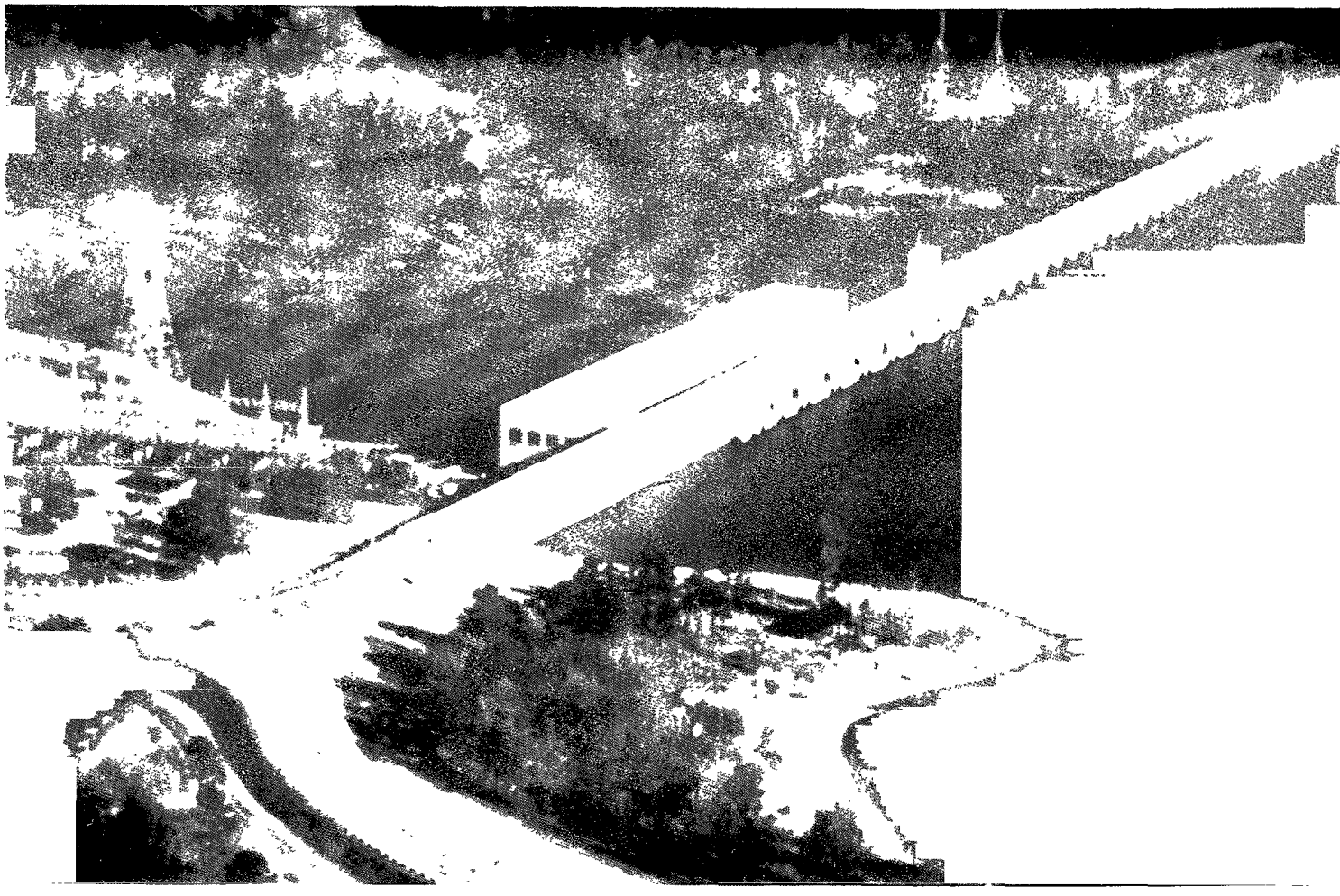
Water Resources And The Nation's Water Supply

Issues And Concerns



As our Nation approaches the 21st century its population growth and industrial development as well as changing water use priorities are placing new demands on our water resources and are leading to increasing water shortages and competition for the limited supply.

How bad a water picture do we face? No one knows for sure. Fortunately, there is now a growing awareness that water resources are limited and seriously polluted and that ways must be found to augment the water supply and achieve the greatest use from existing resources.

This study examines existing and emerging water resources issues and concerns and represents the perspective GAO is using to organize its audit efforts.

Study By The Staff Of The United States General Accounting Office

APRIL 13, 1979

FOREWORD

While the United States as a whole has an abundant water supply, the geographical distribution and availability of its water resources often does not match needs and demands. This condition, magnified by the Nation's continuing population growth and industrial development, has led to water shortages and increased competition for the limited supply. Also, new national priorities have emerged. Satisfaction of energy and food and fiber needs; changing land use policies; and preservation and enhancement of environmental, aesthetic, and recreational values place new demands on our Nation's water resources.

The Water Resources Council's Second National Water Assessment shows that the increase in annual freshwater consumptive requirements by the year 2000 will further compound water supply problems. These include shortages resulting from poor distribution of supplies, instream-offstream conflicts, competition among offstream users, ground water overdrafts, quality degradation of both surface and ground water supplies, and institutional conflicts that inhibit a unified water management.

Fortunately, however, there is now an emerging awareness that water resources are limited and can be polluted to the point where they are not only useless but hazardous to life. It is becoming increasingly clear that our Nation must augment its water supply to avert critical water shortages and must try to achieve the greatest use from existing supplies. Better management and technology is necessary to achieve more efficient use of water from conservation, improved surface and ground water management, weather modification, desalination, and water reuse.

The resolution of existing and projected future problems emphasizes the need for comprehensive, coordinated water resources management. Water resources management--including unified efforts in planning, development, and project operations by all concerned agencies and guided by Federal water policy--is the key to solutions to the water resources problems. The challenge is to reshape our water policies and programs to best satisfy our Nation's social, economic, and environmental goals.

In this study we sought to identify existing and emerging water resources problems and issues, and we hope the study will contribute to a better understanding of the key water

problems facing our country. The study was prepared by the Community and Economic Development Division as part of GAO's continuing reassessment of national concerns and represents the perspective GAO is using to organize and direct audit efforts.

To obtain copies of GAO staff studies and reports, see the instructions on the inside of the back cover. Questions concerning this study should be directed to Mr. Harold Pichney, Water Programs Coordinator. He is located in Room 6812, GAO Building, and can be reached at (202)275-6076.

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Contents

CHAPTER		Page
1	WATER RESOURCES PLANNING, MANAGEMENT, AND DEVELOPMENT	1
	Scope and concerns of this study	1
	Related issues	1
	The Federal role	3
	Water supply and use trends 1975-2000	9
	Water supply problems - today and in the future	15
	President's water policy actions	18
2	WATER RESOURCES ISSUES AND CONCERNS	21
3	MAJOR WATER RESOURCES ISSUES AND CONCERNS	22
	Are existing plans, policies, and programs effectively addressing the water resources problems facing the Nation, regions, and States?	22
	Do water agencies and industry have effective water management and conservation programs which make efficient use of water supplies?	30
	Will Federal and non-Federal efforts ensure an adequate water supply for municipal and industrial purposes?	36
	Are financing, cost sharing, and repayment policies for Federal or federally assisted water resources projects and programs effectively meeting today's needs?	43
	What are the problems impacting on the timely, efficient, and economical construction and maintenance of water resources projects?	49
	Ground water supply management and conservation--what are the problems and how can they be resolved?	55

CHAPTER		Page
4	OTHER WATER RESOURCES ISSUES AND CONCERNS	61
	How can water quality and water supply programs be effectively integrated?	61
	Do Federal agencies adequately consider environmental effects in water resources management and project formulation?	62
	Are water information collection and evaluation efforts promoting optimal water resources programs?	62

CHAPTER 1

WATER RESOURCES PLANNING, MANAGEMENT, AND DEVELOPMENT

SCOPE AND CONCERNS OF THIS STUDY

The focus of this study is on those programs and activities concerning water resources planning, management, and development designed to provide adequate water supplies to meet present and future demands. Also, we are concerned with another water resource problem, flooding, because loss of life and property from floodwaters continue to be significant and affects all parts of the United States.

Water resources planning encompasses the assessment of the quantity and quality of available water supplies, forecasting future water demands, analysis of existing and potential water supply problems, and preparing proposals for resolving such problems.

Management of water resources covers such things as allocating water among competing uses to optimize project benefits, developing technology to augment or make more efficient use of water supplies, and carrying out activities to reduce the demand for and to conserve water supplies.

The development of water resources primarily concerns matters relating to project formulation, justification, and construction. Water resources developments may be single-purpose flood control or navigation projects or multiple-purpose dam and reservoir projects which may provide for hydroelectric power generation, flood control, recreational activities, and water supplies for irrigated agriculture as well as for domestic and industrial uses.

RELATED ISSUES

Federal programs on the development and management of water resources are not so clearcut to deal exclusively with water supply but may concern, to a significant extent, land use, environmental protection, and transportation policy matters. Also, Federal policies and programs on nonwater areas such as energy development and food production can impose significant demands for water supplies and, therefore, impact on the development and management of water supplies. Examples of the more important interrelationships follow.

Land is a major element in developing facilities for the storage and conveyance of water. Lands required for such purposes usually have economic and environmental values in alternatives uses. Intensive land use for urban and industrial development often creates water supply problems. By the same token, the development of water resources to provide irrigation water can transform unproductive land to land more productive for food and fiber products. Also, concern for preserving and protecting outdoor recreation, fish and wildlife habitat, as well as other environmental values has precluded or materially altered the development of water resources. Land use planning, management, and control issues are the subject of another GAO staff study.

Environmental issues affect the management and development of water supply, particularly those matters relating to water quality. For example, water pollution resulting from irrigation and municipal and industrial wastes significantly impacts on the availability and use of our water resources. Also, the development of water resources projects affects environmental conditions such as fish and wildlife habitat, recreation and esthetic values. While we are concerned with water supply quality problems in this study, water quality matters, especially pollution abatement efforts, are primarily examined in a separate GAO study on environmental protection issues.

Energy and food issues also impact upon water supply matters. Water is essential to almost every energy process and is required in tremendous quantities to produce food and fiber products. Federal policies and programs to develop new energy sources, such as synthetic fuels, to help solve the energy crisis as well as those to enhance food production for domestic and foreign markets will result in severe competition among water uses in the Western States where supplies are not adequate to meet demands.

Also, adequate water flows are necessary to maintain our navigable waterways which are a significant part of the Nation's overall commerical transportation network. While some aspects of the navigation purposes of multipurpose water resources projects are covered under this study, the construction of new locks and dams for transportation purposes and other primarily transportation-related Federal programs to maintain and foster waterborne commerce, such as constructing and improving channels, canals, and harbors, are covered under a separate GAO staff study on transportation issues.

Problems and issues resulting from too much water (flooding) are covered under this study as well as by staff studies on domestic housing and community development issues and land use planning, management, and control issues. Under this study, for example, we are concerned with both structural and nonstructural alternatives for controlling floods. Under the other studies, our concerns cover such related matters as flood plain zoning, flood insurance programs, and flood disaster relief programs.

Other GAO Staff Studies Related to Water Resources Issues

Title	Report No. and Date
Land Use Issues	CED-79-15 11/16/78
Transportation Issues	CED-78-159 10/10/78
Domestic Housing and Community Development Issues	CED-79-44 2/5/79
Food, Agriculture, and Nutrition Issues for Planning	CED-79-36 1/29/79
Environmental Protection Issues Facing the Nation	CED-79-63 3/15/79

THE FEDERAL ROLE

Management of the Nation's available water resources is, to a considerable extent, a State responsibility. State and local governments have an immediate and utilitarian interest in water resources management because their well-being, as that of the Nation as a whole, depends upon the availability of water resources of adequate quality and quantity.

The Water Supply Act of 1958 (Public Law 85-500) declared it to be policy of the Congress to recognize the primary responsibilities of the States and local interests in developing water supplies for domestic and industrial purposes and that the Federal Government should participate and cooperate with State and local interests in developing water supplies in connection with the construction of Federal water resources projects. It is interesting to note that Federal projects for the development and use of water resources are seldom initiated without strong State support and generally not undertaken in opposition to State desires.

The Federal concerns with our natural resources, environment, and the economic and social well-being of our people have led to many acts of Congress which clearly indicate that the Federal Government may participate to some degree in all aspects of water resources planning, management, and development. In response to such Federal concerns, the developing body of law has established varying degrees of Federal interest in such areas as hydroelectric power, irrigation, water supply, flood control, navigation, outdoor recreation, and fish and wildlife preservation and enhancement. The degree of Federal participation is generally limited to that required to achieve national objectives in an optimal manner and varies from a maximum participation in planning activities to minimum participation in operation and maintenance activities.

The Federal role in water resources planning basically stems from the Water Resources Planning Act of 1965 (Public Law 89-80). The act was designed to encourage conservation, development, and use of the Nation's water and related land resources on a comprehensive and coordinated basis by Federal, State, and local governments and private enterprise. Also, the act established the Water Resources Council, provided for establishment of river basin commissions, and authorized financial assistance to States for comprehensive water and related land resources planning. The river basin commissions were designed to be planning-coordinating entities where representatives of States and Federal agencies could coordinate activities and jointly develop river basin or regional plans for water and related land resources.

With respect to the management and use of the Nation's water resources, the Federal Government, by ownership of much of the land in the West, by its responsibilities over Indian lands, by constructing and operating water resources projects, by its various loan, grant, and technical assistance programs to municipalities, rural communities, and farmers, has both a direct and indirect role in such matters as the allocation of water among competing uses, water laws and rights, conservation and efficient use of water supplies, water quality, as well as water research and technology to increase the useable water supply.

The President's Water Policy initiatives call for enhanced Federal-State cooperation and propose grant programs to help States plan for their water needs and a task force with State, local, and Federal officials to

examine water-related problems and to deepen the Federal-State partnership in water resources policy and planning. Also, the Policy initiatives emphasizes nonstructural measures to reduce flood damages, raises the issue of Federal assistance for the deteriorating water systems in the East, and calls for the participation of States in the financing of Federal water projects. The Water Policy initiatives, as well as the increasing concerns over the adequacy of the Nation's water supply to meet future demands, may lead to legislative and administrative policy changes which could materially affect the respective roles of Federal, State, and local governments in water resources planning, management, and development.

Federal water-related programs are spread through 26 agencies within 8 departments and 10 independent agencies and commissions. The agencies have different missions, clientele, as well as a variety of ways for financing their programs.

Federal water and water-related programs are funded by many different appropriation accounts. For example, the public works appropriations for fiscal year 1978 provided about $3.4 billion to the Corps of Engineers (Civil Functions) and the Bureau of Reclamation for construction, rehabilitation, and operation and maintenance of water resources projects. Agricultural appropriations for fiscal year 1978 included, for example, $229 million for conservation operations, $250 million for rural water and waste disposal grants as well as $750 million for water and sewer facility loans.

The principal agencies involved in water resources planning, management, and development are discussed below.

AGC 00620

The Water Resources Council was established to carry out the policy of the Government as set forth in the 1965 Water Resources Planning Act of 1965 (Public Law 89-80)--to encourage conservation, development, and utilization of water and related land resources on a comprehensive and coordinated basis.

Its principal functions include:

--To maintain a continuing study and prepare periodically an assessment of the adequacy of supplies of water necessary to meet the water requirements in each water resources region in the United States and of the national interests therein.

--To appraise the adequacy of administrative and statutory means for coordination and implementation of the water and related land resources policies and programs of the several Federal agencies and to make recommendations to the President with respect to Federal policies and programs.

--To establish, after consultation with appropriate interested Federal and non-Federal entities and with the approval of the President, principles, standards, and procedures for Federal participation in the preparation of comprehensive regional or river basin plans and for the formulation and evaluation of Federal water and related land resources projects.

--To assist the States financially in developing and participating in the development of comprehensive water and related land resources plans.

AGC 00042

The Department of Agriculture is involved in the management of national forests for their multiple uses, products, and services; watershed treatment and management; small watershed and flood prevention projects for flood prevention, water supply, irrigation, drainage, recreation, fish and wildlife, and water quality management; economic analyses and projections of rural activities; credit, cost sharing, and technical assistance to farmers for installation of soil and water conservation practices and to rural bodies for water supply and sewage facilities; and supporting research. The Farmers Home Administration, which administers rural development, provides financial and management assistance in carrying out soil and water conservation, watershed protection and flood prevention, and community water and sewer system loan programs.

AGC 00305

The Department of the Army, Corps of Engineers, develops plans for beach protection, flood control, navigation, and multiple-purpose projects. It constructs, operates, and maintains project facilities. It regulates the use of navigable waters of the United States with respect to dredging and obstructions to navigation. Also, it provides State and local interests with flood plain information and carries out an Urban Studies Program to help metropolitan areas solve water and related land resources problems.

AGC 00033

The Department of the Interior has responsibilities in water resources research; data collection such as monitoring the quantity and quality of ground water supplies; desalination; conservation and development on public lands; studies of outdoor recreation; administration of certain wild and scenic rivers; sports, fisheries and wildlife; hydroelectric power marketing; weather modification; and development and operation of irrigation and multipurpose water resources projects.

AGC 00029

The Department of Transportation is involved with the navigation, marine safety, vessel pollution, and highway and bridge aspects of water resources development.

AGC 00912

The Department of Energy makes studies of the power phases of river basin development and licenses and regulates non-Federal hydroelectric power plants and in cooperation with the Council, assesses the impacts and requirements of water for energy resources development.

AGC 00074

The Department of Commerce conducts hydrometeorological studies; provides river and flood forecast and warning services; performs business and industrial water requirement analyses; makes projections of economic activity; takes census of a broad range of water uses; and conducts supporting research.

AGC 00023

The Department of Housing and Urban Development is concerned primarily with the municipal and urban aspects of water and related land resources, including flood insurance and urban hydrology. It makes financial grants to States and to metropolitan and urban communities for comprehensive planning and community development which may include support for water and sewer facilities, open spaces, recreational areas, and historic and aesthetic preservation.

AGC 00024

The Environmental Protection Agency is concerned with the abatement of water pollution and enhancement of the water quality of rivers and bodies of water, in cooperation with State and local governments and industry. It makes financial grants and provides technical assistance to State and local governments. It establishes standards for effluents from sources of discharge, for use of receiving water, and for drinking water and enforces its regulations for carrying out these standards.

River Basin Organizations

The United States has established several types of organizations for planning and managing river basins:

River Basin Commissions--To meet the need for broad participation in planning, the Water Resources Planning Act provides for the establishment of Federal-State river basin commissions on request of the States and recommendation of the Water Resources Council. Commissions have been established for the Pacific Northwest, the Great Lakes, the Ohio River, the Missouri River, the Upper Mississippi River, and the New England River Basins. Commission functions include:

--To serve as the principal coordinating agency for plans for water and related land development.

--To prepare and keep up-to-date a comprehensive coordinated joint Federal-State plan for water and related land resources development within the basin.

Interstate Compacts--Interstate compacts are entered into because of mutual recognition of the interests of several States in shared interstate waters. One of the principal purposes of many of these compacts is to allocate the use of the waters of an interstate river between or among the participating States to help secure property rights in water in the States concerned. Others have attempted quality management standards. About 35 interstate compacts relating to water resources have been approved by the Congress.

Federal-Interstate Compact Commissions--The Federal-Interstate Compact Commission for the Delaware River Basin was established by the legislatures of four States and the Congress in 1961. The Delaware River Basin Commission, created by the compact, is composed of representatives of the four basin States and the Federal Government. It is vested with broad powers to manage and control the water and related land resources of the entire Delaware Basin. A similar Federal-interstate compact has been established for the Susquehanna River Basin.

Tennessee Valley Authority--An independent Federal corporation was established by Congress in 1933 for water management activities in the Tennessee River Basin. It has constructed and operates an extensive system of dams, powerplants, and electric transmission systems, and other structures. The TVA continues to plan and develop the water and land resources of the basin.

Federal-State Interagency Committees--Federal-State Interagency Committees have been chartered by the Water Resources Council in the Pacific Southwest, Arkansas-White-Red, and the Southeast river basins. These bodies, composed of representatives of Federal and State agencies, coordinate planning activities and operational policies of the participants.

International Implications

The development and management of water resources has international implications. The International Boundary and Water Commission, United States and Mexico; and the International Joint Commission, United States and Canada, administer treaties between the respective nations that establish rights and responsibilities to waters flowing in streams across the international boundaries.

WATER SUPPLY AND USE TRENDS 1975-2000

Water is used for many purposes--domestic, livestock, manufacturing, mining, steam-electric generation, irrigation, navigation, recreation, fish and wildlife habitat, and waste disposal. Water used for these purposes may be withdrawn from its native course or may be used instream--free flowing, regulated, or ponded. It may be supplied by public or publicly regulated distributors or it may be self-supplied; its source may be from surface water, ground water, seawater, or waste water; and its quality may range from clear mountain streams to highly polluted waste waters.

To assess the adequacy of the Nation's water resources, reliable information must be available on the amount, availability, and quality of our water resources and on current usage and future requirements.

From a national perspective, there are abundant fresh water resources. Average annual precipitation is 30 inches for the conterminous United States, and average natural runoff is about 1,400 billion gallons per day (bgd). Large reserves of ground water also exist. However, with existing surface storage and the effects of extremes of annual precipitation that cause floods and drought, only about 680 bgd of the average streamflow is considered available. The difficulty is that the geographical and temporal distribution of water are highly variable. Precipitation varies widely from region to region, from season to season, and from year to year. Similar variation occurs in runoff and streamflow.

Regions exhibiting high levels of consumptive use through irrigated agriculture, such as the Southwest and West Central States, have the most varied annual runoff. Some regions of the country have chronic deficiencies, others have floods and periodic droughts. Most parts of the Nation are not satisfied with their water resources, and poor water quality is a problem in every region. Florida has a serious emerging water-shortage problem because of large increases in population and economic activities; California's water supply problem is one of improper distribution rather than a lack of overall supply; and the Southwest States and most of those in the semiarid regions west of the Mississippi have the Nation's most severe existing and emerging water-short problems.

Even in areas of high average annual precipitation and runoff, a series of dry years sometimes occur, resulting in serious droughts such as occurred in the Northeast during 1961 and 1966, and in the West and other parts of the United States during the period 1976 to 1978. Adverse effects of droughts are particularly serious in areas which use a high proportion of the available average annual runoff or where storage and distribution facilities are inadequate to provide sufficient carryover during prolonged periods of low streamflow. Streamflow in the humid East tends to vary less from year to year and month to month than that of the other regions.

About 30 percent of the Nation's streamflow in an average year is supplied by ground water that emerges as natural springs and other seepage outlets. In turn, seepage from streams, rivers, canals, and reservoirs is a principal source of ground water recharge. During years with subnormal precipitation, most of the flow in many smaller streams in low flow months comes from ground water. Ground water is thus important to the continuity of streamflow.

From a hydrologic perspective, there must be adequate recharge capability and adequate water available for percolation at least equal to the withdrawals, otherwise there will be ground water mining (withdrawal in excess of natural recharge).

In some areas of the Nation, ground water mining is substantial. For example, it is over 14 million acre-feet annually in the High Plains area (mostly parts of Nebraska, Kansas, Oklahoma, and Texas), an amount about equal to the natural flow of the Colorado River.

In summary, two-thirds of the combined total fresh (335 bgd) and saline (57 bgd) water withdrawals in the conterminous United States come from streamflow and surface storage sources, and an additional 15 percent (61 bgd) comes from ground water sources that are highly interactive with streamflows. Thus, a total of 80 percent of the Nation's water presently being withdrawn comes from fresh surface and ground water sources. Remaining sources of water are saline (15 percent) and ground water mining (5 percent).

A Nation's economy--the population; its productivity, income, geographic distribution, trade and travel activities, lifestyles, and even its sense of values--affect the requirements for water and are significant considerations in water and related land resources management.

During the 25-year period from 1975 to 2000, the national population is expected to increase by 52 million, or 24 percent, to about 268 million; gross national product is projected to increase at an annual rate of 3.86 percent from $1,516 billion in 1975 to about $3,134 billion by the year 2000; and personal income is estimated to increase at an annual rate of about 3.7 percent from $1,341 billion in 1975 to about $3,345 billion by 2000.

The greatest percentage growth in population and income is expected in the "Sunbelt" States. If the present trend continues, these States will have about 45 percent of the Nation's population by the year 2000. This growth is expected to occur primarily in existing metropolitan areas, intensifying the pressures on their water and land resources. The rapid growth rate of western cities, many of which are located in arid regions, forebodes increasing problems of competition for water in those areas.

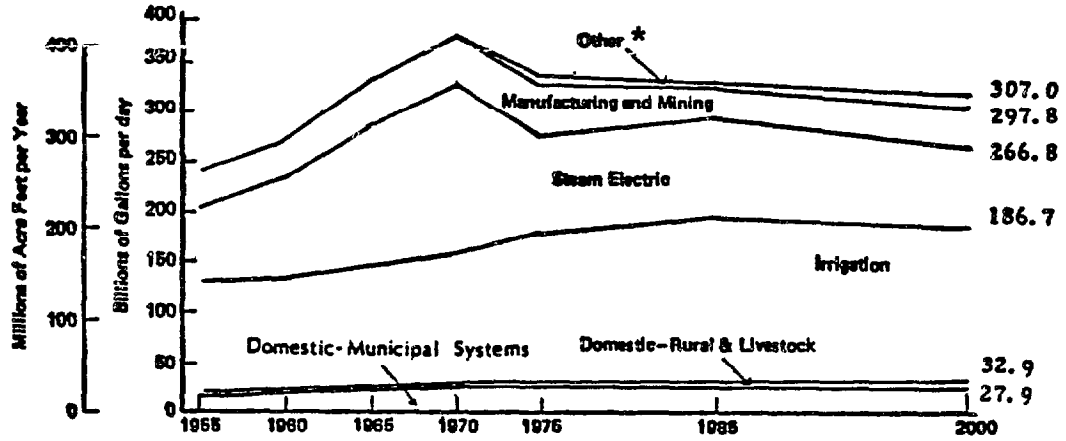
Water use involves two variable components: (1) withdrawal from a surface or ground water source, and (2) consumption of all or some portion of the amount withdrawn. (Withdrawal of water is that amount taken from a surface or ground water source. Consumption refers to that portion of withdrawn water not returned to the source.)

Total freshwater withdrawals for all offstream uses--irrigation, domestic household, manufacturing, mining, and stream-electric generation--for an average year condition were 338.5 bgd in 1975. By the year 2000, freshwater withdrawals are projected to decrease to about 307.0 bgd, 90 percent of the 1975 value. This expected decline

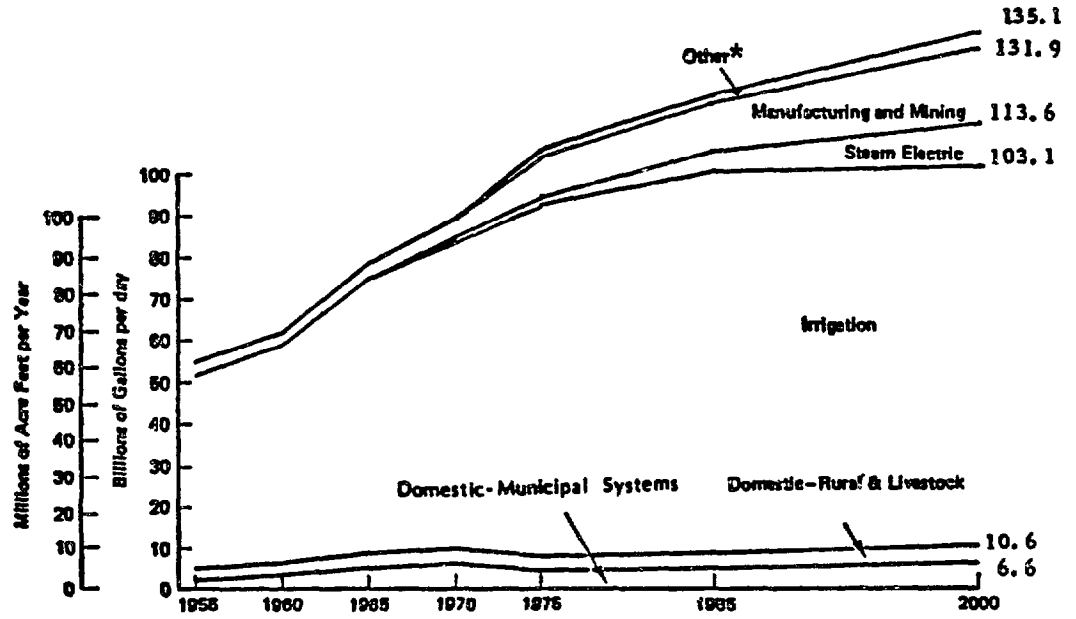
recognizes certain assumptions about water use efficiencies and recycling resulting from available technology and conservation efforts. The most significant contribution to these reductions in offstream uses will be made in the manufacturing sector. Although smaller reductions in withdrawals will be made in other sectors, the portions of total withdrawals represented by irrigation and steam-powered generation of electricity will remain essentially unchanged. All other offstream uses will increase.

Consumptive uses of water are generally more critical than withdrawals because this water is not available for other downstream uses. Offstream consumptive uses for the United States averaged 106.6 bgd in 1975 and are projected to increase by 26 percent to 135.0 bgd by 2000.

FUNCTIONAL USE WITHDRAWALS AND CONSUMPTION, 1955-2000



Freshwater Withdrawals, 1955-2000



Freshwater Consumption, 1955-2000

*Other: Includes commercial water use.

Source: Water Resources Council Second National Water Assessment

ANNUAL WATER REQUIREMENTS FOR OFFSTREAM USES - AVERAGE YEAR

(MILLION GALLONS PER DAY)

Type of Use	Total Withdrawals			Total Consumption		
	1975	1985	2000	1975	1985	2000
Domestic and Commercial						
Central (Municipal)	21,154	23,983	27,918	4,976	5,665	6,638
Non-Central (Rural)	2,092	2,321	2,401	1,294	1,409	1,439
Commercial	5,530	6,048	6,732	1,109	1,216	1,369
Manufacturing	51,210	23,664	19,661	6,049	8,893	14,686
Agriculture						
Irrigation	158,743	166,252	153,846	86,391	92,820	92,506
Livestock	1,912	2,233	2,551	1,912	2,233	2,551
Steam Electric	88,904	94,855	80,052	1,418	4,062	10,544
Minerals	7,055	8,832	11,328	2,196	2,777	3,609
Public Lands and Other*	1,845	2,125	2,425	1,216	1,449	1,712
Total, Freshwater	338,455	330,313	306,914	106,561	120,524	135,054
Total, Saline	59,747	91,239	118,815			
TOTAL	398,202	421,552	425,729			

* Fish hatcheries and miscellaneous uses.

FRESHWATER WITHDRAWAL AND CONSUMPTION BY REGIONS - 1975, 1985, 2000

(MILLION GALLONS PER DAY)

Region	Withdrawals			Consumption		
	1975	1985	2000	1975	1985	2000
New England	5,094	3,935	3,231	480	644	1,059
Mid-Atlantic	18,297	15,854	13,869	1,839	2,471	3,542
South Atlantic-Gulf	24,512	25,453	28,338	4,867	6,777	10,054
Great Lakes	42,809	32,660	25,621	2,593	3,298	4,692
Ohio	34,927	27,835	16,923	1,798	2,525	4,331
Tennessee	7,412	7,129	6,012	314	644	1,103
Upper Mississippi	12,397	10,377	7,908	1,144	1,600	2,687
Lower Mississippi	14,562	17,453	24,839	4,025	4,553	5,510
Souris-Red-Rainy	337	327	587	112	202	446
Missouri	38,016	48,030	44,354	15,463	19,203	19,910
Arkansas-White-Red	12,867	13,797	13,333	8,062	8,766	8,886
Texas-Gulf	16,925	15,930	15,538	11,262	10,225	10,530
Rio Grande	6,318	6,199	5,630	4,240	4,320	4,017
Upper Colorado	6,868	7,841	7,519	2,441	3,017	3,232
Lower Colorado	8,915	8,527	7,858	4,597	4,755	4,708
Great Basin	7,989	7,312	7,258	3,778	3,763	4,034
Pacific Northwest	37,493	38,100	33,843	11,905	14,615	15,193
California	39,635	40,542	41,259	26,637	27,929	29,699
Alaska	295	430	756	58	206	457
Hawaii	1,879	1,619	1,350	603	637	665
Caribbean	908	963	888	343	374	299
Total, Regions 1-18	335,373	327,301	303,920	105,557	119,307	133,633
Total, Regions 1-21	338,455	330,313	306,914	106,561	120,524	135,054

Source: Water Resources Council Second National Water Assessment

WATER SUPPLY PROBLEMS - TODAY AND IN THE FUTURE

The Second National Water Assessment's comparison of water supply and demand data shows that there are major water problems in most of the 21 water resource regions and serious local problems in most of the 106 subregions. For example, almost every region west of the Mississippi River has indicated an inadequate supply of surface water for food and fiber production at present output efficiencies and quantities. Dramatic instances of ground water depletion are found in the High Plains areas extending from Texas to Nebraska, and Central Arizona and parts of California are heavily dependent on ground water.

The increasing demands for surface water is leading to severe competition for offstream uses of water for energy, food and fiber, and municipal and industrial needs. These demands coupled with associated environmental and instream flow requirements will result in more severe basinwide and local problems in many parts of the United States. Excessive ground water withdrawals is increasingly causing diminishing water pressure, declining spring and streamflow, land subsidence, and saltwater intrusion problems. The interrelationship of surface and ground water supplies as well as droughts further complicate the water supply and quality problems.

While droughts are normal climatological phenomena, there is no capacity yet to forecast their occurrence with certainty nor how long they will last. It is clear that no part of the Nation is immune to the possibility of drought. The Northeast drought of 1962-66 presented serious water supply problems. In 1976-77 the Nation was again hit by drought, which centered in the West, Northwest, and upper Midwest, with locally dry areas in the humid East as well. In some areas, precipitation levels were well below the lowest of record.

One potential man-induced way to augment existing water supplies is weather modification. While some progress has been made in weather modification research by Federal and State agencies, such as our understanding of the weather and our ability to effect changes, the overall research goal of developing a technology which can reliably and predictably produce cloud and weather changes in various climatic regions has not been achieved. In addition, increased weather modification activities raise legal and institutional issues which are being considered by the States.

Our current work indicates that a lack of a Federal weather modification policy and problems in managing and coordinating the Federal research efforts have hindered the effectiveness of the Federal programs. Until improvements are made, the basic question of whether weather modification (precipitation augmentation) is a potentially major source of water supplies cannot be positively answered. A recent report (July 1978) by the Weather Modification Advisory Board, an independent group established pursuant to law to study weather modification programs and issues, concluded also that Federal policy and management improvements were needed and made such recommendations.

Demand for municipal and rural domestic water will be an increasingly serious problem, a situation related to population distribution. Some communities are now restricting water connections, zoning land use, and defeating bond issues for water supply projects.

With increasing concern for national energy independence, major new developments for oil, coal mining, including coal slurry pipelines, can be expected. Where water supply is already limited, a transfer of water from an existing use or through importation will be required. In the West, this transfer will almost inevitably be from irrigated agriculture. Retirement of irrigated farmlands, however, will result in a loss of agricultural production, a decline in rural lifestyle, and increased population concentrations in urban centers. On the other hand, limiting energy development and industrial growth because of inadequate water supplies could result in higher unemployment, and economic hardship for some regions and the Nation. A conservation program which would increase the efficient use of irrigation water could provide water for alternative uses such as energy production. However, some conservation actions, such as sprinkler systems, will require additional electric energy.

The interaction between water quantity and water quality is clear. With increased consumptive use, streamflows will continue to be reduced. In some places this may mean that return flows and sewage effluents will constitute an increasing portion of stream volumes. In many rivers of the East today water quality problems are evident as a result of reduced flows. With increasing off-stream uses and urban concentrations, this problem will intensify. Conflicts between flow regulation and downstream water uses could have major interstate and international implications.

Also, the interrelationship of water and land resources presents problems which stem largely from a collection of socio-economic changes resulting from the choices and decisions of individuals, firms, and governments. Urbanization and intensive industrial development often lead to serious pollution problems and water short conditions where water supplies are not sufficient to meet such rapid development. Conversion of agricultural lands to urban-related uses and wetlands to urban and agricultural uses are other major concerns. However, development of water resources can transform unproductive land to high yield farmland or promote economic growth on undeveloped areas. In brief, competition for use of the Nation's water-related land resources is continuing to increase, especially in and adjacent to urban growth centers.

Throughout the Nation plans are being made for increased water use and, when those expectations are summed up, it becomes evident that in many areas, if the present use patterns continue, there will be water shortages and severe conflicts. Unfortunately, no simple solutions are available.

Another continuing water resources problem is flooding which affects all parts of the United States, arid as well as the humid areas. In 1975 flood damages were estimated at $3.4 billion on a flood plain of 140 to 180 million acres, and 113 persons were killed by flood waters. Historically, cities and industries have been located on flood plains, and larger channels, levees, and dams have been constructed to provide flood protection.

In urban areas, property damage is accompanied by unemployment and dislocation of people. Almost half of all flood damages are suffered by agriculture as existing crops and livestock are destroyed and productive land is covered or washed away. The impact of flooding on wildlife, fish, and ecosystems is mixed. Wildlife food and habitat are often removed or covered by floodwaters, resulting in severe damage to natural systems.

Since 1965, increasing attention has been given to nonstructural alternatives in the control and alleviation of flood damages. But, information on flood hazards, environmental effects, flood damage reduction approaches, and institutional arrangements through which unified flood plain management might be achieved is generally lacking. The Unified National Program for Floodplain

Management recently adopted by the Water Resources Council recognizes these deficiencies and indicates progress in overcoming them.

By the year 2000, flood damages are expected to increase to $4.3 billion even with moderate application of flood plain management regulations. However, to reduce flood damage, better management of the flood plain is required, which includes a combination of traditional structural measures such as dams and levees, and non-structural measures such as relocation of high risk properties out of the flood plain. The participation of local, State, and Federal governments is required for successful flood plain management.

How bad a water picture do we face? This question is difficult to answer; probably, we can only guess. Some believe our Nation will not take effective action to solve our water resources problems until we are faced with severe crises similar to those when other natural resources became short or endangered. Others are more optimistic but show an anxiety that present water management policies, institutional arrangements, and strategies leave us in a poor position to cope with the foreseeable shortage of water supplies.

Basic questions that must be addressed include how can water resources be managed optimally to meet national, regional, and local needs and can changes in the present patterns of water allocation and use be made in the face of political and institutional opposition by numerous and well-organized constituencies.

Federal, State, and local governments as well as the private sector must share the responsibilities for solving our water problems. With the sharing of responsibilities; integrated and comprehensive water resources planning and management, including intensive, coordinated water research programs; and compromises between competing uses and interests; our Nation can find the ways to more efficiently and effectively manage its water resources to best satisfy our future economic, environmental, and social goals.

PRESIDENT'S WATER POLICY ACTIONS

Recognizing our Nation's water resources problems, the President's Environmental Message of May 23, 1977, directed the Office of Management and Budget, the Council on Environmental Quality, and the Water Resources Council,

under the chairmanship of Secretary of the Interior, Cecil Andrus, "* * * to conduct in consultation with the Congress and the public, a review of the present Federal water policy." He further stated that "* * * we need comprehensive reform of water resources policy, with water conservation as its cornerstone."

Water Resource Policy task forces were established to study the following matters

--revision of water resources planning and evaluation criteria and procedures,

--cost sharing,

--policy considerations and alternatives relative to institution and institutional arrangements,

--water conservation,

--water quality,

--research, and

--reserved water rights.

In July and August 1977, hearings were held in major metropolitan areas. Considerable adverse reaction was voiced, especially from water interests in the Western States. Consequently, the Senate passed a resolution, S. Res. 284 (October 1977), expressing its concern about possible interference with the traditional State role in water allocation actions and the need for consultation with the Congress.

On June 6, 1978, the President announced his water policy message and sent to the Congress water policy initiatives designed to:

--Improve planning and efficient management of Federal water resource programs to prevent waste and to permit necessary water projects which are cost effective, safe and environmentally sound to move forward expeditiously.

--Provide a new, national emphasis on water conservation.

--Enhance Federal-State cooperation and improved State water resources planning

--Increase attention to environmental quality

The President concluded his water policy message by saying,

> "These initiatives establish the goals and the framework for water policy reform. They do so without impinging on the rights of States and by calling for a closer partnership among the Federal, State, county, city, and other local levels of government. I want to work with the Congress, State, and local governments and the public to implement this policy. Together we can protect and manage our Nation's water resources, putting water to use for society's benefit, preserving our rivers and streams for future generations of Americans, and averting critical water shortages in the future through adequate supply, conservation and wise planning."

The reaction to the President's water policy message varied; some were disappointed and considered it "watered down," others gave it cautious approval because of the policy's "mild tone." In general, the policy drew, initially, limited praise from environmentalists, who had hoped for more changes, and from those interests who prefer "business-as-usual."

On July 12, 1978, the President issued directives for all agencies to take certain actions to implement his policy initiatives. In response to a request from the Senate Budget Committee, GAO reported on the water policy initiatives. 1/

1/"Review of the President's June 6, 1978, Water Policy Message" (CED-79-2, 11/6/78).

CHAPTER 2

WATER RESOURCES ISSUES AND CONCERNS

The following are important water resources issues and concerns facing the Nation.

*1. Are existing plans, policies, and programs effectively addressing the water resources problems facing the Nation, regions, and States?

*2. Do water agencies and industry have effective water management and conservation programs which make efficient use of water supplies?

*3. Will Federal and non-Federal efforts ensure an adequate water supply for municipal and industrial purposes?

*4. Are financing, cost sharing, and repayment policies for Federal or federally assisted water resources projects and programs effectively meeting today's needs?

*5. What are the problems impacting on the timely, efficient, and economical construction and maintenance of water resources projects?

*6. Ground water supply management and conservation--what are the problems and how can they be resolved?

7. How can water quality and water supply programs be effectively integrated?

8. Do Federal agencies adequately consider environmental effects in water resources management and project formulation?

9. Are water information collection and evaluation efforts adequate to promote optimal water resources programs?

*Deserving priority attention.

CHAPTER 3

MAJOR WATER RESOURCES ISSUES AND CONCERNS

ARE EXISTING PLANS, POLICIES, AND PROGRAMS EFFECTIVELY ADDRESSING THE WATER RESOURCES PROBLEMS FACING THE NATION, REGIONS, AND STATES?

Adequate planning is an essential ingredient in developing and administering an effective, efficient water resources program. Such plans include the establishment of policies and programs for water research and technology efforts. Defects in water planning can have major impacts, both short and long range, on the Nation's multi-billion dollar water resources activities. In view of the shortages and emerging water problems facing our Nation, such planning should provide a sound basis for rational, well-considered decisions among alternatives or competing uses of our water resources to meet the needs and desires of the people.

THE PROBLEMS AND ISSUES

Water resources planning encompasses analyzing existing and potential water problems and preparing solutions to such problems. Planning procedures and policies differ from region to region and among agencies. Each region has different problems to address while each agency has a different mission.

Efforts to coordinate or combine water resources planning, such as the Water Resources Planning Act of 1965, have produced few positive results. However, the President's Water Policy Statement called for improved planning, enhanced Federal-State cooperation in water policy and planning, and increased attention to environmental quality. The President issued specific initiatives for improving the planning and evaluation of Federal water resources programs and projects, as well as for strengthening Federal-State water resources planning and policymaking.

Usually, several alternatives are available to solve a water-related problem. It is during the planning stage that these alternatives must be evaluated and the best solution chosen. Some of the factors that must be considered in evaluating the alternatives are:

--whether there is a need for development of alternative supply sources;

--what is the most cost effective method of getting additional water;

--whether structural (project construction) or non-structural solutions are appropriate;

--how water should be allocated to users;

--how to minimize the harmful environmental impacts of water development; and

--how to coordinate the Federal, State, and regional water, land, transportation, and environmental policies most effectively.

Efforts to plan and implement water resources programs are concerned with and are affected by several factors. Some of these factors follow:

--Federal, State, and local planning roles.
--Regional and basin water resources planning.
--National water policy.
--Institutional arrangements.
--Federal planning grant programs.
--Methods to increase water supplies.

Federal, State, and Local Planning Roles

Prior to the last decade, the primary Federal role in water resources planning related to public works activities, such as flood control, navigation, irrigation, and watershed activities. Federal involvement generally arose in response to interstate needs; in cases when the financial commitments were beyond State or local capability, and to foster national objectives, such as western land settlement or soil and watershed conservation. Federal agencies, created to execute the programs, generally operated independently of the States and were responsible for program and project implementation decisions. State and local involvement in the decisions varied, depending upon the nature and purposes of the programs and projects, the relationship between State, local and Federal officials, and the non-Federal financial repayment requirements.

States had defined their own policies relative to water quantity and quality management and had developed laws and practices for the allocation and use of water. States were also engaged in water resources planning and development. Local governments generally had primary responsibility for

local water supply and wastewater treatment and disposal. Planning efforts were generally of a localized nature and were usually directed at a specific problem.

In more recent times, a number of new Federal water related programs have emerged. For example, the Water Pollution Control Act Amendments of 1972, the Coastal Zone Management Act, the Safe Drinking Water Act, the Water Resources Planning Act, and flood plain management legislation indicate where the Federal interests and activities have been expanded over its traditional role in relation to other levels of government.

Regional and Basin Water Resources Planning

Some river basins have no overall basinwide planning authority, others have established river basin commissions, and some have interstate compacts.

River basin and interstate compact commissions develop basinwide water resources plans. Also, States have planning systems to address their water problems. Assessments of all types of basinwide planning systems and a cross section of State planning systems are needed before judgments can be made on the best planning mechanism and techniques for seeking resolution of national and regional water problems.

National Water Policy

One of the President's water policy task forces addressed planning and evaluation criteria and procedures for Federal water resources development. One of the major issues raised in the task force study concerns the objectives which should govern the formulation and evaluation of water resources plans, for example, consideration of water conservation and nonstructural solutions.

Selection and definition of national objectives establish the basic character and direction of Federal water resources planning. The "national economic development" and "environmental quality" objectives have governed water resource planning undertaken directly by a Federal agency as well as interagency basin planning. The Congress, in passing the Rivers and Harbors Act of 1970, stated

> "It is the intent of Congress that the objectives of enhancing regional economic development, the quality of the total regional economic development, the quality of the total environment, including its protection and improvement, the well-being of the people of the United States, and the national

economic development are the objectives to be included in federally financed water resource projects * * *."

These additional factors have not yet been fully included in the Principles and Standards which govern Federal water resources planning and project formulation, or implemented by the Federal agencies.

In addition to concerns over the expanding national objectives, there are many uncertainties at the State and local level over interpretation of environmental laws and regulations, future needs for energy development, relationship of water resources development and land use controls, and the future Federal commitment to water resources development. A definitive national policy that clears up these and other uncertainties is needed to ensure effective, coordinated water resources planning between the Federal, State, and local governments.

Institutional Arrangements

The President's water policy task force said that practically every problem which can be identified in the water resource area, except physical availability, can be defined as an institutional problem. The President and others have said that the water resources agencies may need to be reorganized to effectively integrate their diverse but related objectives. Agencies charged with protecting the environment or fish and wildlife conservation often disagree with those responsible for water resources development. In other cases, the objectives of those primarily responsible or concerned for a project purpose such as flood control, conflict with the objectives of those concerned with hydropower electric generation from the same project. These disagreements sometimes result in project delays, higher costs, and decreased benefits.

The President, working with Governors, has created a task force of Federal, State, and local officals to act as a continuing guide for implementing water policy reforms and to ensure that the State and local role in the Nation's water policy is constant and meaningful. This task force should provide ideas for resolving some of the institutional problems.

Federal Planning Grant Programs

The President's Water Policy Statement proposed an increase in the funding of State water planning under the 1965 Water Resources Planning Act. He recommended

increasing the program from $3 million to $25 million annually to assist Governors in developing a total water management capability. This program, a 50/50 costs sharing program is to be available to all States so they can address their priority concerns.

Some Colorado River Basin States said that Federal planning grants were an important part of their planning efforts. Many State plans are being prepared with different levels of implementation. A concern often heard is that Federal funds are used to develop plans that are put on the shelf and never used. It would seem desirable to examine the grant program so that any necessary improvements can be made before increased funding takes place.

Methods to Increase Water Supplies

One of the long-term solutions to predicted water shortages is to increase the available usable water supply. Such efforts have generally received a low priority. If development is to continue and shortages avoided in some areas, the usable supplies will have to be increased.

Most of the methods of increasing water supplies will concern research and development activities. Such methods include (1) weather modification through cloud seeding to increase rainfall or snowpack, (2) desalination of sea, brackish, and used water, and (3) salvaging water by channeling streams and controlling stream-side plant life and vegetation which consume water, and (4) reuse of waste water. These methods of augmentation are in various stages of development or implementation. Further development and use of these methods generally involves overcoming technical, economic, social, or political constraints.

In addition, there is some water imported from other basins to augment supplies in some areas. However, legislation prohibits study of interbasin transfers as a source of supply for the Colorado River Basin.

ISSUES AND CONCERNS FOR CONSIDERATION

Some of the more important matters which should be considered when addressing, planning, and programming issues and concerns include:

1. How well do Federal, State, and regional agencies choose between alternative projects or purposes when planning for the development of an area's water resources, including the coordination of

water resources plans with environmental, land use, and transportation plans and policies. Also, are the impacts and value of proposed individual projects adequately considered, on a basin-wide basis, during the planning phases?

2. How effective is the Federal organization structure for addressing water resources issues? What should the Federal role be in water resources planning? Is there effective integration and coordination of planning efforts between Federal, regional, and State agencies? What are the organizational impediments and institutional constraints to effective planning and what actions are necessary to resolve such problems?

3. Are the river basin commissions adequately meeting their objectives? Do regional water development and State plans comprehensively address their water problems? Are regions and States looking far enough into the future to recognize emerging water problems and plan for solutions? Are incentives needed for better regional planning?

4. What are the benefits and disadvantages of the alternative plans and programs for increasing water supply in water short areas? Can demands be controlled or decreased as an alternative to increasing supplies? How can problems related to water shortages be effectively solved?

5. How effective are WRC's monitoring procedures for Federal planning grants and is the grant program meeting its objectives? How are the State plans used by the States, regional authorities, and Federal Government?

PAST AND CURRENT GAO EMPHASIS

Recent GAO work has concentrated on reviews of water resources planning and programming and related Federal efforts and programs. We are reviewing the plans and programs to solve the water resources problems in the Colorado River Basin. Also, we are reviewing plans and programs to meet water needs for energy development, irrigated agriculture, metropolitan areas; and the Nation's desalination and weather modification efforts. We have also responded to congressional requests by reviewing such matters as: the California drought of 1976-77, and drought relief programs, snowpack measurement and data collection to forecast water supply, alternative ways for authorizing water projects, and the President's water policy.

GAO Reports	Report No. and Date
Problems Affecting Usefulness of the National Water Assessment	CED-77-50 3/23/77
California Drought of 1976 and 1977--Extent, Damage, and Governmental Response	CED-77-137 10/19/77
Water Resources Planning, Management, and Development: What are the Nation's Water Supply Problems and Issues?	CED-77-100 7/28/77
Improvements Needed by the Water Resources Council and River Basin Commission to Achieve the Objectives of the Water Resources Act of 1965	CED-78-1 10/31/77
Review of Federal Efforts to Forecast Snow Depth and Run-off Information	CED-78-43 1/27/78
Analysis of the Process of Authorizing Water Resources Projects	CED-78-41 1/30/78
Reserved Water Rights for Federal and Indian Reservations: A Growing Controversy in Need of Resolution	CED-78-176 11/16/78
Federal Response to the 1976-77 Drought: What Should Be Done Next?	CED-79-26 1/31/79

GAO Studies in Process

Review of Plans and Programs to Meet Competing Water Needs in the Colorado River Basins

Survey of Nonstructural Alternatives for Solving Water Resources Problems

Review of the Nation's Saline Water Conversion Needs

Survey of Energy and Mineral Development Needs and Other Alternative Uses of Water to Fulfill Changing Priorities

Survey of Coal Slurry Pipelines and Their Effect on Water Supplies

Review of Weather Modification Efforts (Rainfall Augmentation)

Survey of Effectiveness of River Basin Commissions

DO WATER AGENCIES AND INDUSTRY HAVE EFFECTIVE WATER MANAGEMENT AND CONSERVATION PROGRAMS WHICH MAKE EFFICIENT USE OF WATER SUPPLIES?

The President, on June 6, 1978, announced his "Water Policy" which, among other things, is designed to "Provide a new, national emphasis on water conservation." He said that this new policy resulted from a comprehensive review of Federal water policy which showed that water conservation had not been addressed at a national level even though we have pressing water supply problems. The review showed that

--21 of the 106 total watershed subregions in the country already had severe water shortages and by the year 2000 this number could increase to 39 subregions,

--the Nation's cities are beginning to experience water shortage problems which can only be solved at a very high cost,

--in some areas, precious ground water supplies are being depleted at a faster rate than they are replenished, and

--in many cases, an effective water conservation program could play a key role in alleviating these problems.

The President detailed 12 specific initiatives for increasing the emphasis on conservation in Federal water resources programs including: requiring the consideration of water conservation in the principles and standards for planning water and related land resources developments; making appropriate community water conservation measures a condition of Federal water supply, wastewater treatment, and housing grant and loan programs; providing assistance to farmers and urban dwellers on how to conserve water; establishing water conservation goals and standards in Federal buildings and facilities; examining Federal programs and policies so that more water conservation and reuse measures can be implemented; and implementing certain irrigation repayment and water service contract procedures. The President also said that none of the initiatives would impose any new Federal regulatory programs for water management.

THE PROBLEMS AND ISSUES

The problems and issues concerning effective water management and conservation programs primarily involve three basic areas: agricultural use, municipal and industrial use, and ground water management. The first two areas are discussed below. Ground water problems and issues are fully covered on page 55.

Agricultural use

The greatest potential, as well as the greatest need, for better water management and conservation is in the irrigated areas of the West. Irrigation of crops accounts for over 80 percent of consumptive uses of water, most of which occurs in the arid and semiarid West.

Irrigation is a relatively inefficient water use, since under present practices less than half of the water delivered for irrigation is actually consumed by the crops. The remainder, which is excess to crops needs, may be absorbed by weeds; oversaturate the lands causing drainage problems; or return to the supply system for further uses at a downstream location, degraded in quality by minerals, fertilizers, sediment, and pesticides. These return flows may be used downstream for additional irrigation purposes. In some cases, however, the excess water may bypass downstream potential users and be lost or become ground water and require substantial energy to pump the water back to the surface.

Some techniques which could lead to "productivity increases," that is, maximizing agricultural output per unit of water, are the lining of water conveyance and distribution systems, more exact timing of water deliveries by computer techniques, avoiding overdeliveries, and use of water savings methods, such as drip and sprinkler irrigation systems. Other measures include suppressing reservoir evaporation, controlling unwanted vegetation which consumes considerable water, and increasing yields without additional water through better crop varieties, fertilizers, and management.

Additional water conservation techniques which could be effective, but are sensitive issues, are water-pricing policies which encourage conservation such as (1) charging progressively higher rates as greater quantities of water are used and (2) eliminating or reducing Federal subsidies to recipients of Federal irrigation water.

Municipal and industrial use

An adequate supply of water is essential to the Nation's citizens and industries. If the demand continues to increase, the Nation will have to develop new supplies or use existing supplies more efficiently. If neither of these steps is taken, emergency restrictions on water use will have to be imposed if and when shortages occur, and communities will have to make hard decisions on future growth and development.

The Congress has consistently held that supply and water use regulations are the responsibility of State and local governments. However, various Federal programs offer numerous opportunities for encouraging and implementing water conservation programs. For example, Federal agencies (1) provide funds for water resources planning, (2) construct dams and reservoirs to increase the water supply, (3) construct and operate public buildings and military and civilian housing and finance housing programs where water conservation programs could be undertaken, and (4) provide grants to local entities for constructing wastewater treatment facilities, the size and costs of which could be reduced if conservation were practiced.

Several techniques which can help make more efficient use of municipal and industrial water supplies are water-saving devices, metering, pricing, leakage control, water pressure control, educational campaigns, and industrial conservation such as reuse and recycling. Each of these techniques must be considered on a case-by-case basis. Although these techniques generally are believed to save water, many have either not been thoroughly studied or had their cost effectiveness evaluated. No centralized data bank or clearinghouse on water conservation measures and techniques exists.

ISSUES AND CONCERNS FOR CONSIDERATION

The more important matters which should be considered in addressing water management and conservation issues and concerns include:

1. Have the Federal agencies developed adequate data to determine what role they should take in promoting agricultural efficiencies? Have they related their roles and efforts to the basic causes of agricultural inefficiencies?

2. Do Federal, State, and private enterprise effectively coordinate their efforts to promote better water management and conservation? What are the constraints to effective coordination and are they adequately recognized and dealt with?

3. What efforts have been made to meet the needs for a clearinghouse on municipal and industrial water conservation practices? Are the efforts and Federal activities effective in ascertaining the current technology, additional research needed, Federal incentives needed, priorities, and legislative authority needed for implementing effective water management and conservation practices?

4. How effective are Federal housing programs in promoting better municipal and industrial water management and conservation? Have federally controlled building and facilities led the way?

5. Are water agencies using pricing systems and user charges as a means for reducing water demand and promoting more efficient use?

6. Are there new technologies for promoting better water management and conservation, and which offer the most potential? How effective is the Federal effort to develop new technologies and are Federal agencies effectively implementing such technologies? What are the constraints to their implementation and are efforts made to overcome them? Are any changes in the Federal role necessary?

PAST AND CURRENT GAO EMPHASIS

GAO has issued four reports recently dealing with water conservation programs in the agricultural, and municipal and industrial sectors. Currently, our efforts are centered on the impact on water supplies of industrial water reuse and recycling and the Department of Agriculture's efforts to promote better water management and conservation.

In two reports 1/ issued in June 1976 and September 1977 we identified many problems concerning the implementation of improved agricultural water management and conservation practices and we made applicable recommendations to the Secretaries of the Interior and Agriculture and the Administrator of the Environmental Protection Agency. These agencies have established a task force to deal with these matters.

In a report 2/ issued in April 1978, we recommended that the Chairman of the Water Resources Council establish an interagency task force to jointly develop Federal objectives, policies, and action plans for a clearinghouse for water conservation practices involving municipal and industrial water supplies. In addition, the task force would ascertain the current technology, additional research needed, Federal incentives needed, priorities, and additional legislative authority needed for implementing effective water conservation practices. We also made recommendations to individual Federal agencies, most of which were included in the specific initiatives announced by the President in his "Water Policy."

GAO Reports	Report No. and Date
Municipal and Industrial Water Conservation--The Federal Government Could Do More	CED-78-66 4/3/78
More and Better Uses Could Be Made of Billions of Gallons of Water by Improving Irrigation Delivery Systems	CED-77-117 9/2/77
Better Federal Coordination Needed to Promote More Efficient Farm Irrigation	RED-76-116 6/22/76

1/"Better Federal Coordination Needed to Promote More Efficient Farm Irrigation" (RED-76-116, June 22, 1976) and "More and Better Uses Could Be Made of Billions of Gallons of Water by Improving Irrigation Delivery Systems" (CED-77-117, Sept. 2, 1977).

2/"Municipal and Industrial Water Conservation--The Federal Government Could Do More" (CED-78-66, Apr. 3, 1978).

GAO Reports	Report No. and Date
Better Water Management and Conservation Possible--But Constraints Need to be Overcome	CED-79-1 10/31/78
Review of the President's June 6, 1978 Water Policy Message	CED-79-2 11/6/78

GAO Studies in Process

Review of U.S. Department of Agriculture's Efforts to Promote Better Water Management and Conservation

Survey of Impact on Water Supplies of Industrial Reuse and Recycling

WILL FEDERAL AND NON-FEDERAL EFFORTS ENSURE AN ADEQUATE WATER SUPPLY FOR MUNICIPAL AND INDUSTRIAL PURPOSES?

Municipal and industrial (M&I) water supplies are becoming more critical each year. An increasing number of the Nation's urban areas periodically suffer from water short periods, requiring conservation programs. Most of our urban areas estimate M&I water shortages by the year 2000. By that time, demographers expect that 90 percent (about 242 million) of the population will be served by central systems. Yet, water resources available to meet the corresponding growth in municipal and industrial water needs are limited. Increasingly, metropolitan areas are going outside their immediate sources of supply or are using local water supplies faster than they can be replenished. Such sources of supply will not be available indefinitely, and a lack of an adequate future water supply can have significant local, regional, and national implications.

In the past year much public attention has focused on municipal and industrial water supply and, increasingly, as shown in the President's water policy statement, it is becoming a national concern. Within the last two years a Congressional lobby has been advocating that the Federal Government establish programs to aid urban M&I water systems. As a result, the Congress has become more interested in such programs.

PROBLEMS AND ISSUES

Problems and issues which revolve around M&I water supply vary considerably from city to city and region to region. Issues include water quality, quantity, distribution systems, and management of the systems. All major M&I problems may not have been identified because data on individual cities' problems have not been compiled.

Urban areas are now becoming more aware of their problems because of difficulties in meeting water quality standards, the increased publicity on water conservation, the increased costs of meeting demands, difficulties in obtaining water rights, and the continued environmental conflicts with water resources development. However, in the past, metropolitan population and industrial growth have occurred without adequately considering the problems, such as environmental and social impacts and increasing costs of providing water supplies to meet demands. The attitude of planners has been that water can be obtained in unlimited

quantities to meet any demands which arise from economic growth. As a result, demands for municipal and industrial water supplies continued to rise in all areas of the country, including the water-short areas.

In the drought of the early 1960's more than 14 million of the 50 million persons living in the Northeast were forced to restrict their water use to conserve the dwindling supply. In the 1976-77 drought, communities in certain parts of the United States were faced with water shortages, empty or near empty reservoirs, and water rationing.

Solutions to M&I water shortages are not simple. Short-term solutions may include instituting conservation measures, raising reservoir levels, increasing intake from existing resources, purchasing supplemental supplies, reusing waste water, or a combination of these and other solutions. Long-term solutions would include those above and others, such as building reservoirs, increasing research efforts in weather modification and desalinization, and controlling growth in water-short areas. Often, it is not feasible for cities to implement many of the short-term solutions, and they sometimes lack the will or financial resources to undertake the long-term solutions early enough to avert a future water supply crisis.

Many metropolitan areas and municipalities depend on local funding resources to solve water supply problems while others depend largely on state or federal aid. States vary in the amount and type of aid which they provide for water supply.

In view of the increasing efforts to establish Federal financial assistance programs for urban water systems and the potential for the Congress to enact such legislation in the near future, it becomes desirable to study the pricing systems for M&I water supplies. Costs of municipal water supplies are increasing as cities must rehabilitate old deteriorating water systems, go farther for new water sources, and as low-density suburban areas are brought into the supply systems. An important issue, therefore, is whether water utilities are financially self-supporting, through appropriate pricing policies and systems, so that they can rehabilitate their water systems and meet future demands.

Systems of pricing and user charges are employed for a number of purposes, including the provision of revenues to recover costs, allocation of financial burdens to direct

beneficiaries, as well as to provide general revenues. Often, pricing policies may be established on the basis of political as well as financial considerations, and general revenue funds are used to compensate for deficits in water system revenues. Also, water pricing systems may be an important factor which directly or indirectly impacts on the allocation of water supplies as well as on land use and an area's growth and development. Another factor which may significantly affect water prices are the costs of implementing the requirements of the Safe Drinking Water Act.

Water for Small Communities and Rural America

While central water supply systems provide safe, potable drinking water to most of our Nation's population, a large segment is not so well protected. In all parts of our Nation, in varying degrees, about 33 million Americans reside outside the service areas of central systems and have their own domestic water supplies, usually obtained from deep wells. About 4 million persons have no piped water supply. Also, many rural communities are reporting that their water supplies do not meet the Safe Drinking Water Act standards, and they are faced with potential high costs of additional treatment or new supply sources. The Farmers Home Administration has identified over 24,000 rural communities with a need for a central water system or an improved one.

While the national policy enunciated in the Rural Development Act states adequate water supplies should be provided for economically distressed communities to help provide efficient and orderly growth and development, many small communities are faced with an insufficient quality and/or quantity water supply to maintain or improve their viability. At least one-quarter of the 6,500 nonmetropolitan communities in the 11 Western States have water in short supply, water of poor quality, inadequate storage and treatment facilities, and deteriorating distribution systems.

The types of problems and potential solutions often extend far beyond a single community's boundary. For example, up-stream waste discharges create water quality problems for downstream communities, and lowered ground water levels from deep-well pumping have caused problems for communities with neighboring shallow wells.

M&I water distribution systems

In the East and in small, old western towns there is a special concern about deteriorating water distribution systems. It is not unusual for a city's central distribution system to be over 100 years old. These systems, ravaged by rust, nearby construction, and water pressures much greater than anticipated when designed, are beginning to show signs of complete collapse.

As the water systems age, they begin to leak. A lot of municipal and industrial water is lost while it is being conveyed to the users. For example, Boston cannot account for 50 percent of its water supply due to either leakage or its metering system. Leakage can lead to low water pressure, high costs, and infiltration of foreign substances causing low water quality. These problems can be reduced by locating and eliminating leaks, and replacing or relining pipes. However, this can be extremely expensive and, for the most part, is funded locally. Federal funding for municipal and industrial water distribution has been minimal.

Another concern about distribution systems is the inadequacy of some present systems to handle increasing populations. Many systems are operating at or about full capacity. As a result, future development centers will need entirely new systems instead of tapping into existing systems.

The constraints to solving M&I problems

Because M&I water problems and solutions have not been completely identified, it is difficult to identify the constraints to solving the problems; however, there are examples which indicate the nature of such difficulties.

Many municipalities are experiencing difficulties in solving their problems because of institutional, financial and other constraints which limit their capabilities or willingness to address the problems. In some instances, communities have experienced water shortages while adjacent or nearby communities have water to spare. Institutional agreements between communities could solve or reduce many of these problems. In other situations, municipalities complain that funds are not available for water projects while, at the same time, charge low water rates or use M&I water revenues for other purposes.

The availability of water is another possible constraint to solving M&I problems. More than half of the Nation's urban areas are projecting water shortages, under normal rainfall conditions, by the year 2000. With the trend of increasing population movements to cities, particularly in the water-short Southwest, and increased per capita consumption of water, there is the question whether there is sufficient water available to adequately satisfy future M&I demands.

While the capital requirements for M&I water systems are high, the cost of water until fairly recently has generally been low. However, the heavy dependence on water for energy development and production could drive up the cost. The energy and minerals industries have the financial resources to successfully compete for the available water supplies if the water is allocated on the basis of who can pay the most. This could seriously impact on meeting M&I needs unless government establishes priorities and allocates water on a basis other than economic factors in the market place.

Other issues

To have sound, comprehensive M&I water resources planning and development, there must be integrated management of water supply and quality, wastewater collection and disposal, and storm water management. Although improvements are being made in water supply-quality planning, different Federal, State, and local agencies continue to carry out their individual programs without the integrated comprehensive water planning and management necessary to most efficiently and effectively meet future water demands.

Many municipal and industrial areas have continued to grow in arid regions of the country despite the concerns for depleting the regions' water supply. In some areas, such as Phoenix, there is a growing reliance on the Federal Government to provide future water supplies to meet increased demands of a growing population. At this point, we can only guess at the future implications that depleting regional water supplies and diverting other water sources will have on meeting water needs in such regions. This matter raises the question whether the Federal Government should provide assistance for development of water resources which might unwisely encourage growth in water-short areas.

Another matter of interest is how industries, who are not recipients of water from public water systems, obtain their water supply, the extent to which their water withdrawals and uses are subject to regulation, and how metropolitan areas anticipate and make provision for future industrial needs. Much of the water used by industry does not pass through a public water system but is withdrawn from and returned to the streams by the individual industries whose needs often represent a large portion of water demand in metropolitan areas.

ISSUES AND CONCERNS FOR CONSIDERATION

In addressing the issues and concerns for M&I water supply, important questions which should be considered include:

1. What are the M&I water supply problems and potential solutions in small communities and rural areas; what are the institutional, financial, or other constraints to solving these problems; and what is the Federal role and should it be modified to best help communities meet their water needs?

2. What is the extent of the deterioration of distribution systems in cities, towns, and rural areas; what are the constraints to solving the deterioration problems; and what should be the Federal role in solving the problems?

3. What are the causes of the constraints to solving water problems and what can be done to reduce or eliminate them? Are there viable alternatives to the traditional solutions for solving the water supply problems?

4. Are there municipalities that do not have sufficient water sources for meeting demands? If such shortages exist, what alternatives are available and should there be a Federal role to help meet this problem?

5. What are the water pricing policies and systems of M&I water suppliers? Are such water suppliers financially self-supporting and provide the revenues to rehabilitate antiquated water systems and to meet future water demands?

6. What is the extent of, and how can improvements be made, in integrated management of water supply, water quality, wastewater use, and storm water runoff?

PAST AND CURRENT GAO EMPHASIS

GAO's past audit work in M&I water supply is mostly related to water conservation in metropolitan areas. Our current work includes a review of actions by metropolitan areas to meet water resources needs, survey of M&I water distribution systems problems in large cities, and study of M&I water supply problems for small communities and rural America.

GAO Reports	Report No. and Date
Municipal and Industrial Water Conservation--The Federal Government Could Do More	CED-78-66 4/3/78

GAO Studies in Process

Review of Actions by Metropolitan Areas in Meeting Water Resources Needs

Survey of Municipal and Industrial Water Distribution System Problems in Large Cities

Survey of Municipal and Industrial Water Supply Problems in Small Communities and Rural America

ARE FINANCING, COST SHARING, AND REPAYMENT POLICIES FOR FEDERAL OR FEDERALLY ASSISTED WATER RESOURCES PROJECTS AND PROGRAMS EFFECTIVELY MEETING TODAY'S NEEDS?

Financing, cost sharing, and repayment requirements for Federal and federally assisted water resources projects and programs have evolved over the years as new agencies, programs, and project purposes have been authorized to meet needs. As a result, there are many variations in these requirements among agencies as well as among programs with similar purposes and objectives. This situation leads to widespread confusion, encourages local interests to "shop around" among agencies to get the most favorable arrangement, and results in inequitable treatment of project beneficiaries.

When Federal water resource developments were first authorized, the thrust of the programs was to provide for transportation and the settlement and economic development of the West. The conditions in the Nation were vastly different from those of the highly developed and affluent country we live in today. As a result of these programs, the general taxpaying public who may not directly receive any of the benefits often pays all or most of the costs of federally subsidized water resources developments. Most past decisions on financing, cost sharing, and repayment policies were made given the circumstances of the time. However, circumstances and priorities have changed.

New national concerns have surfaced, such as environmental protection and water conservation. Furthermore, there is increasing competition for the Nation's resources, the demands on them have become much greater, and the value placed on water resources has increased significantly. New policies may be needed to encourage better water resources management and provide a more equitable distribution of financial burdens. Increasing water shortages will create an insistent demand that the users of water and water-related services more fully pay for the benefits they receive.

PROBLEMS AND ISSUES

Policies for financing, cost sharing, and repayment are separate from, although closely related to, policies of economic evaluation (benefit/cost analysis). The question of whether a project is economically justified

and, therefore, should be developed is a separate issue from that of who should pay for the costs associated with project planning, construction, and operation and maintenance. However, the question of who pays for a project often determines the enthusiasm with which the project is supported and the prospects for its authorization. Many believe that the best test of the need for a project is the willingness of the direct beneficiaries to pay for it.

The need for water policy reform has long been recognized, but numerous attempts by various groups, until recently, have met with little success. The National Water Commission in its June 3, 1973, report to the President and the Congress, was very concerned with cost sharing and financing of Federal water resource projects. The Commission made a number of recommendations calling for more State and local participation in project financing and recommended that identifiable beneficiaries pay more of the costs. In November 1975, the U.S. Water Resources Council studied this issue (as directed by section 80c of the Water Resources Development Act of 1974) and reported its findings to the President. However, little action has been taken on the findings, conclusions, or recommendations contained in those reports.

The President's recent water policy initiatives proposes legislative changes to improve financing and cost sharing for water projects. The proposals are designed to encourage more local initial commitment in financing water resource projects. In addition, the President proposed revising the methods for determining the repayment requirements from irrigation beneficiaries.

Some observers believe that there is now an increasing recognition and willingness to place more emphasis on State and local sharing of initial project costs and on project beneficiaries to repay more costs of federally financed water resources projects.

Federal financing, cost sharing, and repayment policies affect the "construction" agencies--Corps of Engineers, Bureau of Reclamation, Soil Conservation Service, and the Tennessee Valley Authority--as well as the "grant" agencies--such as HUD and EPA--which also help finance water projects. Altogether, there are about 25 Federal agencies which participate in project financing with about 185 different legal sources of authority governing the financing, cost sharing, and repayment arrangements. Following is a discussion of the problems and issues.

Should There Be More Consistency Among Federal Programs?

A major issue deserving consideration is whether more consistent financing, cost sharing, and repayment requirements should be developed for agencies and programs which present alternative means for accomplishing similar purposes and objectives. The formulas and repayment terms presently used to determine the Federal/non-Federal participation differ among agencies and types of projects. Certain types of Federal programs are, therefore, more attractive than others to local interest groups.

Cost sharing policies should provide incentives for Federal and non-Federal interests to negotiate projects that will be most desirable and cost effective from both the national and local viewpoints. This does not imply that there is a single method that will be suitable in all circumstances, but there seems to be a need to reform policies to provide such incentives. Present policies provide inconsistent incentives in several major respects, for example (1) alternative ways of achieving the same purpose, such as reservoirs, levees, or nonstructural measures for reducing flood damage, are often inconsistent in terms of financing and cost sharing procedures, (2) financing and cost sharing provisions differ among agencies, and (3) incentives are often inconsistent in terms of repayment provisions.

Should Beneficiaries Pay More Project Costs?

Another issue to be considered is whether identifiable beneficiaries should more fully pay for their share of the water resources programs from which they receive benefits. Repayment requirements for projects vary depending on (1) the allocation of construction costs to different purposes (for example, flood control, irrigation, and power), (2) non-reimbursable features included in the project, and (3) repayment terms--interest rates, periods of repayment, and interest free years--which often vary among agencies and project purposes.

Also, the Federal Government often subsidizes water resources projects in several different ways. Presently, it advances funds for the full cost of building a project and permits repayment of the reimbursable costs over a long period. In effect, these are loans to the non-Federal

entities and, depending upon the terms of repayment, provide various financial benefits to the project beneficiaries. Investments in water resources development projects usually are financed by U.S. Government borrowings. If reimbursement policy does not provide for repayment of the non-Federal cost share with interest comparable to the interest paid by the Federal Government on its borrowings, the interest foregone is an additional Federal subsidy.

A very important issue is whether the conditions today justify the continuation of cost sharing policies which were established under very difficult conditions and for achieving certain national objectives. Those who support full repayment contend that private identifiable beneficiaries, as distinguished from the general public, should pay their full share of costs unless subsidies are justified to serve some compelling social, environmental, or national economic objectives.

Would More Non-Federal Participation Eliminate Uneconomical or Potentially Harmful Projects?

Another consideration is whether increased participation by non-Federal interests would help eliminate less cost-effective projects which might not be supported if more non-Federal money were involved--thus relating support for a project to willingness to invest. It would be worthwhile to explore and identify ways that the Federal Government could encourage such investments and identify incentives which might be offered.

Present policies can tempt potential water project beneficiaries to request projects that they would not be willing to finance if their own money were involved. Also, such policies often lead to types of developments; for example, flood control, drainage, and beach and shoreline protection projects which have encouraged more intensive development in the flood areas. Often, subsequent more intense floods or storms far exceed the projects' capability to protect life and property, and greater losses result from the development generated by the projects. Also, some projects provide windfall gains to a few beneficiaries as well as adversely impact on existing water and related land uses such as fish and wildlife habitat and recreation.

Legislative and administrative constraints related to financing, cost sharing, and repayment provisions may discourage selection of the most economical or beneficial solution to water-related problems. Planning a Federal

or federally assisted water project, involving cost sharing sometimes leads to negotiations between the Federal and non-Federal interests over the kind of project and the mix of project services. A loss in net benefits may result if, because of cost sharing requirements, non-Federal interests negotiate for a project that does not provide optimum net benefits but one that is more desirable from the standpoint of required local cost sharing.

Are Water Projects Being Effectively Managed?

An important question is whether water resource projects are being managed in a way that will provide greater insurance of full repayment of reimbursable costs. Marketing practices at projects with vendible outputs as well as their day-to-day management should be examined to determine whether projects' operations help maintain the project beneficiaries capability to meet their financial obligations as well as provide sufficient funds to operate and maintain these projects and satisfy repayment obligations.

ISSUES AND CONCERNS FOR CONSIDERATION

The more important issues and concerns which should be addressed include:

1. Should policies and requirements be changed so that they are more consistent among agencies and programs which present alternative means for accomplishing similar objectives and purposes? Should financing and cost sharing policies be designed to encourage the formulation of projects and programs which will provide optimum net benefits, considering national as well as local objectives and interests?

2. Should identifiable beneficiaries be required to assume a larger share of the costs of the water provided by Federal water resources projects? Currently, the Nation's general taxpayers assume a large portion of the cost of such projects yet receive no direct benefits in return. On the other hand; flood control, irrigation, navigable waterway, and recreation users receive direct benefits from water resources development sometimes at no or little cost of providing the benefits.

3. Would increased financial participation by non-Federal interests help eliminate less cost beneficial water resource projects? State and

local interests often provide little if any "front end" financing.

4. Are the debt repayment provisions such as interest rates, and repayment schedules and procedures reasonable and consistent with legislative intent? In some cases, when debt repayment arrangements are made, specific repayment schedules of amounts and dates are not designated. In certain cases, there are long periods before any repayments are required even though the projects provide vendible products.

5. Do Federal agencies manage and operate water resources projects to best ensure compliance with repayment requirements and in accordance with authorized purposes? If water resource projects are not managed efficiently and do not maximize the benefits (vendible projects) provided, the financial soundness of the projects may be adversely affected.

6. Are alternative methods of establishing financing, cost sharing, and repayment requirements available, or should they be established, which could better promote water conservation and environmental protection?

PAST AND CURRENT GAO EMPHASIS

Over the past several years, GAO has not made reviews of the financing, cost sharing, and repayment policies for water resources programs and projects. Recently, GAO began an analysis of the issues involved if the water users who receive water from Federal irrigation projects were required to pay full costs. Also, GAO is reviewing, on a selected basis, the financing, cost sharing, and repayment policies and requirements for various Federal agencies, and programs for the primary purpose of identifying issues and problems for further GAO study.

GAO Studies in Process

Survey of the Development and Repayment of Municipal Water Supply and Recreation Agreements for Federal Water Resources Projects

Analysis of Issues on Repayment of Full Costs of Federal Irrigation Water Supply

WHAT ARE THE PROBLEMS IMPACTING ON THE TIMELY, EFFICIENT, AND ECONOMICAL CONSTRUCTION AND MAINTENANCE OF WATER RESOURCES PROJECTS?

The fiscal year 1978 budget for construction and maintenance of Federal water resources projects totaled about $3.7 billion. These activities are primarily performed by the Corps of Engineers, the Bureau of Reclamation, the Soil Conservation Service, and the Tennessee Valley Authority. Rising construction costs, environmental concerns, lengthy construction periods, and the President's reevaluation of the desirability of constructing many water resources projects has focused increasing attention on project selection, authorization, and construction.

There are about 1,900 Federal water projects in various stages of planning and construction, of which about 1,200 projects are authorized for construction. Over 780 projects, at an estimated cost of about $20 billion, are under construction. In June 1978, President Carter asked the Congress to fund more than 3 dozen new projects which would cost the Federal Government $718 million to complete. This request was in addition to new project starts included in the Public Works Appropriation bill that would cost about $1.3 billion.

The Federal Government has invested over $50 billion in water resources projects which includes the ownership of over 2,000 dams. In addition, it also regulates over 1,600 non-Federal dams. The recent failures of the Bureau of Reclamation's Teton Dam in Idaho and non-Federal dams in Georgia and Pennsylvania have intensified interest in dam safety.

THE PROBLEMS AND ISSUES

New Project Construction

The programs of the Federal water construction agencies have been directed toward meeting the major water needs of the Nation. For example, the Bureau of Reclamation has been responsible for the reclamation of arid and semiarid lands in the 17 Western States. The Corps of Engineers, on the other hand, has provided flood control protection to communities and agriculture interests throughout the Nation for years by constructing dams, levees, and drainage projects.

In his "Water Policy Message" to the Congress, the President stated that the Policy is designed to "* * * permit necessary water projects which are cost effective, safe, and environmentally sound to move forward expeditiously." He concluded that "some water projects are unsafe or environmentally unwise and have caused losses of natural streams and rivers, fish and wildlife habitat, and recreational opportunities." The President recognized that nonstructural means and conservation practices by themselves will not meet the Nation's future water needs. Structural measures will be needed because:

--The Western States will require increased water supplies for agricultural and municipal and industrial purposes.

--The Eastern States are requesting Federal assistance to repair or replace their aging municipal water supply systems.

--The energy crisis will focus increased attention on water needs for mineral extraction and production, coal slurry pipelines, and other energy development projects.

--Hydropower can be increased by installing additional generating capabilities.

--Flood damages can be reduced through the acquisition of flood-prone land and property.

--The mitigation of fish and wildlife losses will require the construction of facilities and the acquisition of land.

But, historically, it has taken a long time to construct water resources projects. For example, in many cases it takes about 15 to 26 years from project conception to the appropriation of construction funds. Actual construction, depending on the project type and size, often requires an additional 5 years beyond the 15 to 26-year period. Although construction does not take the major portion of the time, it represents the major portion of the cost in project development. Besides the design and construction of a project, the construction phase includes (1) site investigation work, (2) purchase of land, (3) relocation of housing, roads, and power transmission lines, (4) foundation preparation, and (5) purchase of equipment and supplies.

Project construction can be delayed for the obvious reasons beyond the agencies' control, such as bad weather and labor strikes. But some delays can be avoided or reduced with (1) better utilization of Government and contractor personnel, (2) improved inspection practices, (3) increased use of consultants during construction, and (4) improved practices for the purchase and design of equipment. In addition, some delays are caused by environmental and/or safety issues which are not known until construction is started or, in some cases, when the project is near completion. For example, project construction was stopped or delayed on the Tellico Dam in Tennessee, Blue Marsh Lake Dam in Pennsylvania, and the Auburn Dam in California because of consideration of an endangered species, historical preservation, and dam safety purposes, respectively. There are other dams in the same situation.

In a report 1/ issued in June 1977, GAO recommended that (1) the Bureau of Reclamation study some of its questionable dam design practices and (2) develop procedures to better ensure that design intent is achieved during construction. These recommendations were accepted by the Bureau and endorsed by an independent panel of dam experts as being applicable to all Federal agencies. The independent panel also recommended that the Federal agencies establish programs to better coordinate their use of the latest design techniques and construction practices. Also, a Federal interagency committee in November 1977 recommended that the Federal agencies improve their construction inspection and quality control procedures and practices.

The purchase of land, rights-of-way, and the relocation of facilities involve considerable costs and is of great concern to the local citizenry. Also, as projects are modified or terminated, the Federal Government has found itself in a position of utilizing the land for purposes other than originally intended or disposing of it, such as that which occurred at the Garrison Diversion Unit and the Tocks Island Project. Therefore, the Federal agencies' policies, practices, and procedures for purchasing and disposing of land and rights-of-way, and relocating facilities is an important concern.

1/"Actions Needed to Increase the Safety of Dams Built by the Bureau of Reclamation and the Corps of Engineers" (CED-77-85, June 3, 1977).

Rehabilitation and Maintenance of Existing Projects

Aging dams are becoming of increased concern which will intensify as the dams become older and need for the storage facilities increase. For example, about 12 percent or 250 Federal dams are more than 50 years old. It has been estimated that by the year 2000 over one-third of the dams then in existence will be at least 75 years old. The Corps and Bureau expect their operation and maintenance budget to increase over 300 percent in the next decade.

The condition of older reservoir dams or other structures, such as navigation locks and dams, may require renovation or replacement of the facilities. Also, the potential exists for expanding or redirecting existing projects' benefits to meet new or changing water demands. In some cases, this will require the redesign and modification of projects.

In order to implement an effective repair and rehabilitation program, the Federal agencies must establish a thorough inspection program. This inspection program should consider structural and material deterioration, impact of design problems, and other effects which can result from misuse, and poor operational practices and equipment.

Federal Dam Safety Programs

The dam failures of the past few years have brought dam safety issues to public attention. In June 1977, we issued two reports dealing with dam safety for both Federal and non-Federal dams, including emergency preparedness programs for Federal dams. In November 1977, the Federal Coordinating Council for Science, Engineering, and Technology issued proposed guidelines to improve Federal dam safety programs. An independent panel of non-Government experts is expected to issue a report on its review of these guidelines.

ISSUES AND CONCERNS FOR CONSIDERATION

Some of the more important matters related to construction and maintenance activities which should be addressed include:

Construction

1. Do Federal real estate acquisition requirements (legal and administrative) hamper the timely, efficient, and economical construction of water resources projects?

2. Is the construction process being efficiently managed and controlled? Does the Federal Government need to maintain better control over contractor work? How effective are the construction quality control programs of the contractor and the Federal agencies?

3. Are construction practices appropriate? For example, are new and updated design techniques and practices being used? Do the Federal agencies coordinate and disseminate information about the most current construction practices?

4. What are the pros and cons for having several Federal water construction agencies? Should their roles be better defined?

Maintenance

1. Are existing facilities being adequately inspected and maintained? Is there a Federal role for ensuring adequate inspection and maintenance programs for non-Federal water projects?

2. What efforts are being made to rehabilitate existing facilities and equipment for (1) safety purposes and (2) the expansion and reallocation of project benefits? Is this work being performed to meet priority water needs, such as energy production and municipal and industrial water supply?

3. How effective are Federal efforts in implementing a national dam safety program for both Federal and non-Federal dams? Have emergency preparedness plans been prepared for these dams? Does the Federal role in dam safety need to be better defined?

PAST AND CURRENT GAO EMPHASIS

GAO has not issued any reports, within the last 3 years, which specifically address construction and maintenance activities of the Federal water construction agencies. In the past few years, we have concentrated our efforts on dam safety. Also, at the request of a congressional committee

we have reviewed matters relating to congressional control over the development and funding of water resources projects, and the reasons for and potential solutions, for the long time frames for completing flood control projects. Currently, GAO is reviewing the Federal efforts to improve the safety of dams and beginning its analysis of construction and maintenance activities at Federal water resources projects.

GAO Reports	Report No. and Date
Actions Needed to Increase the Safety of Dams Built by the Bureau of Reclamation and Corps of Engineers	CED-77-85 6/3/77
Slow Progress in Developing and Implementing a National Dam Safety Program	CED-77-94 6/29/77
Improved Project Authorizations and Agency Practices Can Increase Congressional Control of Water Resources Projects	CED-78-123 7/11/78
Corps of Engineers Flood Control Projects Could Be Completed Faster Through Legislative and Managerial Changes	CED-78-179 9/22/78

GAO Studies in Process

Review of Federal Efforts to Improve the Safety of Federal and Non-Federal Dams

Survey of Maintenance Activities on Federal Water Resources Projects

Survey of Construction Activities on Federal Water Resources Projects

GROUND WATER SUPPLY MANAGEMENT AND CONSERVATION--WHAT ARE THE PROBLEMS AND HOW CAN THEY BE RESOLVED?

In a GAO report entitled "Ground Water: An Overview" (CED-77-69, 6-21-77), we discuss the importance of ground water, identify problems in managing the resources, and pose a number of questions on its management, conservation, and use which warrant attention by the Congress and Federal and State agencies responsible for planning and administering water resources development.

Since the GAO report was issued, many of the problems have become more serious because much greater reliance was placed on use of ground water supplies during the 1976-77 drought in many parts of the country. Currently, imbalances in water supply and demand cover considerable portions of our Nation, and many of the areas are drawing on a diminishing ground water supply to meet water demands. The President's recent water policy message reemphasizes the concern that ground water supply problems are emerging as one of the major water resources issues facing our Nation.

THE PROBLEMS AND ISSUES

Presently, ground water supplies about 20 percent of all fresh water used in the United States. The estimated storage capacity of aquifers (underground reservoirs) is nearly 20 times the combined volume of all the Nation's rivers, ponds, and other surface waters. Although the ground water supply in the 48 contiguous States is plentiful, little more than one-quarter of it--equivalent to about 10 years annual precipitation--is available for use because it cannot be economically extracted using present techniques.

The dependence on ground water varies from locality to locality. Only 2 percent of the water Montana uses comes from ground water, while 62 percent in Arizona comes from ground water. About 80 percent of municipal water systems are supplied by wells which serve about 30 percent of the Nation's population. Irrigation accounts for over half of ground water use.

The Nation's ground water supply is suffering from serious problems. Many places across the Nation are withdrawing the ground water faster than the water in the aquifer is replenished. Diminishing artesian pressure,

declining spring and streamflow, land subsidence, and salt-water intrusion problems are strong evidence of excessive use of ground water. The use of ground water at rates exceeding natural recharge defers the inevitable day when (1) alternative sources must be found or (2) serious decisions must be made concerning the continued existence of water dependent industries, irrigation developments, and proposed community expansions. In some areas, declining water tables will cause abandonment of activities before the water is totally consumed because of the increasing energy cost to bring it to the surface. Also, overpumping of ground water has environmental consequences. Base flows in streams are reduced or eliminated, resulting in increased harm during critical low-flow periods to aquatic and wild-life habitats in streams, wetlands, coastal marshes, and estuaries.

In the High Plains region of western Texas-eastern New Mexico, the ground water problem is particularly acute. The fast-dwindling and increasingly expensive supply of ground water, with no other water sources identified, may soon lead to serious economic and social consequences. Similar problems are developing in the ground water aquifer which extends from Texas to as far north as the Platte River in Nebraska.

Less dramatic, but prevalent throughout the Nation, are problems facing municipalities that draw water from aquifers. Because ground waters have traditionally been assumed to be relatively inexpensive sources of unpolluted water of generally uniform temperature, cities, given an option, have chosen those waters rather than surface supplies. As the population has increased so has the amount of pumping and and the number of wells. Some cites have found themselves forced to go deeper in aquifers of diminishing volume. As a consequence, forecasts indicate that many areas will face serious water supply problems by the turn of the century. If present use patterns continue, alternative water supplies will be required, probably at a much higher cost.

Although ground water depletion may have divergent causes and have a variety of adverse effects, the demand for ground water and the diminishing supply seem certain to continue under current projections. While ground water may, in many areas, continue to meet much of the increasing need in the short term, State governments, perhaps with the assistance of the Federal Government, will inevitably be forced to bring rates of withdrawal into balance with rates of recharge to ensure the availability and fullest use of fresh ground water supplies.

Ground water contamination is recognized increasingly as a serious problem. Ground water recovery from contamination and pollution is typically slow. Thus, ground water degradation may be considered a semipermanent condition once it has occurred. Waste from animal feedlots, community landfills, toxic and hazardous materials, septic tanks and cesspools, and municipal and industrial discharges are proving to be major sources of contaminants of ground water in many locations across the country. Because a considerable percentage of the population derives drinking water from ground water sources, contamination, whether real or potential, poses a health threat.

In areas dependent upon ground water for municipal, industrial or agricultural uses, continued degradation of ground water quality will have significant implications in the economies of the affected communities. One effect will be to raise the cost of treating water to achieve a suitable quality.

Surface and ground water are often interrelated, and actions on one can affect the other. For example, the excessive use of ground water in one area may result in surface water depletions in another; the benefit in one area may be a cost to another.

As with surface water systems, ground water aquifers are no respecters of political boundaries. Although water rights legislation in most areas covers ground water, the same institutional problems of managing surface waters that cross State boundaries exist for ground water management.

Another serious problem of ground water management is lack of information regarding the extent, volume, recharge rate, and effect of pumping. Too often wells are dug, pumping begun, and problems of ground water depletion realized only when ground water levels begin to fall. Without better capability to predict the consequences of ground water pumping programs, the beneficial value of the conjunctive use of surface and ground waters cannot be planned effectively.

Management of ground water resources has been primarily a local and State responsibility with assistance from the Federal Government. Major Federal ground water activities have been data gathering, research, technical assistance, and water resources development. The problems associated with managing aquifers, where the Federal Government is the owner or trustee for a portion of the overlying land, gives the Federal agencies a direct interest in ground water

management. Considering the extensive Federal landholdings, especially in the water-short Western States, the interest is very substantial.

Ground water management in the Western States has basically involved a degree of regulation of ground water withdrawals and use under the State water rights systems. More intensive regulation has taken place in some areas of severe ground water problems. However, substantial damage had already occurred in some of these areas and other problem areas have not received needed attention.

Federal and State agencies recognize the need for improved ground water management, and point out that ground water management must improve to provide orderly development, proper use, and conservation of the resource. Also, effective planning and management of ground water supplies should include research programs for developing better techniques for (1) obtaining geological and hydrological data, including pollution sources, (2) monitoring ground water supply and quality, (3) protecting and conserving the resource, (4) recharging aquifers to compensate for excessive use, and (5) utilizing underground aquifers as storage reservoirs.

In our June 1977 report, we raised the following questions about ground water management, conservation, and use:

--Should the Government take a more active role in ground water management? If so, what should its role be and what agency or agencies should be responsible?

--Should future construction of Federal water resource projects depend on whether the States show that their laws provide for integrating surface and ground water rights?

--How crucial is an inventory of water rights to proper management of ground water? Should the Government be responsible for inventorying these rights?

--Should the Government systematically identify areas with ground water problems to assign priorities for Federal assistance in obtaining ground water data?

--Should there be a national water policy requiring all Federal agencies involved in water planning or construction activities to require use and management

of surface and ground waters as a unit? If so, how should such a policy be implemented?

--Should water be transferred from one river basin to another to reduce ground water pumping or to recharge aquifers?

--Is enough being done to identify and prevent the intrusion of saltwater into ground water?

--Should Federal programs be devised which provide incentives to decrease dependency on ground water for irrigation in water-short areas? Is it feasible to compensate for decreased farm production in such areas by increased farm production in areas not requiring irrigation?

These questions, involving basic policy, warrant consideration by the Congress. Some should be studied by the Federal and State agencies responsible for the planning and administration of water programs; others may be more suitable for private research associations or academic institutions.

ISSUES AND CONCERNS FOR CONSIDERATION

The more important ground water issues and concerns which should be addressed include:

1. Is the informational base on the quantity and characteristics of ground water aquifers adequate to provide for effective planning and management of ground water resources?

2. What efforts are being made, or what are the constraints, to controlling excessive depletion of ground water supplies and establishing programs for recharging the aquifers?

3. Do administering organizations' laws, regulations, and policies adequately recognize the interrelationship of surface and ground water and require and promote their conjunctive management and use?

4. Are there effective mechanisms and implementing efforts to protect ground water resources from pollution?

5. What is the nature and extent of research and development efforts to find better ways to protect, recharge, and manage ground water resources?

6. In planning for and managing of Federal water resources projects and programs, do Federal agencies consider ground water problems and seek to provide for effective conjunctive use of ground and surface waters?

PAST AND CURRENT EMPHASIS

Until recently, GAO had not made reviews of ground water resources because Federal programs and projects essentially covered surface waters and ground water problems were not considered significant issues. Currently, we are reviewing the Federal efforts to promote more effective ground water management and conjunctive use of surface and ground water as well as efforts to control depletion and contamination of ground water.

GAO Reports	Report No. and Date
Ground Water: An Overview	CED-77-69 6/21/77
Waste Disposal Practices - A Threat to Health and the Nation's Water Supply	CED-78-120 6/16/78

GAO Studies in Process

Survey of Federal Efforts to Promote More Effective Ground Water Management and Conjunctive Use of Surface and Ground Water

Survey of Efforts to Control Depletion and Contamination of Ground Water

CHAPTER 4

OTHER WATER RESOURCES ISSUES AND CONCERNS

HOW CAN WATER QUALITY AND WATER SUPPLY PROGRAMS BE EFFECTIVELY INTEGRATED?

From early times, our country encouraged urban, economic, and industrial growth through unlimited use of our water resources. As time progressed, rapid growth occurred and along with it came water supply and quality problems and changing priorities. While cumulative water use patterns grew, other matters, such as health and environmental factors, became prominent; subsequently, our Nation's water resources planning and management broadened into two distinct categories: water supply and water quality.

Although the Congress enacted major water supply and quality legislation, it did not formally link either the areas themselves or the respective legislative acts. Since its inception in 1965, the Water Resources Council has given little attention to water quality planning and management. It was not until 1977 that the Environmental Protection Agency (EPA) was made a full statutory member of the Council. EPA, conversely, had conducted water quality planning outside the Council's programs for comprehensive water resources planning. Consequently, the water supply and quality areas have not been effectively merged.

The matters for concern include Federal agencies' policies, procedures, and practices for determining whether environmental matters are adequately considered during water project and program planning and development and whether projects and programs comply with requirements. Also, what are the problems and constraints to effective implementation of the requirements from both a programmatic and legislative standpoint? Another important area warranting attention is whether Federal agencies are conducting research into the environmental impacts so as to improve the prediction of ecological effects and to develop alternatives or modifications as well as ways to mitigate the expected environmental damage.

Issues which should be explored under this topic include (1) assessing the respective roles of Federal water pollution control and water supply planning and development agencies, particularly as they comprise interrelated elements of a comprehensive, total water management scheme, (2) exploring Federal assistance and/or incentive programs for promoting integrated water quality and quantity programs at the State

and local level, and (3) analyzing legal, technical, monetary, and/or other constraints or obstacles impeding or adversely affecting water quantity and quality management integration at the Federal, State, and local levels.

DO FEDERAL AGENCIES ADEQUATELY CONSIDER ENVIRONMENTAL EFFECTS IN WATER RESOURCES MANAGEMENT AND PROJECT FORMULATION?

In the past, water resources projects were constructed and water-related activities were undertaken with little regard for adverse environmental effects. As a result, our natural environment has suffered substantial damage. Natural stream channels have been altered or relocated; feeding and spawning areas and estuary habitats have been severely damaged; and wetlands and grasslands have been destroyed. Rivers, streams, lakes, and oceans have been heavily damaged by uncontrolled waste discharges.

To protect the environment and to ensure that environmental values are carefully considered along with other project purposes, the Congress enacted, for example, the Fish and Wildlife Coordination Act of 1958 and the National Environmental Policy Act of 1969. Other legislation, as well as the principles and standards for planning and formulating water and related land resources developments, require consideration of environmental and social values.

Although water projects may provide economic and social benefits, the public interest may best be served when the environmental costs of development are kept within acceptable limits and a balance is struck between environmental and developmental values. The challenge is to foresee the environmental and social consequences of proposed water uses and projects; to evaluate alternative ways to accomplish the project purposes, considering the economic benefits and costs as well as the environmental effects; and develop projects which provide net optimum benefits, including the recognition that some environmental change is inevitable.

ARE WATER INFORMATION COLLECTION AND EVALUATION EFFORTS PROMOTING OPTIMAL WATER RESOURCES PROGRAMS?

To effectively plan, manage, and develop water resources, managers must have complete and reliable information on such matters as the weather, water supply, and demand. Data collection and evaluation is vital for planning and assessing alternative actions and making

decisions; a deficient information inflow can adversely affect decisionmaking and, hence, ultimate program results.

Also, environmental and socio-economic data was not extensively developed in the pre-1970 years; with the advent of the National Environmental Policy Act, however, the need for such data increased tremendously. While progress has been made, gaps in existing data and probable future needs still chronically plague water resource planners. For example, ground water is an important, emerging water resource concern. Relatively little is known about the extent and quality of ground water resources, the movement of underground aquifers, aquifer boundaries, and ground water and surface water interrelationships.

As the water resources decisionmaking framework changes, basic data requirements also change; the problem is ensuring that the right kind of data will be available when needed, and that potential users know that it exists and have access to it. Therefore, there must be adequate research efforts to develop techniques and data collection systems. Without a complete information base, water resource planners and managers are seriously hampered in seeking to optimize the use of our Nation's water resources.

Issues and concerns which should be examined in this area include (1) assessing the adequacy of existing data collection and use, (2) determining whether standards or procedures exist, need to be or can be developed, for consistently obtaining and analyzing data, and (3) analyzing the Federal Government's role in hydrologic data collection and evaluation.

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