BY THE COMPTROLLER GENERAL

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Report To The Congress

OF THE UNITED STATES

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Water Supply For Urban Areas: Problems In Meeting Future Demand

The Nation's cities face serious water problems. Use in some areas already approaches or exceeds the dependable supply, and demand in urban areas is increasing. These areas must cope with shortages, ground water depletion, inadequate distribution systems, and water quality problems. Environmental opposition and the lack of funding may make it difficult to take the actions needed to assure an adequate supply.

No simple solutions exist. Desalination of saltwater and wastewater reuse are feasible but have not been adopted on a broad scale. Conservation and reducing demand will lessen, but not eliminate, the need for developing new sources of supply.

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To the President of the Senate and the
Speaker of the House of Representatives

This report provides an overview of urban water problems. We made this review to obtain information on what water problems urban areas face and what selected urban areas are doing to assure an adequate water supply in the future.

We are sending copies of this report to the Director, Office of Management and Budget; the Secretaries of the Army and the Interior; the Administrator, Environmental Protection Agency; and several congressional committees and subcommittees.

Elmer B. Staats
Comptroller General
of the United States

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COMPTROLLER GENERAL'S REPORT TO THE CONGRESS

WATER SUPPLY FOR URBAN AREAS: PROBLEMS IN MEETING FUTURE DEMAND

D I G E S T

About 85 percent of the Nation's people will live in urban areas by the year 2000. ~~Will~~ they ~~have enough water~~?

Water use already approaches or exceeds the dependable supply in some cities. Much urban growth is projected for areas already short of water, and there is a potential for shortages in areas assumed to have abundant water, as in the Northeast.

Cities will have to use water more efficiently and find new sources. Water distribution systems in many cities need substantial improvement. Water quality problems also may hinder attempts to assure an adequate water supply in the near future. And there are other problems, such as lack of funds.

SURFACE WATER

Most municipal systems rely on rivers, lakes, and streams for the bulk of their supply. However:

--Some of these sources cannot be relied on to provide a uniform flow throughout the year.

--Some already are fully allocated and cannot accommodate increased demand without changing allocations.

--Flows are declining in some water bodies.

~~Also~~, the amount of water that can be withdrawn for water supply is limited by requirements to maintain flows at certain levels for other purposes, such as water quality or fish and wildlife protection. (See p. 8.)

GROUND WATER

About 30 percent of all municipal water supplies come from water wells, and in many areas ground water is being used faster than it can be replenished. Besides depleting a valuable resource, long-term "overdrafting" of ground water reserves can result in

--reduced flows of surface water,

--increased energy costs to pump water from lower levels,

--saltwater intrusion into freshwater supplies, and

--land subsidence. (See pp. 10 to 14.)

WATER QUALITY

Urbanization leads to increased pollution, making a source of water unusable or treatment more expensive.

Surface water may be polluted from municipal and industrial waste discharges or from other sources such as runoff from urban, agricultural, or mining areas. Some progress has been made in cleaning up municipal and industrial discharges, but little has been done to combat pollution from urban, farm, and mining runoffs, which produce more than half the pollution entering the Nation's waters. (See pp. 14 to 16.)

Saltwater intrusion and improper disposal of wastes on land are the prime sources of ground water pollution. Saltwater intrusion is widespread, affecting both coastal and inland ground water aquifers. With respect to waste disposal on land, GAO reported previously that in some heavily populated areas, past practices had contaminated ground water to the point of threatening public health. This threat will continue, since most municipal disposal sites do not meet Environmental Protection Agency standards. (See pp. 16 to 18.)

DISTRIBUTION SYSTEMS

In some areas, growth and resulting increase in water usage have created the need for significant expansion of urban water distribution systems. In other cities, some pipes in the existing system may be 100 years old. Where replacement and maintenance have been put off, costly rehabilitation projects may be necessary to reduce leakage and water main breaks. Some cities may be losing a great deal of water because their distribution systems are structurally unsound. (See pp. 18 to 21.)

INSTITUTIONAL PROBLEMS

International and interstate water treaties and compacts as well as State water laws place limits on the amount of water available and the ways it may be used. The resolution of questions involving Indian water rights and Federal reserved water rights also may reduce the amount of water available to the Western States. Environmental concerns can result in disapproval or delay of projects needed to assure an adequate water supply. (See pp. 21 to 26.)

DEALING WITH URBAN WATER SUPPLY PROBLEMS

Because developing municipal and industrial water supplies is the responsibility of State and local governments, the Congress has not initiated any comprehensive Federal programs to develop, treat, or distribute urban water supplies. Most federally financed projects have been concerned primarily with irrigation, flood control, or hydroelectric power.

There are many alternative ways to increase water supplies, reduce demand, and manage existing supplies more effectively. Some of these are still experimental. Others, including desalination and wastewater reuse, are feasible and have significant potential, but economic, environmental, and public health considerations have precluded their

adoption on a broader scale. Conservation and demand reduction programs can lessen or postpone the need to develop additional supplies, but they will not preclude the need entirely. (See pp. 27 to 31.)

The 14 urban areas GAO visited varied considerably in terms of how much additional water they need by 2000, how they plan to provide these additional supplies, and the obstacles they face in doing so. (See pp. 31 to 46.)

As part of his water policy message of June 6, 1978, the President directed that an intergovernmental water policy task force be formed to continue examining key issues. At its first meeting in December, the task force identified urban water supply as a priority concern and formed a subcommittee to make an inventory of existing Federal programs which could assist in construction or rehabilitation of urban water systems and evaluate the institutional and financial problems surrounding supply and distribution of municipal water.

AGENCY COMMENTS

Comments on this report were obtained from the Corps of Engineers, the Department of the Interior, the Environmental Protection Agency, and the Water Resources Council. Their suggested changes were made in the report where appropriate. Several suggestions for more detailed studies of related issues will be considered as part of GAO's long-range planning process.

Contents

ABBREVIATIONS

EPA	Environmental Protection Agency
GAO	General Accounting Office
mgd	million gallons per day
USGS	United States Geological Survey
WRC	Water Resources Council

GLOSSARY

Acre-foot	A unit of measurement equal to the quantity of water required to cover 1 acre to a depth of 1 foot, or 325,851 gallons.
Aquifer	A porous, water-bearing geological formation.
Brackish water	Slightly saline water with a dissolved solids content of between 1,000 and 3,000 milligrams per liter.
Consumptive use	Processes which consume or evaporate water, thus making it unavailable for reuse.
Dependable yield	The maximum dependable demand which can be made continuously upon a source of surface or ground water during a period of years during which the probable driest period or period of greatest deficiency in water supply is likely to occur.
Ground water	Water in the porous rock and soils beneath the Earth's surface.
Land subsidence	Sinking of land surface due to compaction of underground sediments. It is often caused by overdrafting ground water.
Overdrafting	Withdrawal of ground water at a faster rate than the aquifer is replenished.
Recharge	The replenishment of water to an aquifer.
Saltwater intrusion	Invasion of saltwater into an environment where freshwater normally is present.
Water table	The upper limit of a source of ground water, measured from the Earth's surface.

CHAPTER 1

INTRODUCTION

An adequate supply of water is a social and economic necessity; however, serious water supply problems exist throughout the world. How to deal with those problems was the subject of a United Nations conference held in 1977, attended by representatives of 116 countries and 70 organizations. Like other countries represented at the conference, the United States has its share of water supply problems. Although the Nation as a whole has enough water, the supply is not always where it is needed when it is needed. As a result, shortages occur. The U.S. Water Resources Council (WRC), a Federal entity responsible for assessing the Nation's water situation, has projected that in practically all of the Nation's 21 water regions there will be shortages or water quality problems by the year 2000. In the second national water assessment, WRC concluded that the Nation has serious water management problems and is facing more problems.

The process of assuring an adequate water supply involves

--finding the needed quantities of water and obtaining the authority to use them,

--conveying the water to where it is needed,

--treating the water so that it is of acceptable quality, and

--distributing water to the ultimate users.

Increasing population, rising demand, and more stringent water quality standards will make it more difficult to assure an adequate supply of water in the future. According to a Congressional Research Service study, the U.S. population will reach 268 million by the year 2000 and the demands on our national water resources by that time will increase significantly.

URBAN WATER SUPPLY PICTURE

It is becoming more difficult to provide urban areas with adequate water supplies; in some areas use already approaches or exceeds the water supply system's dependable yield. Urbanization is also spreading. About 70 percent of the population lived in urban areas in 1960;

85 percent of the population is expected to live in these areas by 2000. A great deal of this growth is projected to occur in cities located in semiarid regions of the West. However, serious difficulties in meeting projected water demand are also forecast for areas assumed to have an abundance of water, as in the Northeast.

According to WRC, during the past 60 years more than 20 commissions have examined national water policies and problems. However, implementation of proposed solutions has been lacking to a great extent, and as a result water supply problems persist. For example:

--The 5-year drought of the 1960s created an emergency situation in the Northeast. About 14 million people--28 percent of the Northeast's population--were subjected to restrictions on water use. Since the drought, only one major water supply project has been built in the three most critically affected metropolitan areas.

--Parts of the Midwest and West experienced a serious drought in 1976-78. In our report on the California drought, we observed that the State water plan showed that dependable water supplies would not provide for State needs through the year 2000. 1/

--EPA predicted in 1978 that if current trends persist, more than 200 New England cities and towns would suffer severe water shortages by 1990.

--Ground water is being extracted faster than it is being replenished in areas nationwide. Much of the nonrenewable ground water in the arid West is being exhausted at a rate which will cause significant reductions in total ground water availability by the year 2000.

WRC issued a summary of its second national water assessment in December 1978. Among the 10 problems of national significance identified were 5 related to water supply: (1) inadequate surface water supply, (2) ground water

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1/ "California Drought of 1976 and 1977--Extent, Damage, and Governmental Response," (CED-77-137), Oct. 19, 1977.

overdraft, (3) pollution of surface water, (4) pollution of ground water, and (5) domestic water supply contamination. According to WRC, water is a scarce resource in most of the United States, and demand for municipal and rural domestic water appears to be a growing problem.

Increasingly, cities will have to use water more efficiently and find new sources of water. Further, the costs of urban water are escalating rapidly and there are competing uses for the water from the same sources. In addition to source problems, many cities have antiquated water distribution systems which need rehabilitation in order to conserve water and assure continued economic growth. Water quality problems may affect supply in other areas.

In urban areas where water shortages are projected, new supplies will have to be developed, the demand for water will have to be reduced, or existing supplies will have to be managed better. However, no simple solutions to urban water supply problems exist, and proposed solutions must consider all offstream uses as well as the protection of instream values. Institutional factors, such as environmental opposition and funding limitations, will also make solving urban water supply problems more difficult.

FEDERAL ASSISTANCE PROGRAMS FOR URBAN WATER SUPPLY

The Water Supply Act of 1958 (Public Law 85-500) recognized that the States and local interests were primarily responsible for supplying water for municipal and industrial purposes but that Federal agencies were to cooperate in these activities. Unlike comprehensive Federal programs in some areas--for example, the Environmental Protection Agency's (EPA's) construction grants program for wastewater treatment projects--no similar programs have been developed to fund projects to develop, treat, or distribute water supplies for municipal and industrial purposes. Generally, Federal water resources activities have been authorized on a project-by-project basis.

Still, significant water development projects have been constructed by the Bureau of Reclamation and the Corps of Engineers. Most, however, were constructed primarily for irrigation, flood control, or hydroelectric power. If water supply was included in a project, it was usually as a feature of a multipurpose project. Further, Federal policy requires localities to repay with interest the costs of water supply components of Federal projects. These water supply features do not include distribution systems.

The West and the South have been the primary beneficiaries of these projects. The Northeast has received the least amount of funds for developing its water resources due in part to the fact that many of its municipal and industrial water supply projects were ineligible for Federal funding and also because the Bureau's authority extends only to the 17 Western States.

Water from the Bureau and Corps reservoirs makes up a significant portion of the domestic water supply in the West and South. Bureau facilities supply 700 billion gallons (2.1 million acre-feet) of water a year for municipal and industrial use; the Corps has under contract 7.7 million acre-feet of storage in its facilities for municipal and industrial water needs. The Corps was authorized in 1965 to study and recommend the construction of water supply projects for the Northeastern United States. No water supply projects have yet been constructed under this authority; however, a pilot water treatment plant on the Potomac estuary is under construction and proposals for three single-purpose water supply projects are under review by the Corps of Engineers.

Although no grant programs currently exist for raw water treatment in urban areas, some limited funding for expanding or rehabilitating water supply distribution systems is available through the Department of Housing and Urban Development's Community Development Block Grant Program and the Department of Commerce's Economic Development Administration.

State water supply planning is supported in part by WRC, which also is required to prepare a periodic national water assessment. The Corps funds studies of the water supply needs of some cities under its Urban Studies Program and other activities and proposes projects to meet those needs. The Bureau has also performed a number of such studies.

OBJECTIVE OF THIS REVIEW

We reviewed various aspects of the urban water supply issue because it is perceived to be a growing problem and because of the concerns expressed in the President's water policy message about the issue. We wanted to determine what factors were making it more difficult to assure an adequate water supply in urban areas and also to find out what selected urban areas were doing to cope with their water supply problems. This overview report discusses the

--nature and severity of existing or projected water supply problems that affect urban areas,

--solutions proposed to solve the problems in selected areas,

--obstacles to implementing proposed solutions, and

--progress being made toward solving the problems.

We have issued several reports that concern urban water problems, which we cite throughout this report.

SCOPE OF REVIEW

We held discussions with and reviewed records supplied by officials of the Corps of Engineers, Department of the Army; the Economic Development Administration, Department of Commerce; the Bureau of Reclamation, Department of the Interior; the Department of Housing and Urban Development; the Environmental Protection Agency; and the Water Resources Council.

We contacted officials of State and local water supply agencies to obtain information on water problems and proposed solutions as follows: Phoenix, Arizona; Denver, Colorado; Atlanta, Georgia; Chicago, Illinois; Indianapolis, Indiana; New Orleans, Louisiana; Boston, Massachusetts; Las Vegas, Nevada; New York, New York; Wilkes-Barre and Scranton, Pennsylvania; Nashville, Tennessee; and El Paso and Houston, Texas.

We also contacted officials of water supply agencies in the Norfolk, Virginia; St. Louis, Missouri; and Washington, D.C., areas and at selected private organizations. Our review included an examination of pertinent literature and several studies of urban water supply.

CHAPTER 2

WHAT WATER PROBLEMS DO URBAN AREAS FACE?

Urban water users--domestic, commercial, and industrial--expect their daily demands for water to be met when rainfall is plentiful as well as during dry spells and droughts. However, a variety of urban water problems exist from area to area, which makes these demands difficult to meet. In some areas the problems may be ground water depletion or a lack of surface water. In other areas an inadequate distribution system or an institutional obstacle to implementing needed programs may cause supply problems. The severity of the problem also varies. In some cases the problem may be local in scope, while in others an entire region may be affected.

All of the urban areas we reviewed projected that additional supplies of water would be needed by the year 2000; however, these areas will face different problems in providing additional supplies. (See app. I for details on the projected water supply needs for the urban areas we visited.)

SURFACE WATER PROBLEMS

Most municipal water systems rely on surface sources of water--rivers, lakes, and streams--for the bulk of their supply. According to the Water Resources Council, problems associated with surface sources of water are perceived to be critical for large portions of the Nation. Because of the following problems, some urban areas may not be able to assure an adequate water supply.

--Some surface sources of water cannot be relied on to provide a uniform streamflow throughout the year.

--Some surface sources are already fully allocated. They cannot accommodate any increased demand without changes in existing allocations.

--Some surface water sources have declining streamflows.

--Reserving instream flows for water quality and other purposes limits their use for water supply.

Unreliable streamflows

Streamflows vary substantially from place to place, year to year, and season to season. In some areas they

are drastically reduced during summer months when demand is the greatest. Droughts result in even lower streamflows. When a drought will occur and how long it will last cannot be forecast with certainty. As a result, some surface sources cannot always be depended on as continuous supply sources.

California is a good example of poor natural distribution of surface water within a State. Areas of water surplus are in the northern portions of the State, but the areas of primary demand are in the central and southern portions. More than half of southern California's water must be imported from other regions.

Surface water resources in arid and semiarid States are not dependable due to low and erratic rainfall. For example, approximately half of Arizona receives less than 10 inches of rainfall each year; more than half of that occurs during a 3-month period. Reservoirs may be constructed to store water and thus regulate streamflows. However, most good sites in the West have already been developed. The areas with the most potential for new storage are east of the Mississippi River, where storage is needed least. Further, storage itself may cause a net increase in evaporation and consequently could reduce streamflows below the reservoir.

El Paso gets about 10 percent of its municipal water supply from the Rio Grande, which is not considered a dependable source. Flows are only available to El Paso during the 7 months in which irrigation takes place in the area. Further, between 1958-73 reservoir releases along the Rio Grande in Texas were stopped on five occasions for 30-day periods during the summer to conserve water.

The East has also experienced extremely low streamflows. For example, in the Washington, D.C., metropolitan area, the low flow of the Potomac River--388 million gallons per day (mgd)--occurred during the summer of 1966. Since then, single day withdrawals from the river have exceeded the record low flow 32 times. If the Potomac again reaches the low levels of the late 1960s, the supply could fall short of demand.

A similar situation exists with the Delaware River. Philadelphia Water Department officials said the Delaware, one of the city's major sources of water supply, cannot be relied on to satisfy its potential needs in case of severe drought. During the drought of the 1960s, when Delaware River streamflow was dangerously low, the

saltwater front came within a mile of Philadelphia's freshwater intake. A deputy water commissioner told us that Philadelphia's system cannot treat for saltwater.

Future growth will result in even lower streamflows. In the South Atlantic-Gulf water resources region, which includes Florida, South Carolina, and portions of five other States, low flows into these areas could be reduced by 40 percent or more by the year 2000 if projected levels of demand are realized. During critical months, flows might even be eliminated.

Some streamflows are fully allocated

The available flows from some surface water sources are already fully allocated. As a result, these sources cannot be expected to support increased demand for water in the areas they now serve or to provide water to other areas. Likewise, a shortage of surface water may force communities to use their ground water resources faster than they are replenished.

Surface waters in some of the Western States are fully allocated. The Colorado River is a good example of this situation. Half of the West's population--including metropolitan areas in southern California, Colorado, New Mexico, and Utah--depends directly on the Colorado River for water. However, by the year 2000 the river will be unable to meet the demands placed on it. In addition, there are claims by various groups which exceed the total amount of water available.

The Nevada water plan states that there are no areas with significant surpluses of uncommitted surface waters available for conveyance to areas of shortage. The plan also states that the municipal and industrial water needs of Carson City, Las Vegas, and other areas of the State will have to be augmented in the future, or growth in these areas will have to be limited. With the exception of those water supplies being developed as part of the Central Arizona Project, most of the natural surface water in Arizona has been developed. This project will provide Colorado River water to the Phoenix and Tucson areas; however, once the project is completed, the amount of Colorado River water exported to California will be significantly reduced.

Similar situations are also projected for other parts of the country. For example, in northwestern and north-central Louisiana abundant surface water supplies are not available and future demand is expected to exceed the

supply of most streams now being used. According to WRC, demands on two rivers in Virginia are expected to exceed their safe yields by 1980. To satisfy the increasing demand for water in the Norfolk-Virginia Beach area of the State, the Corps of Engineers plans to recommend a project to pipe water about 100 miles from another river basin.

Other eastern cities depending on surface water also lack nearby sources to satisfy increased demands. Boston is considering additional diversions of Connecticut River water. In the New York metropolitan area, a proposal has been made to skim water from the Hudson River about 80 miles upstream and convey it to the metropolitan area, since nearby waters are polluted.

Reduced streamflows

In addition to increased demand, other factors contribute to reduced streamflows in certain areas, thus reducing the available water supply. For example, the overdrafting of some ground water aquifers reduces streamflows. So does the increased consumptive use of water, since the water is consumed and therefore is not available for reuse.

The consumptive use of water is increasing generally in the Nation, including in urban areas. According to the President's water policy message of June 6, 1978, urban water consumption increased 13.5 percent between 1970-75; populations receiving urban supplies increased only 6 percent. The message stated that the result has been seasonal or short-term water shortages in certain metropolitan areas in the East. A Corps of Engineers report issued in July 1975 projected that consumptive use in the Delaware River Basin would double in the future to about 600 mgd. The report pointed out that this growth will decrease flows in the Delaware River and pose the problem of saltwater intrusion.

Withdrawal uses limited by instream needs

The use of surface water to satisfy urban water needs must also compete with instream uses of water, including fish and wildlife preservation, recreation, energy production, and environmental protection. The protection of instream values can significantly limit the portion of surface water streamflows available for water supply purposes.

The Chatahoochee River, Atlanta's primary source of water supply, provides a good example. The State of Georgia

requires that a continuous minimum streamflow of 750 cubic feet per second (cfs) be maintained in the Chatahoochee River below Atlanta. This requirement was imposed to provide for diluting the city's sewage effluent so water quality in the river downstream can be maintained. The minimum streamflow requirement of 750 cfs represents a total of 485 mgd used for water quality purposes. With the present operation of Buford Dam, the Chatahoochee River could yield an additional 327 mgd for water supply during the summer months, provided water supply releases are coordinated with hydroelectric power releases.

In 1978 the Congressional Research Service reported that current estimates of instream flow needs for environmental protection were crude but the quantities involved were large, especially during low-flow periods. 1/ The study asserted that if attempts are made to maintain such levels--and some Western States have given them legal standing for the first time--many river basins will experience severe water allocation problems. The study further commented that maintenance of instream values could become one of the most critical water issues of the future.

GROUND WATER OVERDRAFTING

Large quantities of water lie beneath the United States. Many cities--including Memphis, Tennessee; Dayton, Ohio; Wichita, Kansas; Boise, Idaho; and Spokane, Washington--rely entirely on ground water for their municipal supplies; many other cities rely partially on ground water. Overall, approximately 30 percent of total municipal usage is from water wells. There is evidence that our ground water resources are not being managed properly, however, because overdrafting of ground water--pumping water out of underground reservoirs faster than it is replaced--is occurring in some areas nationwide.

As noted in our 1977 report on the Nation's ground water situation, the composition of underground reservoirs varies, and for that reason, the effects of overdrafting also vary. 2/ Overdrafting of some ground water reservoirs results in taking water out of storage and is often referred to as ground water mining or storage depletion. According to WRC, the Nation is mining ground water at an estimated rate of 21 billion gallons per day; total ground water withdrawal is 82 billion gallons per day.

1/"The Nation's Water Outlook to the Year 2000," Jan. 27, 1978.

2/"Ground Water: An Overview," (CED-77-69), June 21, 1977.

Ground water depletion is severe in the West, where ground water aquifers receive little or no recharge. Overdrafting also occurs and poses problems in urban areas of the East, Midwest, and South. For example, Long Island, New York, a heavily populated area which depends on ground water as its major source of supply, is experiencing significant water table declines. Wastewater treatment plants in the area discharge their effluent in the ocean, thus eliminating a significant source of ground water recharge. In the Chicago area, ground water levels are estimated to be declining 20 feet each year. Overdrafting is also occurring in cities in California, Florida, Iowa, New Jersey, and Pennsylvania, as well as some other States.

In the long run, unless recharge balances ground water withdrawal, the supplying aquifer will be completely depleted. Besides the loss of a valuable resource, long-term overdrafting of ground water can result in

--reduced surface water streamflows,
--increased energy costs to pump water from lower levels,
--saltwater intrusion into freshwater aquifers, and
--land subsidence.

The following sections discuss ground water problems in several areas.

Arizona

More than 60 percent of the water used in Arizona is ground water. The State water plan stated that ground water is vital to Arizona's present and future; however, it characterized the depletion in the water stored in underground reservoirs as "alarming." The State estimated that annual withdrawals exceeded ground water recharge by 2.2 million acre-feet.

Arizona is one of the fastest growing States in the Nation; its population is projected to double by 2020. Most of this growth is projected for the Phoenix and Tucson metropolitan areas. Based on 1974 data, the 2,500 manufacturing firms operating in Arizona were concentrated in these two areas, and ground water withdrawals greatly exceeded recharge in both areas. In the Phoenix area,

ground water withdrawals were 30 times the rate of natural recharge; in the Tucson area, withdrawals were 12 times the rate of recharge. Tucson is the largest city in the Nation to rely solely on water wells.

Water tables in central Arizona are declining at a rate of 7 to 10 feet annually. The Arizona Water Commission estimated that by 2005 the ground water table would be 200-400 feet below the surface in the Tucson Basin and that water well production could be expected to decrease as a result. Studies by the city of Tucson have indicated that the lost production could not be regained by deepening the wells. In the Phoenix area, water table levels are expected to decline to from 200 to more than 300 feet from the surface; however, in north Phoenix the ground water table is expected to decline between 500 and 600 feet below the surface.

The Federal Central Arizona Project is expected to provide Phoenix and Tucson with imported Colorado River water by the mid-1980s. This would reduce the ground water overdraft by 60 percent, but it would not completely eliminate the gap between usage and dependable supply. Further, by 2000 increased water use may exert renewed pressure on ground water resources in the area.

Texas

A draft water plan for Texas, dated May 1977, states that significant ground water depletion has occurred in various urban areas, including Houston-Galveston, Dallas-Fort Worth, and El Paso. According to the plan, when the aquifers are overdrafted, well yields are reduced and the aquifer's ability to transmit water is decreased. The plan concluded that this phenomenon threatens the long-term water supplies for major areas of Texas.

In the Dallas-Fort Worth area, approximately 41,500 acre-feet of ground water was withdrawn from two aquifers in 1974. The estimated safe annual withdrawal rate in the area for those aquifers was about 14,700 acre-feet; therefore, an overdraft of about 26,800 acre-feet occurred. Overdrafting has caused extreme water level declines of 500 to 550 feet since the early 1950s and has resulted in current water levels ranging from 800 to 850 feet below the land surface.

El Paso receives only 8 inches of rainfall each year; 90 percent of its water comes from ground water sources. Currently, ground water withdrawals are 10 times the amount of recharge, and El Paso's water needs are increasing. City

officials estimate that by 2020 the population will double and water needs will triple. San Antonio's water supply situation also poses problems, since it depends on one aquifer (the Edwards) for its total supply. The U.S. Geological Survey (USGS) has predicted that if demands on this aquifer continue, as is likely in this rapidly growing area, there could be severe declines in water levels during droughts, large reductions in water available to all users, and reductions in flow or even periods of no flow.

Land subsidence

Land subsidence may occur in areas where ground water is being pumped extensively. As a result, the ground surface may drop several feet over a relatively large geographic area. Land subsidence can cause costly structural damage, lower property values, and make areas more vulnerable to floods. According to USGS, significant subsidence due to declining ground water levels has occurred in Louisiana, Texas, Arizona, Nevada, and California. Land has subsided more than 10 feet in some areas.

A serious land subsidence problem exists in a 3,000-square-mile area centered in Houston, Texas. Land has subsided 8 feet in some locations. In Houston, subsidence is greatest in the eastern portion of the city where industry makes concentrated ground water withdrawals. Damages already incurred include abandonment of a subdivision and periodic flooding of coastal areas near Clear Lake, including parts of a county park. Because of increased vulnerability where subsidence has occurred, property losses from the region's next hurricane are projected to grow by millions of dollars.

The State began to control land subsidence in the area by creating the Harris-Galveston Coastal Subsidence District in 1975. The district regulates ground water extraction by issuing permits to major users. Less ground water was withdrawn in 1977 than in 1976 due in part to conversions to surface water. The rate of subsidence in areas susceptible to flooding has also declined. Water levels have increased where surface water conversions have taken place; however, there will be no corresponding increase in land elevation.

USGS reported in 1978 that land subsidence exceeding 7 feet had occurred in a large area of Arizona. According to the report, much of the sinking was in a 120-square-mile area southeast of Phoenix. The area is part of a 4,500-square-mile portion of two counties where the land

has sunk and narrow cracks have appeared in the surface due to a decline in ground water levels.

Land subsidence in the Baton Rouge, Louisiana, area has been about 2 feet to date.

WATER QUALITY PROBLEMS

In addition to problems associated with locating adequate quantities of water, the quality of surface and ground water supplies is under continuous pressure from point and nonpoint sources of pollution. According to WRC, increased urbanization will increase water quality problems.

Surface water pollution is more severe near metropolitan areas because many are located at points where streamflows cannot assimilate accumulated waste products from upstream. For example, New Orleans takes its drinking water from the lower Mississippi River after thousands of towns and industries have discharged all types of waste into it. Metropolitan areas also discharge large volumes of wastewater effluent to surface waters; this affects the quality of water available to downstream users. For example, the Chatahoochee River is Atlanta's major source of water, but below Atlanta the river is polluted and unsuitable for use.

Most areas of the Nation already have some ground water contamination, and the problem is growing worse. Because ground water aquifers lie below the surface, out of sight, the seriousness of ground water pollution is being realized only gradually. Once contaminated, ground water is not as easily restored to a healthful condition as surface water.

Pollution may render a source of water unusable or make treating that water more expensive. The cost of treating water before it is used is a matter of concern. The State and local officials we contacted generally agreed that complying with proposed Federal safe drinking water standards would be costly and could cause water rates to double.

Surface water pollution

Surface water pollution is caused by point and nonpoint sources. Discharges by municipal waste treatment plants and by industry account largely for point source pollution. Runoff from urbanized, agricultural, and mining areas represents nonpoint sources of pollution.

EPA administers programs requiring that municipal and industrial wastewater be cleaned up before being discharged into rivers, lakes, or streams. Some progress has been made, but a great deal remains to be done. For example, municipal treatment plants were required to provide secondary wastewater treatment by July 1, 1977; however, only one-third of the plants met the deadline. On the industrial side, EPA estimated that as of June 1978 more than 45,000 industrial facilities required discharge permits; about 30,000 industrial permits had been issued by that date. According to EPA, most of the 15,000 facilities without permits were classified as minor dischargers. Even where permits had been issued, we found a high degree of noncompliance with discharge limitations during a previous review. 1/

Discharges of nonpoint pollution can occur anywhere along a river, lake, or stream. Because the source of discharge is diffuse, nonpoint pollution is difficult to collect and treat. We reported previously that nonpoint sources of pollution produce more than half of the pollution entering the Nation's waters. 2/ We also reported that progress toward controlling nonpoint pollution had been minimal and that, if not controlled, it would prevent attainment of national water quality goals.

Problems with surface water quality affect its use for municipal and industrial purposes nationwide. For example:

--Metropolitan New York City must import most of its water because available freshwater supplies are limited or expensive to treat. One of its potential sources of supply, the Hudson River, is brackish for most of its length in the region.

--Many municipalities and industries in the lower Mississippi region use ground water because of poor quality surface waters.

1/ "More Effective Action By The Environmental Protection Agency Needed To Enforce Industrial Compliance With Water Pollution Control Discharge Permits," (CED-78-182), Oct. 17, 1978.

2/ "National Water Quality Goals Cannot Be Attained Without More Attention To Pollution From Diffused or Nonpoint Sources," (CED-78-6), Dec. 20, 1977.

--Increased consumptive use will make Colorado River water more saline. This will adversely affect municipal and industrial water supplies in southern California; the Las Vegas area; and, upon completion of the Central Arizona Project, the Phoenix and Tucson areas. Nearly 17 million people will be involved.

--El Paso surface water quality is not good. The city blends it with ground water to maintain adequate quality.

--During a dry year, Mississippi River flow is insufficient during 4 months of the year to prevent saltwater intrusion into water supply intakes in the river's lower reaches.

--New England has generally been considered a water-rich area; however, the poor quality of many of New England's waters precludes their use as water supplies.

--Critical water quality problems exist in the Atlanta area involving the same streams used for water supply. Some of these problems are caused by point sources. Others are caused by nonpoint sources, including combined sewer overflows and urban runoff.

Ground water pollution

State/regional study teams participating in the second national water assessment reported ground water pollution problems in practically all of the Nation's 21 water regions. Two factors threaten the quality of ground water nationwide--saltwater intrusion and improper disposal of wastes on land. Each is discussed briefly in the following paragraphs.

Saltwater intrusion into fresh ground water aquifers can result from seawater moving into coastal aquifers or saline ground water moving into inland freshwater aquifers. As discussed previously in this chapter, overdrafting of ground water aquifers contributes to saltwater intrusion. If too much saltwater enters a freshwater aquifer, that portion of the aquifer could become unusable for drinking water purposes.

EPA reported in 1973 that saltwater intrusion problems were widespread and had affected both coastal and inland ground water aquifers. The seriousness of the problems usually depends on the intensity of urban and industrial

development, which causes the increased withdrawal of ground water. In Jacksonville, Florida, for example, the salt content of area ground water has increased from 20 to 80 parts per million since 1940. Besides the potential for making a source of water unusable, drinking water with an excessive salt content presents health problems.

Waste disposal practices also affect ground water quality. Previously we reported that in some heavily populated areas past practices for disposing of waste on the land have contaminated ground water resources to the point of threatening public health. 1/ The extent of the damage to this important resource, however, had not been determined. Our report pointed out that pressure on water quality will continue, as EPA stated that most municipal waste disposal sites do not comply with State standards.

In 1975 the Maryland Water Resources Administration released the results of a study which concluded that all or nearly all existing discharges of industrial wastes to the ground and underground waters were causing some environmental damage. The study commented that as the degree of waste treatment increases, so does the potential for ground water contamination. Maryland depends on ground water for 40 percent of the supplies used by its residents. An EPA study underscored the seriousness of the problem and commented that:

--Ground water has been contaminated on a local basis in all parts of the Nation and on a regional basis in some heavily populated and industrialized areas.

--Increasing amounts of waste will be dumped on the land because of tightened regulations against, and the rising costs of, waste disposal to the air, ocean, rivers, and lakes.

--Effective monitoring of potential sources of ground water contamination is almost nonexistent.

Programs attempting to deal with these problems are being carried out by EPA under the Resource Conservation and Recovery Act and the Safe Drinking Water Act.

1/"Waste Disposal Practices--A Threat to Health And the Nation's Water Supply," (CED-78-120), June 16, 1978.

DISTRIBUTION SYSTEM PROBLEMS

Once a source of water has been developed, the water must be taken to the area where it is needed and distributed to residential, commercial, and industrial users. In some areas increased water usage has created the need for significant expansions of the water supply distribution system. In other cities some of the pipes in the distribution system may be 100 years old. Where replacement and maintenance have been deferred, costly rehabilitation projects may be needed to reduce leakage and the increasing number of water main breaks.

The deteriorating condition of water conveyance and distribution systems has gained wide attention. The President's water policy message expressed concern about the soundness of these systems as did the National Governors Association. In addition, a nationwide survey of water supply engineers, conducted for the Department of the Interior's Office of Water Research and Technology, revealed that techniques must be developed to facilitate finding leaks in water supply distribution systems, identifying their causes, and preventing them from recurring.

A recent newspaper article stated that several cities were losing up to half of their water supply through old pipes and water main breaks. It attributed the delays in implementing replacement programs to funding shortages resulting from the Depression of the 1930s and the emphasis on social programs in the 1960s.

The extent of leakage in a system is not always known. For example, 36 percent of the water supplied in 1977 by the Sewerage and Water Board of New Orleans was identified as "unmetered free use." The category included leaks in the distribution system as well as firefighting and other municipal uses; however, we were unable to determine what portion was attributable to leakage. In 1977 the Pennsylvania Gas & Water Company reported "unaccounted for water" rates of 35 percent for its Wilkes-Barre service area and 46 percent for its Scranton service area. The chief engineer of the company told us that a significant part of the unaccounted for water was due to leakage in the aging distribution system, but he did not know exactly what portion was due to leakage.

Problems related to water conveyance and/or distribution systems in Boston, New York, and Houston are discussed below.

Boston

The Metropolitan District Commission supplies water to Boston and more than 40 other Massachusetts cities and towns. A 1975 study indicated that Boston's unmetered water usage was high and that the major component of unmetered water was distribution system leaks and breaks.

The study, performed for the commission under the supervision of the Water Resources Research Center, analyzed 1972 water use patterns for communities served by the commission. At that time Boston's unmetered water use was 51 mgd, or 46 percent of the water supplied to the city. Some of the "missing water" could be accounted for--it was used for firefighting; in public facilities, including schools; and for various other unmetered, unbilled purposes. After allowing for these factors, however, leakage was still estimated at 48 mgd. The study cited previous surveys which estimated leakage at about 10 percent, but it was unable to explain the large differences in the computed leakage rates.

A commission official acknowledged that leakage rates could be high. However, he pointed out that per capita usage figures for Boston, which were computed by the study, were far lower than for the surrounding area. In his opinion the study did not make sufficient allowance for underregistering meters.

In some areas unaccounted for water rates may be inflated because of defective (or underregistering) water meters. A 1976 study conducted in Norfolk disclosed that 47 percent of the meters tested were slow; instead of the 440,000 hundred cubic feet billed through these meters, the billings should have been for about 673,000 hundred cubic feet. The study concluded that the estimated total cost of replacing all 62,846 water meters in Norfolk would be $2.4 million but that the additional revenues would more than pay for the program. The meters are being replaced.

New York

In New York, as in other cities where all water usage is not metered, it is difficult to estimate the amount and extent of distribution system leakage. City officials maintain that the rate of leakage is about the same as for similar systems its age. They could supply no estimate, however, since no recent systemwide leakage survey had been performed.

The city's current financial situation has affected the capital expenditures for water supply purposes in two important ways. First, the city has been unable to keep pace with its 100-year replacement cycle for water supply distribution lines. Officials estimate that current annual expenditures of $20 million would have to more than double to get the program back on schedule. Second, the city has been unable to continue constructing a major new water tunnel which was necessitated by the danger of another transmission facility failing and by future capacity needs. Total cost of the water tunnel is estimated at more than $2 billion. New York is attempting to obtain Federal financing for the tunnel, but to date the Federal Government has made no commitment to participate in the project.

Houston

Since World War II, Houston's population has grown from 385,000 to 1.4 million. This rapid growth has caused problems for the city's water supply distribution system. Low water pressure and insufficient quantities of water are experienced periodically, especially in the outlying areas where new residential and commercial building expansion has placed increased water demands on the existing system. The system has not been modified fast enough to accommodate the additional demands, and furthermore the existing supply and distribution facilities have been overburdened in the past, limiting the water supply available for domestic service and fire protection.

Houston has undertaken a program to convert from a predominately ground water system to one in which greater use will be made of surface water supplies. This conversion program, which was necessitated by heavy, concentrated withdrawals of ground water and resultant land subsidence, will also convey surface water to neighboring communities and industrial users. The conveyance and distribution projects that are needed to meet the future increased demands of this rapidly growing metropolitan area are expected to cost billions of dollars.

The Department of Housing and Urban Development has commissioned the Urban Institute to perform a comprehensive study of urban infrastructure problems, including the problem of deteriorating water supply distribution systems. The study is scheduled to be completed in 1980.

INSTITUTIONAL AND LEGAL CONSTRAINTS

Various institutional, legal, and environmental factors affect the total quantity of water available to the States; affect how water will be used within a State; or make it more difficult to implement proposed solutions to water supply problems, including urban water supply problems.

Treaties, compacts, and court decisions

International water resource treaties and interstate compacts, as well as Federal and Indian reserved water rights doctrines, affect the amount of water available to particular States, areas, and water users. According to WRC, six treaties between the United States and Canada and three between the United States and Mexico establish rights and responsibilities to waters flowing in streams crossing international boundaries. The Mexican Water Treaty of 1944, for example, provides for delivery of 1.5 million acre-feet annually of Colorado River water to Mexico. This commitment means that this water cannot be consumed within the United States.

Likewise, the States have negotiated 33 interstate compacts concerning the flow of streams crossing their boundaries. Some of these compacts provide for minimum flow requirements at specific locations along surface water routes; others allocate streamflows from certain sources to individual States. The streamflows of the Rio Grande, for example, have been apportioned by compact to Colorado, New Mexico, and Texas. In the El Paso area, farmers long ago apportioned all of the Texas allocation of Rio Grande water, and as a result the city must negotiate with farmers to buy water. Since Rio Grande water available at El Paso is not adequate for the farmers' needs, they are unwilling to let the city increase significantly the volume it takes by contract.

The legal status of water flowing through Federal reserved lands and Indian reservations in the Western States is unclear and unresolved. In a previous report, we concluded that undetermined Federal and Indian reserved water rights in Western States were causing great uncertainties about existing uses and for potential water users. 1/ The

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1/"Reserved Water Rights For Federal And Indian Reservations: A Growing Controversy In Need Of Resolution," (CED-78-176), Nov. 16, 1978.

report stated that there was an urgent need to settle the problem as greater demands are placed on the limited water supplies in the West. El Paso, for example, has a serious need for additional water supplies and has requested permission to develop the ground water on a local U.S. military reservation, Fort Bliss. Even though the city provides one-third of Fort Bliss water supplies, the request was turned down. With respect to Indian rights, an Arizona water resources official told us that a court decision in favor of all Indian claims in Arizona would result in all the State's water supplies going to the Indians.

Court decisions also affect the amount of water available. For example, under a 1967 U.S. Supreme Court decree, Illinois may divert from Lake Michigan a maximum of 2,070 mgd. This action was taken, in part, to protect other uses of Lake Michigan water.

State water law

State water law establishes who has the right to use water within the State but may not always assure the efficient use of those water resources. The dominant method of water allocation in the West is the "appropriation doctrine," under which States apportion waters among the various users according to who first put the water to a beneficial use. The "riparian doctrine," commonly used in the East, bases water allocation on land ownership; landowners are entitled to certain rights to use water which crosses or borders their land.

To improve control over the use of water resources, a number of eastern States--including Florida, Georgia, and Maryland--have moved to limit riparian rights and have adopted regulations to control future uses of water. Under these regulations, major water users are required to obtain a State permit.

For example, the Georgia Department of Natural Resources has issued the following permit rule covering surface water withdrawals:

> "After July 1, 1977, any person who, on a monthly average, withdraws more than 100,000 gallons of surface water per day; diverts surface water so as to reduce the flow by more than 100,000 gallons per day at the point where the watercourse, prior to diversion, leaves the property on which the diversion occurs; or constructs an impoundment which

reduces the flow of surface water by more than 100,000 gallons per day downstream of the impoundment, must obtain a permit from the Director prior to any such withdrawal, diversion or impoundment subject to the following exceptions * * *."

Environmental opposition

Historically, the major emphasis in water resource matters has been on development. However, national concern has grown in recent years over protection and preservation of environmental values. This has resulted in conflicts, three examples of which are described below.

The Foothills Water Project was originally recommended in the mid-1950s and was to consist of a dam, reservoir, and water treatment plant to be built by the city of Denver. The project has been the subject of a dispute that has pitted Colorado environmentalists against Denver developers.

Environmentalists contend that the project would increase air pollution by encouraging the development of sprawling suburbs whose residents would use automobiles for transportation. The Denver area already has an air pollution problem caused by automobile exhaust, which becomes worse at high altitudes. Opponents of the Foothills project favor water recycling, domestic water metering, and conservation. They foresee a substantial decrease in per capita consumption as people continue the trend of moving back toward the city.

Construction, development, and banking interests favor the Foothills project, as does the Denver Water Board, which views the project as necessary to meet projected peak demands. In 1973 Denver voters approved a $160 million bond issue for construction of such water supply and treatment projects. In 1978, however, EPA recommended that the Army Corps of Engineers deny a permit needed for construction of the Foothills project.

Another project proposal which has met with significant environmental opposition is the Hudson River Project. The project was recommended by the Corps of Engineers as a result of its "Northeastern U.S. Water Supply Study," completed in 1977. The project would consist of facilities to skim and treat up to 950 mgd from the Hudson River about 80 miles upstream from New York City and to deliver this water to the existing New York City reservoir system. The Hudson River Project also includes facilities to improve the reliability of the city's water supply distribution system and to develop a connection between the New York City

and Nassau County, Long Island, water systems. Estimated cost of the project, in 1975 dollars, was $3.7 billion, to be repaid to the Federal Government over a 50-year period. The Corps study recommended for congressional authorization an $8 million, 3- to 5-year engineering study of the Hudson River Project.

A coalition of environmental groups is opposing the project and the proposal for additional engineering studies on two grounds. First, they believe the skimming project could have potentially severe impacts on human health and the environment by:

--Contaminating New York City's water supply with toxic and carcinogenic chemicals known to be present in the Hudson River. (The technology exists to control these substances but it has never been tested on the scale of the proposed treatment plant.)

--Damaging the Hudson ecosystem and fisheries.

--Causing saltwater intrusion.

Second, the environmentalists question the need for the project. They point out that revised population estimates are projecting a slower growth rate for the area than the Corps of Engineers assumed in calculating the projected water supply deficit. They believe that improved management of supplies, modest conservation, and advanced drought contingency planning will provide reasonable assurance that serious water shortages will not occur by 2000.

To date, no action has been taken on the proposal for advanced engineering studies of the project.

The proposed Tocks Island Reservoir on the Delaware River is another example of how environmental opposition helped to defeat a major water project. The project was authorized by the Congress in 1962 and consisted of an earthfill dam on the main stem of the Delaware River, creating a reservoir 37 miles long. Authorized project purposes included water supply, recreation, hydroelectric power, and flood control. Subsequent to authorization, 67 percent of the land needed for the project was acquired by the Federal Government. In November 1978, however, the the middle Delaware was designated a wild and scenic river, virtually assuring that the Tocks Island Project would not be built.

The Delaware River passes through four States in its 330-mile course to the Atlantic. New York City has constructed reservoirs on the upper reaches of the river which divert flows for the city's water supply needs. The amount of water diverted and the amount released from the reservoirs affect river flows downstream; cities such as Philadelphia and Trenton use these flows as a water supply source. The project's 300-mgd yield would have eased competition for Delaware River water. Philadelphia contended that the dam was necessary to supply the municipal and industrial needs of its metropolitan area.

In the 1970s many concerns began to be expressed about the project involving environmental issues and the project's impact on its surrounding area. In 1974 the Congress directed that a comprehensive review of the project be performed. The resulting consulting engineers report was issued in 1975. It contained no recommendation concerning the project but found, in part, that

--technically viable alternatives to Tocks Island exist, but questions regarding the institutional and political viability of some must be resolved and

--water supply alternatives generally have higher costs than the Tocks Island Project and lesser, but still significant, impacts.

Opposition to interbasin transfers

As increased urbanization and demand for water occur, local supplies may not be adequate and interbasin transfers of water may be required. Proposed interbasin transfers generally receive strong opposition. Environmentalists oppose them because of their potential for environmental harm. Agencies in the area called upon to give up some of their water question whether they should subsidize growth in another river basin at the cost of future growth in their own area. Some of the urban areas we reviewed--including Boston and Norfolk--were considering interbasin transfers of water at the present time. Other areas--like Atlanta and Indianapolis--believed interbasin transfers would be necessary after the turn of the century.

In Massachusetts there are 16 locations in the State where water supplies are diverted from one river basin to another. The largest such diversion involved the transfer of 180 mgd from the Connecticut River Valley in western Massachusetts to the Boston metropolitan area. Increasing water needs in this predominately urban

and suburban part of the State have resulted in proposals for two additional transfers from the Connecticut Basin, averaging 72 mgd and 76 mgd. Both diversions were extremely controversial, as residents of the supplying basin were concerned about the effects of additional diversions on low stream flows, waste assimilation capabilities, fish and wildlife protection, and ground water recharge.

One proposed diversion is no longer being considered because of severe opposition. The other project is still under consideration. In February 1978 the Governor said that interbasin transfers would be used only as a last resort and that conservation would be used first to offset projected water supply deficits in the Boston area.

CHAPTER 3

APPROACHES TO SOLVING WATER SUPPLY PROBLEMS IN SELECTED URBAN AREAS

Water supply problems differ from location to location, and so does the range of available solutions. In theory, diverse measures are available to increase supplies, reduce demand, or manage existing supplies more efficiently. However, all of these measures are not appropriate in all areas. For example, some areas may opt to develop surface water sources further; in other areas, reservoir sites and uncommitted surface water flows may not be available. The same holds true for conservation and demand reduction programs. In some areas these programs may have considerable potential for saving water; in other areas their potential may be limited. In fact, an area may have few alternatives available, and even then institutional or economic factors may make implementing them difficult, if not impossible.

Shortages of additional surface and ground water supplies, the high cost and long leadtime needed to develop these supplies, and the environmental opposition to this development will no doubt encourage consideration of other approaches, like desalination, wastewater reuse, water conservation, and demand reduction. These measures may reduce the need for additional development, but they will not eliminate it entirely.

The previous chapter discussed some of the factors which may preclude or limit further development or use of surface and ground water resources in large sections of the United States. This chapter will

--describe briefly measures which can augment existing water supplies or accomplish demand reduction and

--discuss what selected urban areas are doing to assure an adequate water supply.

MEASURES AVAILABLE TO AUGMENT WATER SUPPLIES

Many suggestions have been considered on how to augment existing water supplies. Some of these approaches are still being developed; others are feasible but, for various reasons, have not been adopted on a large scale.

Two measures under development are remote sensing and evaporation reduction. The World Meteorological Organization, an agency of the United Nations, is coordinating research on the use of photography, radar, and ultraviolet and infrared scanning from satellites and airplanes to discover accessible but undetected ground water. This work is in the early experimental stages. With respect to the second measure, the United States is among a group of countries that have covered lakes with artificial substances to try to slow down the rate of evaporation. This approach has had some success, but it has also encountered problems. For example, it has been reported that the artificial substances prevent essential oxygen from reaching the water beneath them.

The United States has also experimented with weather modification as a means of increasing water supplies. Under this approach, clouds are seeded with chemicals to produce rain or snow. Prior experiments have not had uniform results; some areas have received less rather than more precipitation. Further, the question of whether cloud seeding reduces rainfall downwind has not been settled; until it is, legal disputes are certain to arise. For example, Montana and Idaho threatened to sue the State of Washington over the seeding of Pacific Ocean clouds. They contended that such action would steal water from winds that might have carried it inland.

According to a Congressional Research Service report, meaningful economic and technical evaluation of operational weather modification programs is limited to special, localized cases. The report noted that substantially greater knowledge is needed of the (1) processes to be altered and the methods by which alteration can be achieved and (2) extent to which resulting effects can be predicted in time, space, and degree.

Two other approaches to augmenting water supplies--desalination and wastewater reuse--appear to have significant potential. They are discussed briefly below.

Desalination

The fact that more than 95 percent of the Earth's water is in the oceans has always made the desalting of seawater appear to be a future solution to the world's water supply problems. For many years, the United States, through the Department of the Interior, has carried out desalination research and development at a cost of about $300 million. Desalting is technically feasible, but the high cost has

limited its practical application. Efforts to reduce the cost of desalination have been successful, but these efforts have been thwarted by rapidly increasing energy costs.

In addition to the economic drawbacks, the possible ecological damage from disposing of brine produced by the process is a complicating factor. Ocean disposal usually does not cause serious problems; inland, the disposal problems can be great. No major urban area in the United States currently uses desalted water as its primary source of supply. Federally sponsored research into the process is continuing.

Wastewater reuse

According to a Congressional Research Service report issued in 1978, wastewater reuse is gaining recognition as an option for augmenting local water supplies because of pressures resulting from

--population concentration,

--limited availability of water supplies, and

--opposition to importing water from other regions.

The study pointed out that if the goals of the Clean Water Act of 1977 are pursued, the cleaner wastewaters will be suitable for additional uses; however, the study conceded that direct use of treated wastewater for drinking purposes must await resolution of public health questions.

Presently, the Department of the Interior is sponsoring an evaluation of national and regional water reuse needs and potential. The study is to assess the potential for wastewater reuse of future water supplies and to assist in establishing research and development priorities having the greatest benefits and urgency. The study will provide reuse potential for the years 1985 and 2000 for each of the water resources regions. The study is scheduled to be completed in 1980.

CONSERVATION AND DEMAND REDUCTION

Large reductions in municipal and industrial water use are possible through conservation and demand reduction measures. Water savings accruing from these measures could reduce the need for additional surface or ground water development or postpone the time when such development is needed.

Outside uses of water account for more than a third of all water used by urban systems and, according to the Water Resources Council, probably could be reduced without inconveniencing users. In typical urban areas, especially those in the Southwest, the largest single factor affecting maximum day demands during summer months is residential lawn watering. A developing practice in some areas of the Southwest--notably in Arizona, Nevada, and California metropolitan areas--is residential landscaping with indigenous or native vegetation, as opposed to turf covers requiring large amounts of water.

The City of Tucson has reported on the water use patterns of single-family residences with and without indigenous landscaping. Those residences using low water consuming vegetation achieved water savings of 8 to 26 percent. The City of El Paso has instituted an annual contest designed to promote indigenous landscaping. To be eligible, a home must have at least 75 percent of the front yard used for low water consuming plants or materials. The city has studied the effectiveness of these measures. In 1975 homes with conventional lawns used about twice as much water as homes with indigenous landscaping.

Opportunities also exist to reduce water use inside the home. A 1974 EPA study disclosed that 70 percent of household water use was for toilet flushing and bathing, as the following chart shows.

	Percent of total use
Flushing	39
Bathing	31
Doing laundry	14
Dishwashing	6
Drinking and cooking	5
Oral hygiene	3
Miscellaneous	2
Total	100

Based on a previous review, we concluded that household water use could be reduced through the use of low-flow showerheads and related devices. 1/ We also reported that demand reductions could be accomplished through various

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

water pricing policies and by metering water usage, thus requiring the consumer to pay for all of the water he uses. During this review, we noted that none of the States visited required the use of domestic water saving devices; Georgia had adopted legislation requiring such devices in new construction and most renovations beginning in 1980. Three cities we visited--Denver, New York, and St Louis--do not meter all domestic water usage; charges for water in these areas are based generally on flat rates.

WHAT SELECTED URBAN AREAS ARE DOING TO ASSURE AN ADEQUATE WATER SUPPLY

All of the urban areas we visited projected the need for additional water supplies by 2000; however, the difficulties they expected to encounter in obtaining these additional supplies varied considerably. For example:

--Some areas, like New Orleans and Nashville, have additional surface supplies nearby and will only have to expand their intake and treatment capabilities. Other areas, like Boston and Norfolk, will have to convey water long distances from different river basins.

--Costs of additional supplies to assure an adequate water supply in 2000 vary greatly. The Atlanta area is considering a project estimated to cost $11.5 million; the project proposed for the New York metropolitan area is estimated to cost $3.7 billion.

--Some urban areas, like Indianapolis and New York, believe Federal financial assistance is needed to implement proposed solutions to their water supply problems. Other areas believe adequate financial capability exists locally.

--Some urban areas have already decided on ways to solve their future water supply problems. Other areas, like El Paso and Las Vegas, are still examining alternatives.

The following sections highlight what the future water supply situation is expected to be in selected urban areas and what those urban areas are considering or doing to assure an adequate water supply.

Atlanta

The demand for water in the seven-county Atlanta metropolitan area is expected to exceed the dependable supply by 1980; by 2000, the gap between the average daily demand for water and dependable supply is projected to be more than 200 mgd. State officials told us that because of this situation, large water-using industries are encouraged to locate in other parts of the State where water is more plentiful.

The Atlanta area gets more than 90 percent of its water from the Chatahoochee River-Lake Sidney Lanier system. There are only limited ground water resources in the area, and several small surface water sources are projected to become too polluted to use for water supply. Short- and long-term solutions to the problem are being examined. The Corps of Engineers has recommended that to assure an adequate water supply through the 1980s, the level of Lake Lanier should be raised by 1 foot. This measure would allow for additional releases of water to downstream users during peak demand periods. It would require no capital expenditures but could adversely affect lakefront property.

The Corps, along with State and local agencies, is also considering alternative ways of assuring an adequate water supply in 2000; however, no final decision will be made until late 1980 or early 1981. One proposal receiving considerable attention involves construction of a reregulation dam on the Chatahoochee River. This dam would capture peak water releases from Buford Dam further upstream and provide increased minimum streamflows for downstream water uses. The facility was estimated to cost $11.5 million which would be borne by local agencies. The dam would cause slight decreases in power production and recreation benefits attributed to the Lake Lanier system. Environmentalists oppose the project.

State officials said that after water supplies which are made available by the proposed project are exhausted, interbasin transfers will probably be necessary to meet the Atlanta area's water needs.

Boston

The demand for water in the Boston metropolitan area already exceeds the dependable supply. The Corps of Engineers has identified the area as having critical water supply problems and the "Massachusetts Water Supply Policy Study," issued in May 1978, concurred in that assessment. A decision has not yet been made on how best to assure an adequate water supply in the area.

The Metropolitan District Commission is the major water supplier in the State; it provides water to 2.3 million persons in Boston and about 40 other cities and towns. The dependable supply of the commission's system is 300 mgd; average daily use in 1976 was 317 mgd. A 1977 Corps report projected that the commission would need a dependable supply of 441 mgd by 1990. The State agrees that the Boston area needs additional water supplies, but using revised population estimates, it projected 1990 needs at 370 mgd.

The question of how to provide these additional supplies remains unresolved, although one proposal has received a great deal of attention. The Northfield Mountain Project is designed to provide the Boston area with additional water. The project would divert Connecticut River water during high-flow periods and convey it by tunnel to the major reservoir in the area for storage. The project would supply an average of 72 mgd. The Corps also studied the proposal, and in 1975 Northfield Mountain was recommended for implementation by the Corps Board of Engineers for Rivers and Harbors. The proposal is still awaiting action by the Secretary of the Army. The project would cost about $56 million.

Northfield Mountain involves an interbasin transfer of water. Connecticut opposes the project because the water would be diverted before entering the State. Western Massachusetts residents also oppose it because the water would be diverted from their area.

The 1978 Massachusetts water supply policy proposed that a draft environmental impact statement for Northfield Mountain be prepared, but the Governor stated that transfers such as the project involves would be used only as a last resort. The study also proposed that the water savings possible from conservation and from rehabilitating the Metropolitan District Commission's distribution system be pursued, since these initiatives could save enough water to eliminate the need for major new sources. Until these determinations are made, final solutions to the water supply problem will be held up.

Chicago

The Northeastern Illinois Planning Commission projects a population of 8.9 million by 2000 for the six-county region of Illinois, which includes Chicago; a 28-percent increase since 1970. Although Chicago has experienced a population decline, significant growth has occurred in the outlying suburbs. This six-county area obtains all of its water supplies from Lake Michigan or from ground water

sources. Two factors will make assuring an adequate future water supply in this region more difficult:

--A 1967 U.S. Supreme Court decree limits the diversion of Lake Michigan water by Illinois for water supply and all other purposes to about 2,070 mgd. The State has allocated about 1,160 mgd of this amount in 1980 for domestic, commercial, and industrial uses. In 1974 the average daily pumpage from the lake for these purposes was 1,075 mgd.

--Ground water aquifers in the region are being overdrafted; a deep aquifer system is being pumped at a rate 2-1/2 times recharge. Economic and technical factors will probably preclude further development of the region's shallow aquifer system. Presently, four counties in the region use ground water exclusively; the other two counties rely on ground water for part of their supplies.

Increasingly, ground water-supplied communities in northeastern Illinois have sought to use Lake Michigan as a source of water. In 1977 the State allocated its allowable Lake Michigan diversions to about 130 entities, including 18 municipalities which formerly relied solely on ground water. Recognizing the seriousness of the problem, the Northeastern Illinois Planning Commission examined the region's water supply needs and issued its plan in February 1978. It recommended establishing six major subregional water supply systems at an estimated cost of $348 million. Three systems would use lake water.

Conveying Lake Michigan water to suburban communities will be expensive. For example, the three proposed systems which would use lake water would get their water through Chicago's system. Water would be withdrawn from the lake and treated in Chicago's facilities. It would then be pumped through Chicago's distribution system to the new pipelines to be constructed by communities participating in each system. The regional planning commission estimated that the capital costs of these three systems would be $185 million. Financing will be a problem. A local Congressman proposed legislation to create a Federal loan guarantee program to finance these types of water supply projects, but no action was taken on the proposal.

The Northeastern Illinois Planning Commission has also indicated that based on an analysis of future water supply needs, additional Lake Michigan water would be needed to avoid water shortages in the region. Possible steps to

accomplish this include (1) seeking Federal legislation increasing allowable diversions, (2) asking the Supreme Court for additional diversions, and (3) obtaining relief from requirements for using part of the State's allocation for certain activities not related to water supply.

Denver

A study prepared for the Colorado State Legislature in 1975 projected that the Denver metropolitan area would need about 300 mgd in additional water supplies by 2000; it is expected that demand will exceed dependable supply by 1980. To meet projected needs, the study stated that additional supplies covered by water rights already acquired should be developed and that existing treatment capacity must be expanded significantly to meet peak requirements. The cost to develop this increased supply, distribution, and treatment capacity was estimated at $1.4 billion. Proposed water system development has met with stiff opposition.

Environmentalists and EPA consider the water use projections to be high. Further, they believe that a conservation program would meet the area's near-term needs. Such a program would include metering the 88,000 unmetered homes and reducing the amount of lawn watering, especially during periods of peak demand. These groups also oppose additional water resources development because it reduces the amount of available land and the resulting growth increases air pollution. In addition, they question the advisability of continuing the rapid growth in the Denver area.

The Denver Board of Water Commissioners believes that additional supply and treatment facilities are needed urgently. For example, facilities to treat and distribute the raw water supply are only marginally adequate. According to the board, the existing filtering and treatment capacity of 520 mgd is only slightly more than peak day consumption experienced in recent years. The system would probably not have been able to meet peak demand in 1977 if mandatory water use restrictions had not been imposed.

A major water supply storage and treatment facility--the Foothills Project--has been planned for many years but has been opposed by EPA and a number of environmental groups. At the conclusion of our review, involved governmental and private organizations were settling their differences to allow issuance of the Corps of Engineers permit needed for construction.

El Paso

El Paso is located in an area of limited water resources, and by 2000 the demand for water is projected to exceed available surface water supplies and the natural replenishment rate of area ground water sources by about 95 mgd. The city depends on ground water for 90 percent of its supplies; however, the ground water in the area is being pumped faster than it is being replaced. The rate of ground water depletion is about 1 percent a year. The amount of surface water El Paso receives is limited to Rio Grande water the city purchases under contracts with local farmers. These farmers are not willing to increase significantly the amount of water they sell to the city because they need it for irrigation.

The city has considered various measures to alleviate its water supply problems. It has considered obtaining additional ground water by developing wells in nearby sections of New Mexico or on a Federal military installation located in part in El Paso. However, it appears that New Mexico ground water would not be available for export, and the city has not been able to get permission to develop the ground water on the Federal installation. Investigations of the potential of areas within 300 miles to the east of El Paso indicated that the volume of freshwater in the area is not significant as a long-range dependable supply. Further, development of these sources would involve excessive energy costs to pump water uphill and over several small mountain ranges. Large quantities of brackish water exist in the area, but desalination has been ruled out, primarily because of problems associated with disposing of the brine produced by the process.

El Paso plans to continue its efforts to reduce demand for water and to foster conservation; for example, there has been a campaign to voluntarily reduce lawn watering, which accounts for 35 percent of total water demand. (Still, the city projects an increase in per capita demand by 2000.) The city also is in the preliminary stages of a program to replenish ground water reserves with treated wastewater. Currently, about 50 percent of El Paso's sewage is returned to the Rio Grande and used for irrigation downstream. The city gets no exchange waters or credits from the downstream farmers for these discharges. To maximize the use of its limited water resources, the city is working with EPA on the recharge project. If all goes as planned, the necessary facilities will be operational by 1984 and will provide for the recharge of 10 mgd of treated wastewater. This would reduce, but not eliminate, the overdrafting of ground water resources in the area.

Indianapolis

✓ IN

The Indianapolis Water Co., an investor-owned company, serves a population of about 700,000 persons who live primarily in Marion County, Indiana. Company officials project that the average daily demand for water will exceed dependable supply by 1985; by 2000 and 2020 the gap between demand and dependable supply is expected to reach 32 mgd and 72 mgd, respectively. In 1972 the Corps of Engineers studied the area's water supply needs and recommended for congressional authorization the construction of Highland Reservoir on Fall Creek to provide 57 mgd in additional water supplies. The reservoir was estimated to cost $58 million in 1972. In addition to water supply, it was to provide flood control and recreation benefits. Construction of the project has not yet been authorized.

Water company officials and the State of Indiana favor the project, and the company has indicated a willingness to purchase water at an annual cost based on the construction costs allocated to the project's water supply component. Since 1972 the estimated costs of the project have increased to $75 million--more than a 30-percent increase. Company officials said they could not afford to build the project at that cost without Federal assistance.

Opposition to the reservoir has come from affected landowners and from those who favor developing ground water instead of constructing an additional reservoir. Ground water proponents cite a 1975 USGS study which concluded that a minimum of 59 mgd in additional ground water could be pumped in the Indianapolis area. Also cited were National Water Well Association estimates which purported to show that ground water development would be less costly than reservoir construction.

The water company disagreed with the assertion that ground water development would be less expensive than the Highland Reservoir Project and offered the following objections to the proposed ground water development:

--Locating 78 wells along the 18-mile area designated in the USFS report would disrupt established living patterns in a highly developed urban area.

--Of the water pumped from the designated wells, 90 percent would come from the White River, substantially reducing its flow. This would pose environmental problems since it would drastically reduce the

dilution of discharges from Indianapolis sewage treatment plants.

--Ground water development would require significant increases in energy use for pumping. The water supply from Highland Reservoir will flow by natural gravity to and through the treatment plant.

USGS officials told us that their report on the potential for pumping additional ground water in the Indianapolis area was based on hydrologic factors and did not consider the cost or feasibility of well development.

The Indianapolis Water Co. believes that the proposed Highland Reservoir is the last acceptable reservoir site on its existing watershed and that it should be built promptly. The longer the delay in beginning construction, the more expensive the project will be. Company officials believe that even with the Highland Reservoir and further development of ground water resources in the area, interbasin transfers of water will be needed to adequately supply the area after 2020.

Las Vegas

In 1978 the Las Vegas Valley Water District served nine times the number of customers it served in 1954. The district is not projecting shortages before 2000, but it may need additional supplies after that time. By then, according to district officials, it and other users will be fully utilizing Nevada's allocation of water from the Colorado River. There are currently no other proven sources of additional water supply except the already overexploited ground water basin.

The water district is aware that at some point in the future it will need more water and that additional supplies are not available locally. District officials said they were considering the following near- and long-term measures:

--Interbasin transfers of ground water.

--Exploitation of a deep aquifer zone under the Las Vegas area.

--Use of Colorado River allocations in excess of current needs to recharge local ground water aquifers.

--Exchange of a portion of California's Colorado River allocation with Pacific Ocean water which the water district would have desalted on the west coast.

The University of Nevada's Desert Research Center completed a project in September 1978 which assembled and interpreted information on areas of Nevada believed potentially favorable for water supply development from deep carbonate rock aquifers. The project was designed as the first phase of a major program to explore the potential of deep carbonate rock aquifers in southern and eastern Nevada for municipal and other water supply purposes. The objectives of this first phase were to establish the (1) most favorable areas for initial exploratory drilling and testing and (2) objectives of such exploratory drilling. We were told that the results of phase one were promising and that a funding source for phase two was being sought.

Another current research project is examining the physical, economic, and institutional aspects of recharging ground water aquifers in the Las Vegas area with Colorado River water that has been allotted to Nevada, but that it currently does not need. Nevada receives an allotment of 300,000 acre-feet each year of Colorado River water. However, because this allotment is made on an annual basis, allotment water not used in a given year is lost. Researchers believe that the physical capability exists to deliver unused Colorado River water to Las Vegas and that an average of 50,000 acre-feet could be available for banking over the next 25 years. This water could be developed and pumped at a later date.

Investigators acknowledge that a banking project of this type would be expensive but that reducing the risk of future water shortages may justify increased costs. The research project will also estimate expected reductions in land subsidence in potential storage areas.

Nashville

The population of this 10-county area, according to an ongoing Corps of Engineers study, is projected to increase from 912,500 in 1980 to 1.6 million by 2030--a 73-percent increase. Adequate local water sources appear to be available; however, major expenditures for water transmission, treatment, and distribution facilities will be needed to accommodate the increased growth.

All of Davidson County, including Nashville, is supplied with water from one source--the Cumberland River. The average demand for water is expected to be 109 mgd in 2000; however, county water department officials told us the Cumberland River could yield much more. Still, a water supply master plan completed in 1977 stated that the capacity of some existing treatment facilities will be surpassed by 1990 and that increased demand throughout the county will neccessitate major improvements of water transmission and distribution systems by 2000. The master plan estimated the recommended facilities would cost about $45 million.

An ongoing Corps study has identified water needs in other counties in the metropolitan area, but for the most part, sources of additional supplies appear to be available. For example, the study indicates that even though Springfield's source of water will be inadequate during a severe drought, water supplies could be obtained from the Red River. A 13-mile transmission line could be constructed to accomplish this. A similar situation exists in Murfreesboro, where existing sources of water were deemed inadequate to satisfy future demand. One alternate presented in the study was a 10-mile transmission line to obtain available supplies from an existing reservoir. Another alternative would be to develop ground water. Although the preliminary study did not comment on whether there were any institutional constraints to constructing transmission lines, we were told the final report would include such comments.

The study identified Williamson County, which is expected to grow in population from 56,850 in 1980 to 120,000 by 2030, as a water-short county. It indicated that the county will have to rely on outside sources of supply unless a major impoundment is built on the Harpeth River or the county elects to pursue development of ground water. The Corps study of water supply in the Nashville metropolitan area is due to be completed later in 1979.

New Orleans-Baton Rouge

Although the population increase of New Orleans was minor during 1950-70, surrounding urban areas experienced significant growth during that period. For example, the population of Jefferson and St. Bernard Parishes (counties) tripled. Future population growth is expected to be greatest in urban parishes, reflecting strong migration from rural areas to the cities. Of 20 parishes making up the New Orleans-Baton Rouge metropolitan area, 5 predominantly urban parishes account for 75 percent of the total population.

New Orleans is not projecting a water supply deficit by 2000. The city, like most of the metropolitan area, receives all of its water from the Mississippi River. In this regard, State and Corps of Engineers officials expressed some concern about the lack of a backup supply source based on the following:

--During periods of low streamflow on the Mississippi River, saltwater intrusion could make freshwater supplies undrinkable.

--The Mississippi receives significant quantities of municipal and industrial discharges, which lower water quality in the area.

The metropolitan area relies somewhat on ground water. Baton Rouge, the State capital, relies on ground water, but as discussed previously, it is overdrafting its ground water resources. Corps officials told us that Baton Rouge could use Mississippi River water, but it is not inclined to do so because it is more expensive than ground water. Increased water rates could force industry in the area to relocate.

The Corps of Engineers is presently studying water supply problems in the 20-parish area. Its final report is expected to be completed by mid-1979.

New York

In a 1977 report, the Corps of Engineers' "Northeastern United States Water Supply Study" (NEWS) concluded that the New York metropolitan area, including parts of Connecticut and New Jersey, had critical, immediate need to develop new water supply sources. Demand already exceeds dependable supply in the area. NEWS projected that by 2000 the gap between demand and dependable supply would be 940 mgd. To correct this situation, NEWS identified a number of projects to provide additional supplies. Connecticut and New Jersey indicated they could meet their needs beyond the year 2000 from in-State sources. New York State requested that the Corps investigate the feasibility of a $3.7 billion project identified in the study, which would improve the area's water supply and conveyance facilities.

NEWS projected that New York City and eight suburban counties in the State would have a water supply deficit of 520 mgd by 2000. The study proposed the Hudson River Project to augment supplies in the area. The project would take water from the Hudson River about 80 miles from New York City at a maximum rate of 950 mgd to produce an annual

average increase of 390 mgd in the system's dependable supply. The water would be pumped to a filtration plant, treated, and then conveyed by a deep tunnel to one of the city's reservoirs. Conveyance to demand centers in the city would be accomplished by completion of stage 1 and construction of stages 2 and 3 of City Tunnel No. 3 as part of this project. (New York City has been unable to complete construction of this tunnel because of its fiscal crisis.) A pipeline to Nassau County on Long Island would complete the Hudson River Project.

The project was estimated to cost $3.7 billion in 1975 dollars. It would be designed and constructed by the Federal Government, and then turned over to a duly authorized public body which would reimburse the Government for the construction costs.

New York State and New York City support further work on the Hudson River Project. There is general support for that portion of the project which would complete construction of City Water Tunnel No. 3. Opponents of the project question whether Hudson River water is safe enough to drink and whether the NEWS population and water use projections were valid. They also assert that conservation could save significant quantities of water. For example, proponents of metering residential water use in New York City say it could reduce demand by more than 240 mgd. City officials do not believe metering would result in significant water savings. Also, they believe it would cost $100 million to establish a metering program.

The Corps Board of Engineers for Rivers and Harbors recommended conducting advanced engineering and design studies of the project. This proposal is being reviewed by the Corps before being submitted to the Secretary of the Army. At some future date the proposal could be submitted to the Congress for authorization. No Federal funding for the study has yet been approved.

Norfolk-Virginia Beach

Peak daily demand for water exceeded the dependable yield of Norfolk's water supply system during the summer of 1978. We were told that average daily demand will exceed the system's dependable yield by the late 1980s. Norfolk does not project a significant increase in population by 2000, but Virginia Beach, to which Norfolk supplies water, is expected to have a population of 359,000 by 2000--an increase of 66 percent since 1975.

In 1974 the Congress authorized the Corps of Engineers to study the long-range water supply needs of the Hampton Roads, Virginia, area which includes Norfolk and Virginia Beach. A draft report on the study, completed in 1978, concluded that an interbasin transfer of water was necessary. The Corps plans to recommend that a pipeline be constructed for some 100 miles from an existing reservoir on the North Carolina-Virginia border to the study area. The Corps believes that one advantage of the proposed project is that it could be implemented without constructing a major impoundment. The estimated cost of the project is over $250 million.

The project recommendation of the Corps district office in Norfolk is currently under review by the Corps North Atlantic Division. Strong opposition to the project is evident. North Carolina residents in the basin around Lake Gaston (from which water would be diverted) say a pipeline would drain away too much water, causing environmental and economic harm. Residents of areas in Virginia through which the pipeline would pass say it would decrease property values and open the door to further water transfers. A major obstacle to implementing the proposed project is that localities have to give permission for the pipeline to run through their areas.

Phoenix

The Phoenix metropolitan area is one of the fastest growing areas in the United States and one of the major centers of economic activity in the Southwest. Current water use greatly exceeds dependable supply with the result that ground water aquifers in the area are being overdrafted. When the Federal Central Arizona Project begins delivering Colorado River water to the Phoenix area in the mid-1980s, it is expected that the level of overdrafting will decrease by two-thirds. The Arizona Legislature has established a ground water study commission to prepare a new ground water code for its consideration. The new code may include programs to reduce or eliminate overdraft in the basins which include the State's major cities. If nothing is done, the level of overdrafting will increase as population and industrial activity increase, until ground water levels drop to a point where certain users can no longer afford the cost of pumping.

The Phoenix metropolitan area uses a combination of surface water and ground water from deep wells. Parts of the metropolitan area, however, rely solely on ground water. A major source of surface water is the Salt River Project,

a system of six dams on the Salt and Verde Rivers. Phoenix receives an allocation of water from the project under a long-standing agreement with the Salt River Valley Water Users' Association. The water supply for the area served by the Salt River Project is believed to be adequate to meet projected demands, provided reasonable conservation measures are taken.

Since the agreement was entered into, however, the city has expanded to land not entitled to water from the Salt River Project. These areas currently rely on ground water. To assist them in providing for increased needs and reducing the level of overdrafting, the State has recommended an allocation of 200 gallons per person per day from the Central Arizona Project in 1985, decreasing to 150 gallons in 2034. The Secretary of the Interior has not yet made a final decision on these recommendations, but State officials believe they will be approved. Urbanizing areas are also provided with additional supplies of water by converting farmland into urban uses and continuing to use the wells to supply the new use. In this regard, a Corps of Engineers official told us that some of the ground water previously used for agricultural purposes may be unacceptable for domestic purposes.

Officials also told us that some of the ground water in the Phoenix area may not meet various Federal drinking water standards. In one suburb of Phoenix, the city of Glendale, we were told that only 7 of 30 wells meet EPA standards for nitrates. Further, because of overdrafting, brackish water is invading the freshwater aquifer in an area to the southwest of Glendale. We were told that a treatment plant for the ground water was needed but that the city could not afford one. An official informed us that the city has sought funds for the treatment plant from several agencies, including four Federal agencies, but to no avail. Glendale's present population is 78,000; it is projected to grow to 200,000 by the year 2000.

St. Louis

Neither the city of St. Louis nor St. Louis County is projecting water shortages. Their primary sources of supply--the Missouri, Meramec, and Mississippi Rivers--appear adequate for the foreseeable future. Water quality, however, may pose some problems. A 1977 Corps of Engineers study of the seven-county St. Louis metropolitan area concluded that most of the existing wastewater treatment systems did not comply with Federal standards. The study pointed out that the continued degradation of area water sources must be eliminated and controls exerted to protect

existing sources. A St. Louis County water official said this situation did not affect the water supplies in the county or the city of St. Louis.

One major problem faced by St. Louis involves the long-term loss of water customers due to a declining population. In 1960 the city's population was about 750,000, but by 1978 it had declined to 515,000. This has led to a decline in total water use; however, the cost of providing this water has not decreased since maintenance and rehabilitation needs do not decline with decreased usage.

The city has proposed a 27-percent rate increase to cover operating and capital expenditures. As a long-term solution to declining water usage, St. Louis has proposed selling treated water to the St. Louis County Water Company, a privately owned utility serving the growing suburban areas. This proposal has not made much headway because the suburban water company currently has excess capacity also. A company official informed us that present reserve capacity was 22 percent of total capacity.

Washington, D.C.

The Washington, D.C., metropolitan area, including parts of Maryland and Virginia, has been identified as having critical water supply problems. In a May 1978 draft report, the Corps of Engineers stated that population and economic growth were straining the ability of the Potomac River (the area's primary source of water supply) to meet not only future but present needs as well. Water supply deficits are expected to grow significantly by 2000. Some efforts are underway to augment area water supplies, but these projects will not eliminate anticipated deficits entirely.

Construction is in progress on Bloomington Lake and Dam in western Maryland. When this project is completed in 1981, it will increase the yield of the Potomac by 135 mgd. From authorization to completion, this project will have required 19 years. The "Northeastern United States Water Supply Study" also recommended two regional dams--Verona Dam in Virginia and Sixes Bridges in Maryland--to augment area water supplies. For various reasons, these projects have not moved forward to the construction phase.

The Congress has also authorized construction of a pilot or prototype treatment plant on the Potomac estuary to determine the safety and feasibility of using estuary water as a drinking water source. If determined to be

feasible, a regional estuary treatment plant could withdraw up to 200 mgd from the upper Potomac estuary during periods of critical low flow in the Potomac River. This project is viewed as experimental at the present time.

A major step toward solving the Washington area's water supply problems was accomplished with the signing of a Potomac low-flow allocation agreement in January 1978. This agreement contains a formula which limits the amount of water which may be withdrawn by each user during periods when Potomac River flow is insufficient to meet total demands. In such an instance, each user would be allocated a percentage of the total river flow. This agreement insures that the water resource is fairly distributed; however, it does not eliminate future shortages.

As indicated previously, the projects currently under construction are not sufficient to meet the anticipated year 2000 water supply deficit. The Corps is presently evaluating future needs under the "Washington Area Water Supply Study," which began in 1976. We were told an interim, early action report will be completed in February 1980. The report on long-range needs for the area is expected to be issued in 1982.

CHAPTER 4

OVERALL OBSERVATIONS AND AGENCY COMMENTS

OVERALL OBSERVATIONS

Urban water problems and the risk of water shortages exist nationwide, in areas of natural water deficiency as well as in areas assumed to have adequate water supplies. In many urban areas usage already exceeds the dependable yield of the water supply system. If population and urbanization increase as expected, it will likely become more difficult in the future to assure an adequate water supply in urban areas.

Many factors affect the process of assuring an adequate water supply. First, the needed quantities of water must be located and authority to use them obtained. International treaties, interstate compacts, and court decisions affect the quantities of water available for use in a particular area. Likewise, the ultimate resolution of questions surrounding Federal and Indian reserved water rights doctrines will affect the amount of water available to particular States, areas, and water users. In the same respect, maintaining minimum instream flows for environmental protection and other purposes can significantly reduce the quantity of water available for offstream uses, including urban water supply.

In addition to the above considerations, urban areas face other constraints on obtaining needed quantities of water. In some areas, surface water streamflows are not reliable; in other areas, all available surface water has been appropriated and no additional demand on existing sources can be met. Increases in the consumptive use of water are contributing to even further reduced streamflows. Ground water aquifers are being overdrafted in areas nationwide, especially where there is a shortage of surface water. This condition causes land subsidence, increased energy costs to pump water from lower levels, and other problems. Continued overdrafting could deplete a ground water source to the point where it can no longer supply water.

In addition to quantity problems, some sources of water have serious quality problems that restrict their use or increase the cost of treatment before use. Surface water supplies are being polluted by municipal and industrial point sources which are not yet in compliance with Federal clean water regulations and by numerous nonpoint sources of pollution. Ground water pollution from waste disposal on land

and from saltwater intrusion into freshwater supplies is also a nationwide problem.

Even if water supplies are adequate in terms of quantity and quality, some cities are experiencing problems distributing the water to the ultimate users. In some older cities, water supply distribution systems have been allowed to deteriorate and leakage rates are believed to be high. In some fast growing areas, distribution system expansion has not kept up with population growth and the increased demand for water.

Urban areas needing water and lacking nearby supplies may have to arrange for interbasin transfers of water. These projects are costly and encounter strong opposition. Environmentalists oppose them in favor of other solutions, such as conservation and reuse. Organizations in potential exporting basins also oppose them because they perceive interbasin transfers as subsidizing growth in one area at the expense of their own future growth.

There is no single, permanent solution to the water problems facing urban areas. Some methods of increasing water supplies are still in the experimental stages. Others--like desalination and wastewater reuse--are feasible, but health, environmental, and economic considerations have precluded their adoption on a broader scale. Conservation-related programs can reduce the demand for water but probably will not eliminate the need to develop new sources.

The urban areas we visited varied considerably in terms of how much additional water they need by 2000, how they plan to provide those additional supplies, and the obstacles they face in doing so. Some areas have adequate supplies nearby and only need to expand their intake, treatment, and distribution systems. Other areas must try to get water from locations outside of their respective river basins or will continue to overdraft ground water resources to meet their needs. In still other areas, proposed solutions are still being examined and evaluated.

The cost of programs to assure an adequate water supply in 2000 varied greatly; in some areas it was in the billions. In addition, some areas believe they need Federal assistance to implement proposed solutions to their water supply problems; other areas believe that adequate financial capability exists locally.

As part of his water policy message of June 6, 1978, the President directed that an intergovernmental water policy

task force be formed to continue examining key water issues. The task force held its first meeting on December 12, 1978, and identified urban water supply as a subject of major concern. As a result, a subcommittee on urban water supply was formed to inventory existing Federal programs which have the potential for assisting in construction or rehabilitation of urban water systems and to evaluate the institutional and financial problems surrounding municipal water supply and distribution. Preliminary work in these areas is underway.

The information in this report should be useful to the President's water policy task force in its deliberations and to the Federal water agencies in developing their long-range legislative proposals.

AGENCY COMMENTS

Comments on the matters discussed in the report were obtained from the Corps of Engineers, the Department of the Interior, the Environmental Protection Agency, and the Water Resources Council. Suggested changes were made in the body of the report where appropriate. Several suggestions were made for more detailed studies of other related issues, which we will consider in our long-range planning.

(080300)

CURRENT AND PROJECTED WATER SUPPLY NEEDS OF SELECTED URBAN AREAS

Metropolitan area	Current (1975-80)				Projected (2000)		
	Dependable supply	Population	Demand	Daily per capita use	Population	Demand	Deficit
	(mgd)	(millions)	(mgd)	(gallons)	(millions)	(mgd)	(mgd)
Atlanta	257	1.6	235	100	3.5	496	239
Boston	300	2.3	317	160	a/N/A	b/370	70
Chicago	1,285	7.0	1,379	250	8.9	1,595	310
Denver	384	1.5	335	207	3.0	691	307
El Paso	21	0.4	75	202	0.6	135	114
Indianapolis	118	0.7	103	148	0.8	150	32
Las Vegas	208	0.3	89	a/N/A	0.6	197	0
Nashville	150	0.4	65	187	0.6	109	0
New Orleans (city only)	242	0.6	135	237	0.6	140	0
New York	c/1,860	12.9	2,070	160	14.9	2,470	520
Norfolk-Virginia Beach	80	0.6	65	94-154	0.7	97	17
Philadelphia	420	1.9	372	180	a/N/A	520	100
Phoenix	c/866	1.2	d/1,673	200-400	1.9	b/1,455	158
Washington, D.C.	660	3.3	533	123	4.6	821	161
Wilkes-Barre/Scranton	103	0.5	70	203	0.7	e/228	125

a/ Information not available at the time of our review.
b/ 1990.
c/ Additional supply will become available by year 2000.
d/ 1970.
e/ 2020.

APPENDIX I

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