Protection Services 505 East King Street Rm. 103 Carson City, NV 89710 (702) 687-4750	Lew Dodgion Administrator Environmental Protection Division Conservation & Natural Resources Department 201 S. Fall St. Carson City, NV 89710 (702) 885-4670	Hugh Ricci, Chief Groundwater Section Division of Water Resources Conservation & Natural Resources Department 201 S. Fall St. Carson City, NV 89710 (702) 885-4380	Peter G. Morros State Engineer Water Resources Division Conservation & Natural Resources Department 201 S. Fall St. Carson City, NV 89710 (702) 687-4380
New Hampshire	Bernard B. Lucey Administrator of Water Supply Engineering Bureau Department of Environmental Services P.O. Box 95, Hazen Dr. Concord, NH 03302-0095 (603) 271-3139	Robert Varney Commissioner Department of Environ-mental Service 6 Hazen Dr. Concord, NH 03301 (603) 271-3503	Harry Stewart Administrator Groundwater Protection Bureau Department of Environ-mental Service P.O. Box 95, Hazen Dr. Concord, NH 03301 (603) 271-3503	Delbert F. Downing Chairman Water Resources Board P.O. Box 2008 Concord, NH 03301-2008 (603) 271-3406 Robert Varney, Comm. Department of Environ-mental Service 6 Hazen Drive Concord, NH 03301 (603) 271-3503
New Jersey	Barker G. Hamill Chief, Bureau of Safe Drinking Water Division of Water Resources Department of Environ-mental Protection Trenton, NJ 09625 (609) 292-5550	Jorge Berkowitz Acting Director Division of Water Resources Department of Environ-mental Protection 401 E. State St. CN029 Trenton, NJ 08625 (609) 633-1175	Stephen Johnson, Chief Groundwater Quality Management Division of Water Resources 401 E. State St. Trenton, NJ 08625 (609) 292-0424	Jorge Berkowitz Acting Director Division of Water Resources Department of Environ-mental Protection 401 E. State St., CN029 Trenton, NJ 08625 (609) 633-1175

State	Drinking Water (a)	Water Quality (b)	Groundwater Protection (c)	Water Resources (d)
New Mexico	Robert M. Gallegos Program Manager Drinking Water Section Department of Health & Environment 1190 St. Francis Dr. Room South 2058 Santa Fe, NM 87503 (505) 827-2778	Kathy Sisneros, Chief Surface Water Quality Bureau Department of Health & Environment P.O. Box 968 Santa Fe, NM 87504-0968 (505) 827-2793	Richard Mitzelfelt Deputy Director Environmental Improvement Division Department of Health & Environment P.O. Box 968 Santa Fe, NM 87504-0968 (505) 827-2850	David Stone, Chief Water Rights Bureau Office of State Engineer Bataan Memorial Building Santa Fe, NM 87503 (505) 827-6120
New York	Michael E. Burke Director, Bureau of Public Water Supply Protection New York Department of Health, Room 406 University Place Albany, NY 12203-3399 (518) 458-6731	Thomas C. Jorling Commissioner Department of Environmental Conservation 50 Wolf Rd. Albany, NY 12233 (518) 457-3446	Thomas C. Jorling Commissioner Department of Environmental Conservation 50 Wolf Rd. Albany, NY 12233 (518) 457-3446	Thomas C. Jorling Commissioner Department of Environmental Conservation 50 Wolf Rd. Albany, NY 12233 (518) 457-3446
North Carolina	Wallace E. Venrick Chief, Public Water Supply Section Division of Environmental Health Department of Environment, Health & Natural Resources P.O. Box 27687 Raleigh, NC 27611-7687 (919) 733-2321	Paul Wilms, Director Environmental Management Department of Natural Resources & Community Development 512 N. Salisbury St. Raleigh, NC 27604-1148 (919) 733-7015	Perry Nelson Groundwater Chief Division of Environmental Management Department of Natural Resources & Community Development 512 N. Salisbury St. Raleigh, NC 27604-1148 (919) 733-3221	John Morris, Director Office of Water Resources Department of Natural Resources & Community Development 512 N. Salisbury St. Raleigh, NC 27604-1148 (919) 733-4064
North Dakota	D. Wayne Kern Environmental Engineer Water Supply & Pollution Control Division Department of Health 1200 Missouri Ave. P.O. Box 5520 Bismarck, ND 58502-5520 (701) 224-2354	Francis Schwindt Director Water Supply & Pollution Control Division Department of Health 1200 Missouri Ave. Bismarck, ND 58501 (701) 224-2354	Milton Lindvig State Water Commission State Office Building 900 E. Blvd. Bismarck, ND 58505 (701) 224-2750	(Vacancy) State Engineer Water Commission State Office Building 900 E. Blvd. Bismarck, ND 58505 (701) 224-4940

State	Drinking Water (a)	Water Quality (b)	Groundwater Protection (c)	Water Resources (d)
Ohio	John J. Sadzewicz Chief, Division of Public Drinking Water Ohio Environmental Protection Agency 1800 Watermark Drive P.O. Box 0149 Columbus, OH 43266-0149 (614) 644-2752	Andrew Turner, Chief Environmental Protection Agency 1800 Watermark Drive Columbus, OH 43266-0149 (614) 644-2856	Gary Martin, Chief Division of Groundwater Environmental Protection Agency 1800 Watermark Drive Columbus, OH 43266-0149 (614) 481-7180	Robert Goettemoeller Chief Division of Water Department of Natural Resources Fountain Sq., Bldg. E Columbus, OH 43224 (614) 265-6712
Oklahoma	George McBride Water Quality Service Oklahoma State Department of Health P.O. Box 53551 Oklahoma City, OK 73152 (405) 271-7370	Ron Jarman, Chief Water Quality Division Water Resources Board 1000 NE 10th St. Box 53585 Oklahoma City, OK 73105 (405) 271-2540	James R. Barrett Executive Director Water Resources Board 1000 NE 10th St. 12th Floor Oklahoma City, OK 73152 (405) 271-2555	James R. Barnett Executive Director Water Resources Board 1000 NE 10th St. Box 53585 Oklahoma City, OK 73152 (405) 271-2551
Oregon	James B. Boydston Manager, Drinking Water Program Health Division Department of Human Resources 1400 S.W. 5th Avenue Room 608 Portland, OR 97201 (503) 229-6302	Fred Hansen, Director Department of Environ- mental Quality 811 SW Sixth Ave. Portland, OR 97204 (503) 229-5696	Fred Lissner, Manager Groundwater Division Water Resources Department 3850 Portland Rd., NE Salem, OR 97310 (503) 378-3671	William H. Young Director Water Resources Department 3850 Portland Rd., NE Salem, OR 97310 (503) 378-3671
Pennsylvania	Frederick A. Marrocco Chief, Division of Water Supplies Department of Environ- mental Resources P.O. Box 2357 Harrisburg, PA 17105-2357 (717) 787-9037	Daniel B. Drawbaugh Acting Director Bureau of Water Quality Management Department of Environ- mental Resources P.O. Box 2063 Harrisburg, PA 17120 (717) 787-2666	Daniel B. Drawbaugh Acting Director Bureau of Water Quality Management Department of Environ- mental Resources P.O. Box 2063 Harrisburg, PA 17120 (717) 787-2666	John E. McSparran Director Bureau of Water Resources Management Department of Environ- mental Resources P.O. Box 1467 Harrisburg, PA 17120 (717) 787-6750

State	Drinking Water (a)	Water Quality (b)	Groundwater Protection (c)	Water Resources (d)
Rhode Island	June Swallow Acting Chief, Division of Drinking Water Quality Department of Health 75 Davis Street Cannon Building Providence, RI 02908 (401) 277-6867	James Fester, Chief Division of Water Resources Department of Environmantal Management 291 Promenade St. Providence, RI 02908 (401) 277-2234	Peter Calise Water Resources Board Department of Environmental Management 265 Melrose Street Providence, RI 02908 (401) 277-2217	James Fester, Chief Division of Water Resources Department of Environmental Management 291 Promenade St. Providence, RI 02908 (401) 277-2234
South Carolina	Robert Malpass, Chief Bureau of Drinking Water Protection Department of Health & Environmental Control 2600 Bull St. Columbia, SC 29201 (803) 734-5310	Lewis Shaw Deputy Commissioner Environmental Quality Control Division Department of Health & Environmental Control 2600 Bull St. Columbia, SC 29201 (803) 734-5360	Raymond Knox, Director Groundwater Protection Department of Health & Quality Control 2600 Bull St. Columbia, SC 29201 (803) 734-5331	Alfred H. Vang Executive Director Water Resources Commission 1201 Main St. Suite 1100 Columbia, SC 29201 (803) 737-0800
South Dakota	Darron C. Busch Off. of Drinking Water Department of Water & Natural Resources Joe Foss Building 523 East Capital Ave. Pierre, SD 57501 (605) 773-3754	Jim Nelson, Director Division of Environmental Health Water & Natural Resources Department Foss Building Pierre, SD 57501 (605) 773-3151	Jim Nelson, Director Division of Environmental Health Water & Natural Resources Department Foss Building Pierre, SD 57501 (605) 733-3151	Floyd Mathew Secretary Water & Natural Resources Department 2nd Floor, Foss Building Pierre, SD 57501 (605) 773-3151
Tennessee	W. David Draughon, Jr. Director, Division of Water Supply Department of Health & Environment 150 9th Avenue, North Terra Bldg., 1st Fl. (615) 741-6636	Elmo Lunn Administrator Office of Water Department of Health & Environment 2nd. Fl., TERRA Bldg. Nashville, TN 37219 (615) 741-6610	Terry Cothren Director Department of Health & Environment 150 Ninth Ave., N. Nashville, TN 37115 (615) 741-0690	James Haynes Director Water Resources Department of Health & Environment 150 Ninth Ave., N. Nashville, TN 37219 (615) 741-2281
Texas	Charles Maddox, Chief Bureau of Environmental Health Department of Health 1100 W. 48th St. Austin, TX 78756-3199 (512) 458-7542	M. Reginald Arnold II Executive Administrator Texas Water Development Board Box 13231 Austin, TX 78711 (512) 463-7847	Bill Klemp, Chief Groundwater Conservation Section Texas Water Commission Box 13087, Capitol Station Austin, TX 78711 (512) 463-7969	M. Reginald Arnold II Executive Administrator Texas Water Development Board Box 13231 Austin, TX 78711 (512) 463-7847

State	Drinking Water (a)	Water Quality (b)	Groundwater Protection (c)	Water Resources (d)
Utah	Gayle J. Smith Director Bureau of Drinking Water/Sanitation Department of Health 288 N. 1460 W. Box 16690 Salt Lake City, UT 84116-0690 (801) 538-6163	Gayle J. Smith Director Bureau of Drinking Water/Sanitation Department of Health 288 N. 1460 W. Box 16690 Salt Lake City, UT 84116-0690 (801) 538-6159 Calvin K. Sudweeks Director Water Pollution Control Department of Health 288 N. 1460 W. Salt Lake City, UT 84116-0690 (801) 538-6146	Robert L. Morgan State Engineer Division of Water Rights Department of Natural Resources 1636 W. N. Temple Salt Lake City, UT 84116 (801) 538-7240	Larry Anderson Director Water Resources Division Department of Natural Resources 1636 W. N. Temple Salt Lake City, UT 84116 (801) 538-7250
Vermont	Winslow Ladue Water Supply Program Department of Health 60 Main Street P.O. Box 70 Burlington, Vermont 05402 (802) 863-7220	David L. Clough Director Water Quality Division Department of Environmental Conservation 103 S. Main St. Waterbury, VT 05676 (802) 244-6951	Timothy Burke Commissioner Department of Environmental Conservation Agency of Natural Resources 103 S. Main St. Waterbury, VT 05676 (802) 244-8755	Timothy Burke Commissioner Department of Environmental Conservation Agency of Natural Resources 103 S. Main St. Waterbury, VT 05676 (802) 244-8755
Virginia	Allen R. Hammer Director, Division of Water Supply Engineering Department of Health 109 Governor Street Richmond, VA 23219 (804) 786-1766	Richard N. Burton Executive Director State Water Control Board P.O. Box 11143 Richmond, VA 23230 (804) 257-6384	William L. Woodfin Jr. Groundwater Program Manager Office of Water Resources Management State Water Control Board P.O. Box 11143 Richmond, VA 23230 (804) 367-6387	Richard N. Burton Executive Director State Water Control Board P.O. Box 11143 Richmond, VA 23230 (804) 257-6384

State	Drinking Water (a)	Water Quality (b)	Groundwater Protection (c)	Water Resources (d)
Washington	D. William Liechty Head, Drinking Water Section Department of Health Mail Stop LD-11 Building 3 Airdustrial Park Olympia, WA 98504 (206) 753-5953	Carol Jolly Assistant Director Water & Shorelands Department of Ecology St. Martins Campus - Abbott Raphael Hall M/S: PV-11 Lacey, WA 98504-8711 (206) 438-7494	Hedia Adelsman Program Manager Water Resources Department of Ecology M/S: PV-11 Olympia, WA 98504 (206) 459-6055	Carol Jolly Assistant Director Water & Shorelands Department of Ecology St. Martins Campus-Abbott Raphael Hall M/S: PV-11 Lacey, WA 98504-8711 (206) 438-7494
West Virginia	Donald A. Kuntz Director Environmental Engineering Division Office of Environ-mental Services Department of Health E. 1900 Kanawha Blvd., East, Rm. 554 Charleston, WV 25305 (304) 348-2981	Donald A. Kuntz, Chief Environmental Engineering Division Division of Health 1800 Washington St. E. Building 3 Charleston, WV 25305 (304) 348-2981	J. Edward Hamrick III Chairman Groundwater Policy & Technical Advisory Commission Division of Natural Resources 1800 Washington St. E. Charleston, WV 25305 (304) 348-2754	L. Eli McCoy, Chief Water Resources Division Division of Natural Resources 1201 Greenbrier St. Charleston, WV 25311 (304) 348-2107
Wisconsin	Robert M. Krill Director Bureau of Water Supply Department of Natural Resources P.O. Box 7921 Madison, WI 53707 (608) 267-7651	Bruce J. Baker Director Bureau of Water Resources Management Department of Natural Resources P.O. Box 7921 Madison, WI 53707 (608) 266-8631	Bruce J. Baker Director Bureau of Water Resources Management Department of Natural Resources P.O. Box 7921 Madison, WI 53707 (608) 266-8631	Bruce J. Baker Director Bureau of Water Resources Management Department of Natural Resources P.O. Box 7921 Madison, WI 53707 (608) 266-8631
Wyoming	William L. Garland Administrator Department of Environmental Quality/Water Herschler Building 4th Floor West Cheyenne, WY 82002 (307) 777-7781	William L. Garland Admininistrator Department of Environmental Quality/Water Herschler Building 4th Floor West Cheyenne, WY 82002 (307) 777-7781	Jake Strohman Engineering Supervisor Department of Environmental Quality/Water Herschler Building 4th Floor West Cheyenne, WY 82002 (307 777-7090	Michael K. Purcell Administrator Water Development Commission Herschler Building Cheyenne, WY 82002 (307) 777-7626

State	Drinking Water (a)	Water Quality (b)	Groundwater Protection (c)	Water Resources (d)
American Samoa	Willie Sword Acting Director Public Works Pago Pago, AS 96799 (684) 633-4116	Pati Faiai Executive Secretary Environmental Quality Commission Office of the Governor Pago Pago, AS 96799 (684) 633-2304	—	Abe Malae, Director American Samoa Power Authority Pago Pago, AS 96799 (684) 644-5251
Guam	Fred M. Castro Guam Environmental Protection Agency Government of Guam Harmon Plaza Complex Unit D-107 130 Rojas Street Harmon, Guam 96911 (671) 646-8863	Fred M. Castro Administrator Guam Environmental Protection Agency P.O. Box 2999 Agana, GU 96910 (671) 646-8863	Anthony Blaz Chief Officer Public Utilities Agency of Guam P.O. Box 3010 Agana, GU 96910 (671) 646-8891	Anthony Blaz Chief Officer Public Utilities Agency of Guam P.O. Box 3010 Agana, GU 96910 (671) 646-8891
Northern Mariana Islands	William Lopp, Chief Division of Environmental Quality Commonwealth of the Northern Mariana Islands P.O. Box 1304 Saipan, CM 96950	F. Russell Mechem II Chief Division of Environmental Quality Public Health & Environmental Serv. P.O. Box 409 Saipan, MP 96950 (670) 234-6114 Pedro Sasamoto Executive Director Commonwealth Utilities Corporation Office of the Governor Lower Base Saipan, MP 96950 (670) 322-4033	F. Russell Mechem II Chief Division of Environmental Quality Public Health & Environmental Serv. P.O. Box 409 Saipan, MP 96950 (670) 234-6114 Pedro Sasamoto Executive Director Commonwealth Utilities Corporation Office of the Governor Lower Base Saipan, MP 96950 (670) 322-4033	Pedro Sasamoto Executive Director Commonwealth Utilities Corporation Office of the Governor Lower Base Saipan, MP 96950 (670) 322-4033
Marshall Islands	General Manager Marshall Islands Environmental Protection Authority P.O. Box 1322 Majuro, Marshall Islands 96960 VIA HONOLULU	---	---	---

State	Drinking Water (a)	Water Quality (b)	Groundwater Protection (c)	Water Resources (d)
Micronesia	Donna Scheuring Environmental Health Coordinator Government of the Federated States of Micronesia Department of Human Resources Kolonia, Pohnpei 96941	---	---	---
Palau	Lucio Abrahan Executive Officer Palau Environmental Quality Protection Rd. Hospital Koror, Palau 96940	---	---	---
Puerto Rico	Clery Morales, Dir. Water Supply Supervision Program Puerto Rico Department of Health P.O. Box 70184 San Juan, Puerto Rico 00936 (809) 763-4307	Santos R. Betancourt Chairman Environmental Quality Board P.O. Box 11488 Santurce, PR 00910 (809) 725-5140	---	Luis Javier, Ex. Dir. P.R. Aqueduct & Sewer Authority Box 7066 Barrio Obrero Station Santurce, PR 00916 (809) 758-5757
U.S. Virgin Islands	Ira Hobson Dept. of Planning & Natural Resources Government of Virgin Islands Nisky Ctr., Suite 231 St. Thomas, VI 00802 (809) 774-3320	Francine Lang Director Environmental Protection Department of Planning & Natural Resources Nisky Ctr., Suite 231 St. Thomas, VI 00802 (809) 774-3320	Francine Lang Director Environmental Protection Department of Planning & Natural Resources Nisky Ctr., Suite 231 St. Thomas, VI 00802 (809) 774-3320	Francine Lang Director Environmental Protection Department of Planning & Natural Resources Nisky Ctr., Suite 231 St. Thomas, VI 00802 (809) 774-3320

Source: Council of State Governments, State Administrative Officials by Function, 1989 (Lexington, KY: Council of State Governments, 1990); U.S. Environmental Protection Agency, Drinking Water Information Guide (Washington, DC: U.S. Environmental Protection Agency, 1990). --- indicates none specified.

APPENDIX H

1990 NRRI SURVEY ON COMMISSION PLANNING ACTIVITIES AFFECTING WATER UTILITES

TABLE H-1

WATER UTILITY ANNUAL REPORTS

State	Are annual reports filed?	Are some utilities exempt from reporting?	Is a simplified form available?	Do reports include financial data?	Do reports address long-term planning?
Alabama	yes	no	no	yes	no
Alaska	yes	no	no	yes	no
Arizona	yes	no	no	yes	no
Arkansas	yes	no	no	yes	no
California	yes	no	yes(a)	yes	no
Colorado	yes	no	yes(a)	yes	no
Connecticut	yes	yes(b)	yes(a)	yes	no
Delaware	yes	no	yes	yes	yes(c)
Florida	yes	no	yes(a)	yes	no
Hawaii	yes	no	yes(a)	yes	no
Idaho	yes	no	yes(a)	yes	no
Illinois	yes	no	no	yes	no
Indiana	yes	no	no	yes	no
Iowa	yes	no	no	yes	no
Kansas	yes	no	yes(d)	yes	no
Kentucky	yes	no	yes(a)	yes	no
Louisiana	yes	no	yes(a)	yes	no
Maine	yes	yes(e)	yes(f)	yes	no
Maryland	yes	no	yes(a)	yes	no
Massachusetts	yes	no	no	yes	no
Michigan	yes	no	yes(a)	yes	no
Mississippi	yes	no	no	yes	no
Missouri	yes	no	yes(g)	yes	no
Montana	yes	yes(h)	no	yes	no
Nevada	yes	no	no	yes	no
New Hampshire	yes	no	no	yes	no
New Jersey	yes	no	yes	yes	no
New Mexico	yes	no	yes(a)	yes	no
New York	yes	yes(f)	yes(a)	yes	no
North Carolina	yes	no	yes(a)	yes	no

TABLE H-1 (continued)

State	Are annual reports filed?	Are some utilities exempt from reporting?	Is a simplified form available?	Do reports include financial data?	Do reports address long-term planning?
Ohio	yes	no	no	yes	no
Oklahoma	yes	no	yes(d)	yes	no
Oregon	yes	yes	yes(a)	yes	no
Pennsylvania	yes	no	yes(a)	yes	no
Rhode Island	yes	yes(a)	no	yes	no
South Carolina	yes	no	no	yes	no
Tennessee	yes	no	yes(a)	yes	no
Texas	yes	no	yes(d)	yes	no
Utah	yes	no	no	yes	no
Vermont	yes	no	yes(d)	yes	no
Virginia	yes	no	no	yes	no
Washington	yes	no	yes(a)	yes	no
West Virginia	yes	no	no	yes	no
Wisconsin	yes	no	yes(a)	yes	no
Wyoming	yes	no	no	yes	no
Virgin Islands	yes	no	no	yes	no
Commissions reporting yes	46	5	26	46	1

Source: 1990 NRRI Survey on Commission Regulation of Water Systems.

(a) For smaller systems.
(b) Homeowners' and condominium associations.
(c) Some recently added sections of the report relate to planning.
(d) All forms have been simplified.
(e) Systems with annual revenues less than $5,000.
(f) Systems with annual revenues less than $50,000.
(g) Systems serving fewer than 5,000 customers.
(h) Nonprofit systems.

TABLE H-2

WATER UTILITY SUPPLY PLANNING

State	Are long-term supply plans required?	Are some utilities exempt from planning?	Is a long-term supply planning policy being considered?	Does another agency prepare a statewide water resource plan?
Alabama	no	na	no	yes
Alaska	no	na	no	no
Arizona	no	na	yes	yes
Arkansas	no	na	no	yes
California	yes(a)	no	no	yes
Colorado	no	na	no	unkown
Connecticut	yes(b)	yes(c)	na	yes
Delaware	no(d)	na	no	yes
Florida	no	na	no	yes
Hawaii	yes(e)	no	na	yes
Idaho	no	na	no	yes
Illinois	no	na	yes	no
Indiana	yes(f)	yes(g)	no	yes
Iowa	no	na	no	unkown
Kansas	no	na	no	yes
Kentucky	yes(h)	yes(h)	yes	yes
Louisiana	no	na	no	unkown
Maine	no	na	no	no
Maryland	no	no	no	yes
Massachusetts	no	na	no	yes
Michigan	no	na	no	yes
Mississippi	no	na	no	yes
Missouri	yes(i)	no	no	yes
Montana	no	na	no	yes
Nevada	yes(j)	no	yes	yes
New Hampshire	no	na	yes	no
New Jersey	no	na	yes	yes
New Mexico	yes(k)	na	no	yes
New York	no	na	no	no
North Carolina	no	na	no	yes

TABLE H-2 (continued)

State	Are long-term supply plans required?	Are some utilities exempt from planning?	Is a long-term supply planning policy being considered?	Does another agency prepare a statewide water resource plan?
Ohio	no	no	no	no
Oklahoma	no	na	no	yes
Oregon	no	na	no	no
Pennsylvania	no	no	no	yes
Rhode Island	yes(l)	yes(m)	na	yes
South Carolina	no	na	no	yes
Tennessee	no	na	no	no
Texas	no	na	yes	yes
Utah	no	na	no	no
Vermont	no	na	yes	no
Virginia	no	na	no	yes
Washington	no	na	yes(n)	yes
West Virginia	no	na	yes(o)	no
Wisconsin	no	na	no	yes
Wyoming	no	na	no	no
Virgin Islands	no	na	no	no
Commissions reporting yes	9	4	8	30

Source: 1990 NRRI Survey on Commission Regulation of Water Systems.

na = not applicable.
(a) Class A water utilities only; characterized as traditional and/or least-cost.
(b) Every five years; characterized as traditional, least-cost, and/or marginal-cost.
(c) Utilities serving fewer than 1,000 customers.
(d) The Department of Natural Resources and Environmental Control has certification authority and requires plans, which are provided to the commission.
(e) Supply projections required for system expansion; characterized as traditional.
(f) Not on an ongoing basis; characterized as traditional supply.
(g) Small rural systems.
(h) Supply plans are only required during certification; characterized as all types.
(i) Not on an onoing basis; characterized as traditional and/or integrated resource.
(j) Resource planning applies only to large systems; characterized as least-cost.
(k) Only if a system amends its certification.
(l) Plans are characterized as traditional supply.
(m) Small systems.
(n) Only in conjunction with the Department of Health.
(o) As a requirement for filing a rate case.

TABLE H-3

WATER CONSERVATION, DEMAND MANAGEMENT, AND DROUGHT PLANNING

State	Is there a policy on conservation or demand management?	Has conservation been addressed in rate cases or other cases?	Is there a policy on on drought management?	Are drought contingency plans required?
Alabama	no	yes	yes(a)	no
Alaska	no	yes	no	no
Arizona	no	yes	no	no
Arkansas	no	no	no	no
California	yes	yes	yes	no
Colorado	no	yes	no	no
Connecticut	yes	yes	yes	yes
Delaware	yes	yes	no	no
Florida	yes	yes	no	no
Hawaii	no	yes	no	yes
Idaho	no	yes	no	yes(b)
Illinois	no	yes	no	no
Indiana	no	no	no	no
Iowa	no	no	no	no
Kansas	no	no	no	no
Kentucky	yes	yes	yes	no
Louisiana	no	no	no	no
Maine	no	yes	no	no
Maryland	no	yes	no	no
Massachusetts	no	yes	no	no
Michigan	no	yes	yes(c)	no
Mississippi	no	yes	no	no
Missouri	yes(d)	no	no	no
Montana	no	no	no	no
Nevada	yes	yes	no	no
New Hampshire	yes	yes	no	no
New Jersey	yes	yes	yes	yes
New Mexico	no	no	no	no
New York	yes	yes	yes	yes
North Carolina	no	yes	no	no

TABLE H-3 (continued)

State	Is there a policy on conservation or demand management?	Has conservation been addressed in rate cases or other cases?	Is there a policy on on drought management?	Are drought contingency plans required?
Ohio	no	yes	no	yes(e)
Oklahoma	no	yes	no	no
Oregon	no	yes	yes	no
Pennsylvania	yes	yes	yes(f)	yes(f)
Rhode Island	no	yes	yes	no(g)
South Carolina	no	no	no	yes
Tennessee	no	no	no	no
Texas	yes	yes	yes	yes
Utah	no	yes	no	no
Vermont	yes	yes	no	no
Virginia	no	yes	no	no
Washington	no	yes	no	no
West Virginia	yes	yes	yes	no
Wisconsin	no	yes	no	no
Wyoming	no	yes	no	no
Virgin Islands	no	no	no	no
Commissions reporting yes	14	35	12	9

Source: 1990 NRRI Survey on Commission Regulation of Water Systems.

(a) A standard statement regarding drought situations and unnecessary water use.
(b) In so far as plans must be instituted under the utility's mandate to provide service.
(c) By regulation the commission allows utilities to make drought arrangements as necessary.
(d) Yes for demand management; no for conservation.
(e) Required by the state Environmental Protection Agency.
(f) In so far as a tariff requirement setting forth what systems must do in the event of a drought.
(g) Utilities adhere to the commission's drought policy.

TABLE H-4

WATER SUPPLY SHORTAGES

State	Have any water systems been affected by supply shortages?	Reason for Supply Shortage: Drought	Population Growth	Impairment of Supplies	Other
Alabama*	no	-	-	-	-
Alaska	yes	X	-	-	-
Arizona	yes	X	X	X	-
Arkansas	no	-	-	-	-
California	yes	X	X	X	-
Colorado	no	-	-	-	-
Connecticut*	yes	-	-	-	X(a)
Delaware*	yes	-	-	-	-
Florida*	yes	X	X	X	-
Hawaii	no	-	-	-	-
Idaho	no	-	-	-	-
Illinois*	yes	X	-	-	-
Indiana*	yes	X	X	-	-
Iowa	no	-	-	-	-
Kansas	yes	X	-	X	-
Kentucky*	yes	X	-	-	-
Louisiana	no	-	-	-	-
Maine*	no	-	-	-	-
Maryland*	no	-	-	-	-
Massachusetts*	yes	-	X	-	-
Michigan*	yes	-	X	-	-
Mississippi*	yes	-	-	-	X(b)
Missouri	yes	X	-	-	X(c)
Montana	yes	X	-	-	-
Nevada	yes	X	X	X	-
New Hampshire*	yes	-	-	-	X(d)
New Jersey*	yes	-	-	X	-
New Mexico	yes	X	X	X	-
New York*	yes	X	-	-	X(e)
North Carolina*	yes	X	X	-	-

TABLE H-4 (continued)

State	Have any water systems been affected by supply shortages?	Reason for Supply Shortage: Drought	Population Growth	Impairment of Supplies	Other
Ohio*	yes	-	X	X	-
Oklahoma	yes	-	-	-	X(f)
Oregon	no	-	-	-	-
Pennsylvania*	yes	-	-	X	-
Rhode Island*	yes	X	-	-	-
South Carolina*	yes	X	X	X	-
Tennessee*	no	-	-	-	-
Texas	yes	X	X	X	-
Utah	yes	X	-	-	-
Vermont*	yes	-	X	X	X(g)
Virginia*	yes	X	-	-	-
Washington	yes	-	X	X	-
West Virginia*	yes	X	X	-	-
Wisconsin*	yes	X	X	X	-
Wyoming	yes	-	-	-	X(h)
Virgin Islands*	no	-	-	-	-
Commissions reporting yes	34	21	16	14	8
Eastern states*	21	11	10	7	5
Western states	13	10	6	7	3

Source: 1990 NRRI Survey on Commission Regulation of Water Systems.

* States east of the Mississippi River

(a) Lack of planned expansion.
(b) Overuse of acquifer.
(c) Demand-management problems.
(d) Shortage due to unmetered system.
(e) Use of acquifer beyond capacity.
(f) Poor system design and system overload.
(g) Leaking distribution system.
(h) Poor system operation.

APPENDIX I

BASIC WATER SYSTEM PLANNING INVENTORY

1. Name and address of the water supply system:

System name ______________________________
Mailing address ______________________________
City ____________ State ____________ Zip Code ________

2. Name and position of person(s) to contact for further information (plant manager, operator, owner, etc.):

Name ____________ Position ____________ Phone ________

3. Operation location and general description of the system's service area (a).

City ____________________ County ____________

Service area (a map showing the service area would be helpful):

____
____

4. Time period for which water use data are being provided:

12-month period beginning: Month _____ Year _____
Seasonal use beginning: Month _____ Year _____ to
Month _____ Year _____

5. Source(s) and amount of supply:

Source of supply by name or number	Water supply intake location	Average daily amount withdrawn or purchased on operating days (gallons per day)	Percent of Total	3Q20 of pump test yield if known
Streams(b)				
______	______	______	______	______
______	______	______	______	______
Wells(b)				
______	______	______	______	______
______	______	______	______	______
Springs(b)				
______	______	______	______	______
______	______	______	______	______
Lakes or ponds(b)				
______	______	______	______	______
______	______	______	______	______
Other Supplies(c)				
______	______	______	______	______
Total			100%	
______	______	______	______	______

Describe the contractual agreements your system may have with other suppliers, specifying the amount to be supplied under various conditions and system contracts.

____

____

6. What percentage of the total average daily withdrawal shown above is metered? __________ estimated? __________

7. Normally, this system operates _____ hours per day, ______ days per week, and ______ weeks per year.

8. Average amount of water reused or recirculated in gallons per day (GPD) on normal operating days; ________ GPD

9. Total water use (average daily withdrawal plus reuse): _______ GPD

10. Historical peak water use: ________ GPD

    Frequency of near peak water use:

    ____

    Approximate time(s) of peak water use (hours of day, days of week, month, and season of year): ____

    ____

11. Specify the location of treatment plant(s) and describe the type of treatment including major processes and the maximum design treatment plant capacity in gallons per day (a): ____

    ____

12. Describe distribution facilities (a):

Diameter of distribution lines:	____________	Average Age:	____________
Diameter of high service lines:	____________	Average Age:	____________
Number of pumps:	____________	Pump sizes:	____________

13. What percentage of the distributed water is metered? ___________ Estimated? ____________

14. Total storage capacity for treated water by type of storage (a):

Type	Amount of Storage (Gallons)	Overflow Elevation
Tanks	____________________	____________
Clear wells	____________________	____________
Reservoirs	____________________	____________
Distribution lines and mains	____________________	____________
Other	____________________	____________

15. Describe how and where records on the location of water lines, system valves and hydrants, storage facilities and pumping facilities are kept (i.e., map, computerized, etc.)

____

____

16. Number of connections by type: residential ______________, commercial ________, and industrial______________. Number of people served by this system: ________.

17. Describe the water use records maintained by the system, i.e., basic data maintained, categories of use, and if computerized.

____

____

18. Number of multiple units with only one meter: ______________

Name	Address	Units

19. Average daily amount of water in gallons per day supplied by this system for each of the following purposes:

Sale to other towns and utility districts	________
Industrial	________
Commercial	________
Residential	________
Public supply (d)	________
System losses (e)	________

Estimated Monthly Water <u>Sales</u> by User Category in Gallons (Use latest typical year)

	Residential	Commerical	Industrial	Towns
January				
February				
March				
April				
May				
June				
July				
August				
September				
October				
November				
December				

20A. Identify below all other towns or utility districts, if any, purchasing water from this system.

____

____

20B. Specify the contractual conditions contained in each agreement:

Name and Address of the Purchasing System	Average Amount of Water Purchased Per Month (GPD)	Contact Point Name and Telephone Number

21. Identify below all industrial and commercial customers purchasing more than 2,000 gallons of water per day from system.

Major Industrial Customers

Customer's Name and Telephone Number	Amount of Water Purchased (GPD)

Major Commercial Customers

Customer's Name and Telephone Number	Amount of Water Purchased (GPD)

Specify whatever contractual conditions may exist between any large water used and the utility, i.e. interruptable service, etc.

____

____

22. Has the system experienced any major change(s) in its water supply source during the past 5 years? ____________________ If so, explain:

____

____

Do you anticipate any major change(s) in the system's water supply source during the next 2 to 5 years? ____________________ If so, explain:

____

____

23. Have you recently made or do you plan to make any major changes in the system's facilities (treatment plant expansion, extension of the system's service lines, installation of new and/or larger water mains and distribution lines, etc.) during the next 2 to 5 years? ____________ If so, describe these changes and provide the completion date or estimated completion date for all completed and ongoing or anticipated system changes: ______________________

____

____

24. What percent change (increase or decrease) in this system's average monthly water withdrawal, if any, has occurred over the past 5 years?

    Explain the reason for this change: ______________________________________

    ____

    Do you foresee any significant increase or decrease in the system's average monthly water withdrawal during the next 2 to 5 years and, if so, by what percentage?

    Explain the reason for this anticipated change: ___________________________

    ____

25. What water supply problems, if any, has this system experienced during the past 5 to 15 years? For example, these problems could include water supply shortages resulting from either inadequate supplies due to low streamflows and groundwater levels or inadequate system pumping and distribution capacity, pump failures, leaking water mains and distribution lines, etc.; water quality problems including taste and odor, excessive iron and manganese concentrations, etc.; turbidity and heavy rainfall and flooding, etc. Describe each problem and indicate its frequency and year(s) of occurrence.

    ____

    ____

26. Describe the general effects of those water supply shortages and water quality problems, if any, experienced by this system and its users during the 1985-1987 drought on the area's economy, its environment, and the social well-being of its residents.

    Economic: ____

    Environment: ____

    Social: ____

27. Describe the specific measures (public information/education, conservation, use restrictions, rate increase, etc.) utilized by your systems to deal with any water supply shortages and quality related problems experienced by your system during the 1985-1986 drought period.

    ____

    ____

28. Describe the public's response to specific measures used by your system to deal with water supply shortages and quality-related problems, if any, experienced during 1985-1986 drought period.

____

____

29. Describe how and what chemical supply records are maintained for this system. Where are the records located and what records are computerized. Also, what basic information is contained in these records?

____

____

30. What chemicals (alum, chlorine, lime, etc.) and/or other supplies does your system use in treating its water and what quantity of each is used in a day. Also, how many days supply of each do your normally maintain?

Chemicals/Supplies	Average Daily Use	Normal Supply in Days

31. What companies supply these chemicals in your area? Provide names, addresses and telephone numbers of back-up sources as well.

Chemicals	Supplier	Address	Phone

32. Describe how and what equipment supply records are maintained for this system. Where are the records located and what records are computerized. Also, what basic information is contained in the records.

____

____

33. Specify the location of all major pieces of equipment and supplies owned by the water system which may be needed to repair the system (including pipes, pumps, hydrants, blowoffs, valves, etc.).

____

____

34. List area suppliers of pipe and other major equipment, including portable filters, pumps, and valves.

Items	Supplier	Equipment	Phone

35. Does your system prepare an annual water management and operations report?
Yes __________ No __________ Where are these kept? ______________

List the names, addresses and phone numbers (or other means of communications) of those individuals who may be able to assist the water system in an emergency. This list should include the plant manager and other current employees, retired personnel, others knowledgeable of water system operations, EPA emergency personnel, Tennessee Office of Water Management Emergency personnel, United States Coast Guard, Tennessee Emergency Management Agency, Food and Drug Administration Poison Control Center, Area Sheriff, Police and Fire Departments, Tennessee Bureau of Engineers, Tennessee Valley Authority, and others.

Person	Address	Phone(s)	Means of Communication	Expertise
________	________	________	________	________
________	________	________	________	________

36. Identify your system's governing body by checking one of the following:
Local government ___ Private, reports to local government ______________
Other (specify) ______________________________________

37. What is the source of your system's operating revenue? ______________

38. What is your system's average cost of water withdrawal? ______________
per __________

39. Indicate your system's present rate structure by checking one of the following:
Uniform __________ Varies by user __________ Other (specify) __________

40. Under your system's present rate structure, what is the minimum cost per 1,000 gallons of water for each of the following user groups?
Residential ______ Industrial ______ Commercial ______________
Other (specify) ______________________________________

41. What plumbing code, conservation measures and/or other ordinances, if any, are currently in effect in your system's service area?

____

42A. Does your system have an active, ongoing public information and education program to inform water users about the relative merits of water conservation and emergency plans in the event of water supply shortages?
Yes _______ No _______ If yes, describe the program briefly.

____

42B. Describe the communication resources available for use in notifying customers and the public of a water shortage or emergency (list newspapers, radio-tv stations, and other means such as automobile public address, etc.):

____

____

43A. Does your system have an active leak detection program? Yes ________ No ______

43B. Does your system have a cross-connection program? Yes __ No __

44. Identify any alternative sources of water which your system has used in past years to alleviate water supply shortages. For each alternate source identified, indicate the years and amount of water used; the length of time over which the alternative source was utilized; the name, address, and telephone number of the water utility district or owner supplying the water; and any problems encountered in utilizing this source: ______________________________

____

45. Identify any alternative sources of water which your system might potentially be able to utilize to alleviate future water supply shortages. For each potential alternate source identified, indicate the type of source and name, address, and telephone number of the water supply district or owner of the water. ______________________________

____

46. List, to the extent the data are available, the latest test results and date of the test for each of the following water quality parameters for your system's raw water supply.

Contaminant	Level	Date
Barium	mg/1	
Chloride	mg/1	
Chromium	mg/1	
Copper	mg/1	
Fecal Coliform	mi	
Fluoride	mg/1	
Iron	mg/1	
Lead	mg/1	
Magnesium	mg/1	
Manganese	mg/1	
Methylene Blue Active Substance	mg/1	
Mercury	mg/1	
Nitrate	mg/1	
Selenium	mg/1	
Silver	mg/1	
Sulfate	mg/1	
Total Dissolved Solids	mg/1	
Zinc	mg/1	

47. What percent of your customers use septic fields? _____% Sewer services? ____% Other ____% Please specify what "other" includes.

____

____

48. Average amount of water returned to a public wastewater treatment system in gallons per day. ___________________________

49. Do your sewer and water supply systems have combined billing?
Yes _____ No _____

50. Describe and list any contractual arrangements that have been made with other towns, water systems, private supplies, etc. for water, bottled water, water tank truck hauling, pumping equipment, etc. in the event of any emergency. Also, note contact person and phone number(s) where contact can be reached.

____

____

Source: Tennessee Department of Health and Environment, *Local Drought Management Planning Guide for Public Water Suppliers* (Nashville, TN: Office of Water Management, Tennessee Department of Health and Environment Office of Water Management, 1988), A1-A14.

Notes:

a. Please describe the system's service area in geographic terms including the names of specific communities and/or urban areas, or parts thereof, as well as any rural areas which are served by the system. Also indicate the names of the counties in which the service area lies. Indicate the location of maps showing the areas served, population served, location of treatment and storage facilities, water mains, valves and hydrants, pumping facilities, and large water users, i.e. industries, etc.

b. The location of all supply wells and intakes should be mapped. If the source of supply is a surface water source, also identify the source's intake location by river mile, where possible, or latitude and longitude. Groundwater supplies should be located by latitude and longitude. Specify intake elevation in reservoir.

c. Other suppliers include both private and public water supply systems from which water is purchased either on a regular basis or occasionally for emergency or backup water supply purposes.

d. Water supplies for carrying out public services include water used in fire fighting, street washing, and the maintenance and operation of municipal parks and swimming pools.

e. Water losses in the system include losses due to deteriorating water mains and distribution lines.

APPENDIX J

ELEMENTS OF AN INTEGRATED WATER RESOURCE PLAN

ELEMENTS OF AN INTEGRATED WATER RESOURCE PLAN

PRELIMINARIES

A. Letter of Transmittal and Acknowledgements
- To the agency for whom the planning report was prepared
- List of individuals and agencies who assisted in the development of the plan

B. Executive Summary
- Should highlight findings, conclusions, and recommendations
- Should be specific, orderly, and concise
- May refer to specific sections of the report
- Requests for agency actions should be clearly stated

C. Table of Contents
- Major headings and subheadings, including appendices
- List of tables
- List of figures

D. Need, Scope, and Objectives of the Plan
- Origins of the plan, including statutory and regulatory mandates
- Time frame of the plan
- What the plan does and does not cover
- Objectives of the plan (such as reliable service, minimal environmental impact, low costs and reasonable rates, load management, drought management, and long-term conservation and wise use)
- How the study will be used in and adapted to future management and regulatory decisionmaking

E. General and Historical Background
- Location of system and nearby systems
- Geography, hydrology, meteorology, geology, surface and groundwater, etc.
- Soil characteristics and subsurface conditions
- Demographics (past, present, and future population characteristics)
- Employment (industry, commercial, service, government)
- Residential, industrial, commercial, recreational, agricultural, and institutional development and redevelopment
- Land use (present and future, including land use in detail in the vicinity of existing and proposed water supply facilities)
- Drainage, water pollution control, and flood control management
- Wastewater facilities

F. **Description of the Water Delivery System**
- Map of the service territory, including location of nearby systems
- Detail of location, age, cost, and physical condition of:
  - source of supply and pumping facilities
  - transmission facilities
  - treatment facilities
  - storage facilities
  - fire hydrants
  - administrative offices and all other physical plant

G. **Description of the Rate Structure**
- Rate history, including regulatory proceedings
- Current rate structure, including fees
- Metering and billing practices
- Ancillary services and rates charged

H. **Water Quality Issues**
- Record of certification by state drinking water agency
- Record of water quality and compliance with water quality regulations
- Existing contamination issues and potential solutions
- Potential contamination issues and potential solutions
- Existing and planned water quality monitoring

I. **Water Quantity Issues**
- Historical water supply and reasons for variations
- Water supply forecasts (for the utility and the region)
- Description of drought probabilities and occurrence
- Historical water demand and reasons for variations
- Description of average and peak demand patterns
- Water demand forecasts (short and long-term by water-use sector)
- Potential for conservation and load management to affect demand
- Estimates of price elasticities for water demand by water-use sector

J. **Anticipated Infrastructure Needs**
- Replacements
- Improvements
- Additions to capacity to meet demand growth

K. **Description of Alternatives for Meeting Infrastructure Needs**
- Includes both structural (new supply) and nonstructural (conservation) options
- Technical feasibility of each alternative
- Benefits and costs of each alternative
- Economic, environmental, societal, and regulatory considerations
- Potential barriers to implementing each alternative

L. **Analysis of Alternatives**

- Selection of most promising options for fashioning an effective, flexible, and responsive plan
- Integration of methods of supply need water for methods for controlling and moderating demand
- Construction of scenarios, pitting the selected mix of options against possible economic, environmental, societal, and regulatory circumstances
- Evaluation of the economic and technical success of each mix of options under the circumstances of the various scenarios.
- Analysis of the uncertainties associated with each course of action
- Screening of the alternatives to eliminate those that are not feasible

M. **Selection of Alternative(s) for the Plan**

- Rank ordering the alternatives according to incremental costs
- Further testing of each alternative for cost-effectiveness from a variety of viewpoints (including ratepayers, utilities, and society)
- Reevaluation of the alternatives considering economic, environmental, societal, and regulatory factors
- Development of decision rules for selecting the alternative(s) that optimize the objectives of the plan
- Selection of the optimal course of action for implementation

N. **Impact Analysis of Selected Alternative(s)**

- Economic impact analysis (such as societal and ratepayer costs)
- Environmental impact analysis (such as irreversible effects)
- Societal and cultural impact analysis (such as consumer satisfaction)
- Regulatory impact analysis (such as regulatory costs)

O. **Drought Contingency and Emergency Management Plan**

- Identification of priority uses, consistent with appropriate public policies
- Sources of emergency water supplies and diversions
- Potential use of pressure reduction
- Plans for public education and voluntary use reduction
- Plans for use bans, restrictions. and rationing
- Plans for pricing and penalties for excess use
- Coordination with other utilities and local authorities

P. **Coordination and Consistency**

- Coordination of the long-term plan with the drought contingency and emergency management plan
- Relationship of the plan to nearby water utilities
- Regional economic, environmental, and societal effects
- Economic development and land use policy issues
- Consistency of the plan with federal, state, regional, and river basin plans and water resource policies

Q. **Planned Implementation**
- Timetables and organization charts
- Anticipated milestones
- Regulatory filings and anticipated decisions
- Monitoring and ongoing evaluation
- Coordination with other planning processes
- Flexibility of the plan in meeting changing conditions

R. **Administration and Financing**
- Administrative structure and associated costs
- Financing methods
- Cost allocation
- Short-term and long-term rate impacts

S. **Public Participation**
- Public information and education
- Opportunities for public comment
- Identification of likely participants in planning proceedings

Source: Authors' construct based in part on Paul T. Carver and A. Ruth Fitzgerald, "Planning for Wastewater Collection and Treatment," in American Society of Civil Engineers, *Urban Planning Guide* (New York: American Society of Civil Engineers, 1986), 403-4 and National Association of Regulatory Utility Commissioners, *Least-Cost Planning Handbook for Public Utility Commissioners, Volume 1* (Washington, DC: National Association of Regulatory Utility Commissioners, 1988), 19-20.

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