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BY THE COMPTROLLER GENERAL

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Report To The Congress

OF THE UNITED STATES

Additional Federal Aid For Urban Water Distribution Systems Should Wait Until Needs Are Clearly Established

A move is on to modify Federal policy to provide more aid to help large cities rehabilitate and improve their water supply and distribution systems. Such programs, if enacted, could add billions of dollars to the Federal budget.

GAO believes that the case for more Federal aid for urban water distribution systems is not convincing and that legislation to provide such aid should not be enacted until the needs are clearly established.

Long-standing Federal policy has recognized that supplying and distributing drinking water for municipal and industrial use is the prerogative and responsibility of State and local governments. However, considerable amounts of largely unrestricted Federal moneys, such as General Revenue Sharing, could have been used for water systems.

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COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON, D.C. 20548

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

This report discusses drinking water distribution system problems in several large cities. We made this review to provide information to the Congress, and the report should be useful to the Congress in considering future water resources projects.

We are sending copies of this report to the Director, Office of Management and Budget; the Secretaries of Defense, the Army, and the Interior; the Acting Director, Water Resources Council; and several congressional committees and subcommittees. We are also sending copies to appropriate officials in the three major cities in our review.

Elmer B. Staats
Comptroller General
of the United States

COMPTROLLER GENERAL'S
REPORT TO THE CONGRESS

ADDITIONAL FEDERAL AID FOR URBAN WATER DISTRIBUTION SYSTEMS SHOULD WAIT UNTIL NEEDS ARE CLEARLY ESTABLISHED

D I G E S T

Long-standing Federal policy has recognized that supplying and distributing drinking water for municipal and industrial use is the prerogative and responsibility of State and local governments. While no specific Federal programs currently exist to help large cities rehabilitate their water supply and distribution systems, considerable amounts of largely unrestricted Federal moneys, such as General Revenue Sharing, have been available for this purpose. (See pp. 37 and 38.)

Many Federal, State, and local officials are proposing to modify Federal policy to provide more Federal aid to help large cities rehabilitate and improve their water supply and distribution systems. Such programs, if enacted, could add billions of dollars to the Federal budget and may not be warranted for urban water distribution systems. (See pp. 1, 39, 48, and 49.)

GAO looked at water distribution systems in three large cities--Boston, New Orleans, and Washington, D.C.--and also obtained information from several other large cities. GAO's review focused on the areas of major concern to water distribution system operators--water mains, metering and water inventory management, and financing. (See pp. 4 through 6.)

PERSPECTIVES ON WATER DISTRIBUTION MAINS

Most water distribution mains in older cities are made of cast iron. No industry standard exists for replacing mains based on age alone, and many cities have mains over 100 years old which provide satisfactory service. Usually mains are replaced

only when they are beyond economical repair or too small.

An improved cast iron pipe, called ductile iron, came into use in the late 1960s because it is stronger and has the favorable characteristics of both steel and cast iron. Mains have also been manufactured since 1922 with cement mortar linings to prevent internal corrosion and water discoloration. Mains that were not installed with this protection often can be restored to their original capacity by in-place cleaning and cement lining at one-third to one-half the cost of replacement. (See ch. 2.)

CONDITIONS OF DISTRIBUTION MAINS

Contrary to the popular impression that older water distribution systems are already past the point of no return, the systems in Boston, New Orleans, and Washington, D.C., are providing enough water for all uses. None of the systems was without problems, however.

Boston experiences a relatively small number of main failures annually, but a large percentage of the system is old--some mains were installed in the 1850s. To protect the system, the Boston Water and Sewer Commission plans to rehabilitate or replace by the year 2000 all mains that will be 100 years or older by then. (See pp. 17, 18, 23, and 24.)

New Orleans experiences a large number of main failures each year due largely to soil subsidence. However, Sewerage and Water Board officials saw no need for a comprehensive main replacement program and expected to be able to cope with future failures. (See pp. 17, 18, 19, and 24.)

In Washington, D.C., main failures are moderate compared to other cities. However, the distribution system suffers from a lack of maintenance and capital improvements due to budgetary and staffing restrictions. Water department officials predicted a bleak future if the

restrictions are not lifted. (See pp. 17, 18, 25, and 26.)

MANAGING WATER INVENTORY

Controlling unaccounted-for water can help large cities conserve water and keep water rates reasonable. In addition to leakage, unaccounted-for water includes other types of non-revenue-producing water use such as firefighting, illegal hydrant openings, and meter underregistration. Metering and surveys intended to detect leakage and unauthorized uses are major aids in controlling unaccounted-for water.

Systems required to be financially self-sufficient or to operate at a profit place more emphasis on controlling unaccounted-for water. This seemed to be the case in New Orleans, in Boston after the creation of the Boston Water and Sewer Commission in 1977, and in two other cities which GAO used for comparison. Conversely, water management received less attention both in Boston under the old city operation and in Washington, D.C., where no attempt was made to achieve financial self-sufficiency. (See ch. 4.)

IS FEDERAL AID NEEDED?

Despite considerable interest in providing more Federal aid to help large cities rehabilitate and improve their water supply and distribution systems, two water industry trade associations generally oppose such aid. Both believe that water systems should be financially self-sustaining entities supported from charges to customers, and GAO found nothing to lead it to conclude otherwise.

The Subcommittee on Urban Water Supply of the President's Intergovernmental Water Policy Task Force, while speculating that 20 percent of the Nation's urban water systems might experience capital investment shortfalls in the next 20 years, cautioned that the estimating process was

both difficult and uncertain without a city-by-city analysis. The subcommittee also said that adopting any new policies to provide Federal aid should be accompanied by a detailed study of urban water resource problems. Such a study should, among other things: (1) relate urban water supply problems and solutions to other urban infrastructure problems, (2) inventory urban water system needs case by case, and (3) provide for reviewing and correcting the approach or approaches selected.

The subcommittee also found that most urban water systems are financially self-supporting from consumer payments and receive little or no aid from municipal government or other sources. The water systems in Boston and New Orleans are run by such entities and did not need outside financial aid from the standpoint of not being able to set rates at a level sufficient to enable them to finance annual operations and extensive capital improvement programs.

In Washington, D.C., on the other hand, water system operations are a part of city government and are not financially independent. The need for extensive work appears to have resulted from city-imposed budgetary restrictions rather than from a decision that rates could not be set to cover the costs of capital improvements and annual operations.

GAO believes that if, as the subcommittee reported, most water systems are financially self-sustaining, there should be little need for Federal aid. The case for more Federal aid for urban water distribution systems is not convincing, and legislation to alter Federal policy to provide such aid should not be enacted until the needs are clearly established.
(See ch. 5.)

AGENCY COMMENTS

GAO asked for comments on a draft of this report from the Boston Water and Sewer

Commission, the New Orleans Sewerage and Water Board, and Washington, D.C.; the Departments of Defense, Army, and the Interior; and the Water Resources Council. The Army responded for the Department of Defense, and Boston did not comment. Some comments agreed with some of GAO's findings and conclusions, and none disagreed. Most comments dealt with suggested changes for clarity. None required GAO to modify its findings and conclusions. (See pp. 6 and 7.)

Contents

ABBREVIATIONS

AWWA	American Water Works Association
DES	Department of Environmental Services (Washington, D.C.)
GRS	General Revenue Sharing
HUD	Department of Housing and Urban Development
MDC	Metropolitan District Commission (Commonwealth of Massachusetts)
mgd	million gallons per day
NAWC	National Association of Water Companies
WPA	Work Projects Administration
WRC	U.S. Water Resources Council

GLOSSARY

Aggressive	Used to describe water or soil that will corrode iron or steel water mains.
Centrifugal casting	The current method of manufacturing cast iron pipe.
Circumferential break	A fracture across the diameter of a water main.
Ductile iron	A type of cast iron made metallurgically different from ordinary (gray) cast iron by the injection of magnesium into the molten iron.
Leakage	Water lost through breaks and leaks in water mains.
Longitudinal break	A split along the length of a water main.
Main failure	A break or joint leak in a water main.
Static casting	An early method of manufacturing cast iron pipe.
Tuberculation	The buildup of encrustations on the interior of unprotected cast iron water mains caused by the corrosive action of certain water.
Unaccounted-for water	The difference between the amount of water delivered to a distribution system and the metered or estimated use by customers during a given period. Also called unbilled or non-revenue-producing water.
Water main	A pipe, usually buried underground, used to convey and distribute water.

CHAPTER 1

INTRODUCTION

As the Nation focuses on its ability to supply water into the 21st century, the adequacy of drinking water distribution systems in our older cities is receiving increased attention. Daily losses of millions of gallons are being attributed to aged, poorly maintained systems, and questions are being raised about their ability to provide continued reliable service.

Because questions are also being raised about the ability of water systems to finance maintenance and improvements with their own resources, many Federal, State, and local officials are proposing Federal programs to help rehabilitate publicly owned systems. In response to concerns of some of its members, the President's Intergovernmental Water Policy Task Force established a Subcommittee on Urban Water Supply to better define municipal water supply problems and to compile a list of existing Federal programs that could be used to improve water supply and distribution systems. The Departments of Commerce and Housing and Urban Development (HUD) have ongoing studies of urban infrastructures which include water distribution systems. A recent study of water resource priorities for the Northeast, sponsored by the Consortium of Northeast Organizations, also briefly discusses distribution system problems. Congressional interest takes the form of fact-finding hearings and bills introduced that would provide Federal financial aid to replace or rehabilitate deteriorated systems.

In recent years, we have issued a number of reports on needed improvements in water supply planning, management, and conservation. Two recent ones touched briefly on water distribution system problems. 1/ This report on older, larger cities is our first to deal specifically with these problems, potential solutions, and the abilities of systems operators to implement solutions with their own finances.

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

"Water Supply for Urban Areas: Problems in Meeting Future Demand" (CED 79-56, June 15, 1979).

THE WATER SYSTEMS IN BOSTON, NEW ORLEANS, AND WASHINGTON, D.C.

Boston

Based on a city home rule petition, the Massachusetts Legislature created the Boston Water and Sewer Commission in July 1977 as an autonomous, self-sustaining subdivision of the State to take over the financially troubled water distribution and sewage collection operations of the city Public Works Department. The commission began its first year as a truly separate entity on January 1, 1978, when all operating employees of the two city departments were transferred to the commission. The commission is headed by three commissioners appointed by the Mayor with City Council approval to staggered 4-year terms. Rates set by the commission are not subject to city or State approval.

As did the city previously, the commission purchases drinking water (and sewage treatment services) from the Metropolitan District Commission (MDC), a State agency. MDC wholesales water to 34 municipalities in the Greater Boston area that make up the Metropolitan Water District and to 10 nonmember communities under special agreements. The principal reservoir is about 65 miles west of Boston. The water is untreated except for chlorination, fluoridation, and the addition of a corrosion-reducing chemical. Water enters the Boston distribution system through 28 metered connections with the MDC system.

The first detailed discussion of Boston's present water distribution system appears in an 1847 city report when the system was only 30 miles long. The system reached 1,000 miles in 1939 and, at the end of 1979, consisted of about 1,080 miles of 2-inch and larger mains within the 45-square-mile city limits. The system is divided into five networks corresponding to various elevations of the city. About 90 percent of all water flows through two of the networks. In 1979 the commission had about 90,000 water customers and served a resident population of about 640,000.

New Orleans

The New Orleans Sewerage and Water Board was created by the Louisiana Legislature in 1899 as an independent entity to construct, maintain, and operate city water

treatment, distribution, and public sanitary sewer systems. In 1903 the legislature gave it control of and responsibility for the drainage system. Operations are entirely within the New Orleans city limits, whose boundaries are coterminous with Orleans Parish.

The board has 13 members including the Mayor of New Orleans who is the ex officio president. Other members come from the City Council; the Board of Liquidation, City Debt; and the citizenry at large. The board has independent control of the administration of its activities and finances subject to the approval of the City Council and the Board of Liquidation for bond issues and certain rate increases, and subject to the approval of the City Council for capital improvements over $50,000.

Since May 1, 1967, the water, sewerage, and drainage departments of the board have been separate entities for funding purposes. Previously, water revenues had to cover most of the costs of sewage collection and treatment.

The New Orleans water distribution system consists of two separate networks--one serving the part of the city on the east bank of the Mississippi River, where about 93 percent of the population resides, and one serving the west bank. Each has its own treatment plant which takes water from the Mississippi River. The total average daily use from 1969 through 1978 was about 123 million gallons with only small annual variations.

At the end of 1978, the two networks had a total of about 1,500 miles of distribution mains installed since 1904. About 34 percent of the mains were installed from 1904 to 1910, 29 percent from 1911 to 1950, and the balance (37 percent) from 1951 to 1978.

Washington, D.C.

The city of Washington, through its Department of Environmental Services (DES), operates the water distribution system which includes, in addition to the mains, pumping stations and distribution storage locations. The general age of the system is about 85 years, although some mains are over 100 years old. In 1946 the system reached about 1,100 miles and by 1979 included 1,406 miles of mains divided into seven pressure zones corresponding to various elevation areas of the city. The system distributes water

to about 750,000 consumers within the 69-square-mile city and also supplies water to several large Federal installations outside the city, such as the Pentagon and National Airport.

Washington's water is supplied by the Washington Aqueduct Division of the Army Corps of Engineers, an entity whose history goes back to 1850. The Washington Aqueduct takes water from the Potomac River at Great Falls and Little Falls, Maryland, treats the water, and delivers it to the city distribution system. The Washington Aqueduct also supplies treated water to Arlington County and the city of Falls Church, both in Virginia, which serve another 350,000 people.

Although the Washington Aqueduct is a wholesaler in relation to the three retail distribution systems, there are no direct purchase-sale transactions. Funds to operate the Washington Aqueduct are included in the Washington city budget, which must be appropriated by the Congress. The Washington Aqueduct bills Arlington County and Falls Church, but the payments are made to the city.

OBJECTIVES, SCOPE, AND METHODOLOGY

Older water distribution systems are often pictured as antiquated, poorly functioning, inadequately maintained, and on the verge of complete collapse. To test the validity of this dismal impression, we performed extensive work in three cities--Boston, New Orleans, and Washington. Boston was selected because of persisting reports that its system was leaking nearly 50 percent of water purchased; New Orleans because published reports showed a high incidence of main breaks; and Washington because the system is old.

Water distribution systems, which convey potable water from its treatment or collection source to users, include pipes (usually called water mains), distribution storage, pumps, control valves, fire hydrants, service connections to users, and meters. We did not review all these aspects; rather, we concentrated on water mains because they form the nucleus of any system, controls over unaccounted-for water because they are important in managing and conserving water, and system financing because of concerns expressed about how cities will be able to pay for needed system improvements.

We reviewed records and documents and interviewed water distribution system officials to find out the type, extent, and causes of problems each city had been having with its distribution system; what each city had done or was planning to do in the way of major maintenance or capital improvement programs; and how each city had financed these programs and overall operations in the past and how they planned to finance them in the future. For the most part, we reviewed data for the 10-year period 1969 through 1978 but in some instances included 1979 and 1980 data also.

To add some national perspective and broaden our knowledge, we interviewed and obtained data from systems operators in five other cities--Cincinnati, Ohio; Indianapolis, Indiana; Louisville, Kentucky; Seattle, Washington; and Troy, New York. We visited all but Seattle. We selected these cities based strictly on judgment. As our work progressed, people whom we interviewed indicated that officials in these five cities could provide information on and help us better understand water distribution system problems and solutions.

We also held discussions with and got information from officials of The American Water Works Association (AWWA), The National Association of Water Companies (NAWC), The Ductile Iron Pipe Research Association, The National Association of Regulatory Utility Commissioners, four water main rehabilitation companies, one leak survey engineering firm, and various other sources. AWWA has over 27,000 members from publicly and investor-owned water companies and others associated with the water supply industry in the United States, Canada, and other nations. AWWA publishes standards and policy statements on matters of concern to the industry. NAWC represents investor-owned companies that provide about 20 percent of the Nation's water supply.

In addition, we held discussions with and got information from officials of the Departments of Commerce and Housing and Urban Development, the Environmental Protection Agency, the U.S. Water Resources Council (WRC), the Subcommittee on Urban Water Supply of the President's Intergovernmental Water Policy Task Force, and various State agencies.

Our overall review objective was to provide information and observations to the Congress at a time when constituencies were building to request direct Federal financial aid to replace or rehabilitate these systems in larger, older cities. Seven of the cities--Boston, New Orleans, Washington, Cincinnati, Indianapolis, Louisville, and Seattle--

ranked from 11th to 44th in population in 1976, although the actual population served was sometimes larger. Troy, New York, has a population of about 60,000. All of the systems except New Orleans had distribution mains laid in the 1800s. The Indianapolis Water Company is investor owned; the others are publicly owned under various forms of business organization.

AGENCY COMMENTS

We asked for comments on a draft of this report from the Boston Water and Sewer Commission, the New Orleans Sewerage and Water Board, and Washington, D.C.; the Departments of Defense, Army, and the Interior; and the Water Resources Council. None of the comments required us to modify our findings or conclusions, although we did make changes to the report text based on some of them.

Boston

On September 8, 1980, an official of the Boston Water and Sewer Commission advised us that the commission had decided not to provide written comments. Any comments would be reserved until the final report was issued. This official stated, however, that he was satisfied with the factual accuracy of the data in the draft relating to the Boston system.

New Orleans

The Sewerage and Water Board of New Orleans commented in an August 22, 1980, letter. The comments emphasized the desirability of financing water systems from rates charged to customers and made suggestions for improving the technical accuracy of the report. We incorporated these suggestions in the final report except as noted on the copy of the response shown in appendix III.

Washington, D.C.

The Washington Department of Environmental Services responded by letter of August 29, 1980. DES agreed with our conclusions about the Washington system and stated that it should be financially independent and supported from charges to customers. DES also suggested changes to the report wording which we made except as noted on the copy of the response shown in appendix IV.

Departments of Defense and Army

The Department of the Army commented in a letter dated September 10, 1980. Most of the comments were suggestions to improve our handling in chapter 5 of the findings of the Subcommittee on Urban Water Supply of the President's Intergovernmental Water Policy Task Force. All of these suggestions were incorporated in the final report. The Army also agreed with our discussion of unaccounted-for water in chapter 4. (See app. V.)

Department of the Interior

The Department of the Interior response of September 9, 1980, did not comment on the substance of our draft report. It did, however, discuss the ability of the Water and Power Resources Service to support two of the policy options suggested by the Subcommittee on Urban Water Supply. (See app. VI.)

Water Resources Council

WRC replied to our request for comments in a letter dated August 27, 1980. It agreed with some of our observations and did not comment on others. It also suggested we consider in our final report that lack of maintenance of water systems may indicate a larger problem of overall deterioration of urban capital infrastructures and that the role of the States in providing aid to urban water systems should command as much attention as that of the Federal Government. (See app. VII.) However, the scope of our work for this report did not include either of these areas.

CHAPTER 2

PERSPECTIVES ON WATER DISTRIBUTION MAINS

Most water distribution mains in our older cities are made of cast iron, an extremely long-lasting material. Many American cities have cast iron mains over 100 years old which are still providing satisfactory service. No industry standard exists for replacing cast iron mains based on age alone. Ordinarily, breaks and leaks in mains are repaired, and large sections are replaced only if the mains are badly deteriorated or too small. A new form of cast iron, called ductile iron, has come into general use in recent years. This product has been almost failure free, a good sign for the future. Reduced carrying capacity caused by tuberculation--the products of internal corrosion--occurs in many older cast iron mains but can often be remedied by in-place cleaning and cement mortar lining, a less costly solution than replacement. Deterioration caused by external corrosion does not appear to be a major factor.

WATER DISTRIBUTION MAINS IN OLDER CITIES

Cast iron has been the material most used for water distribution mains in older cities since its introduction in the United States in the early 1800s. Current estimates of the total number of miles of distribution mains, or of cast iron mains, are not available. A survey done in the late 1960s by the Cast Iron Pipe Research Association 1/ reported that in the 100 largest cities, about 90 percent (87,000 miles) of water mains 4 inches and larger were cast iron. Twenty-eight cities reported having cast iron mains 100 years old or older. Based on this survey, this association estimated that the United States had over 400,000 miles of

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1/Now called the Ductile Iron Pipe Research Association.

cast iron water mains in 1970. In Boston, 99 percent of the distribution system is cast and ductile iron; in Washington, D.C., 95 percent; and in New Orleans, 69 percent. 1/

Early developments

America's first piped water supply was built in Boston in 1652 when water was brought from springs and wells to near what is now the restored Quincy Market area. In about 1746, the first piped supply for an entire community was built in what is now Schaefferstown, Pennsylvania. In both instances, the water was stored in wooden tanks from which citizens filled buckets. Early systems used wooden pipes and the force of gravity to move water from higher to lower elevations. Water systems as we know them today began when steam-driven pumps were first used in 1764 to move water uphill in Bethlehem, Pennsylvania.

Development of cast iron pipe

The first cast iron water main in the United States was laid in Philadelphia in 1817. Even that early in United States history, a cast iron main in Versailles, France, was already 153 years old. This main, laid in 1664, is still in use after more than three centuries.

Like most manufactured items, cast iron pipe has undergone a number of changes and improvements over the years. Early iron pipe was statically cast in horizontal sand molds. By the late 1800s, most pipe was cast vertically in static sand molds--often called pit casting. Some pipe made by both methods had portions of the pipe wall thinner than others because the mandrel around which the iron was poured to form the pipe bore shifted. While many cities have such "thick and thin" pipe still in use today, it does not withstand stress as well as more recently manufactured pipe.

1/At the end of 1978, 27 percent of the New Orleans distribution system was asbestos-cement pipe. In April 1980 news broke that a suspected cancer-causing chemical was being released from the vinyl linings in asbestos-cement water mains in some New England States. The Environmental Protection Agency was studying possible solutions to the problem in June 1980. Also in April 1980 an official of the New Orleans Sewerage and Water Board advised us that none of the asbestos-cement pipe in the city had this lining.

In 1908 AWWA published the first standards for vertical pit casting. The formula for wall thickness considered internal pressures and included an arbitrary factor to provide for stresses which were unknown or could not be satisfactorily calculated.

Static casting continued until about 1921 when the centrifugal casting method came into use. This method, using either sand or metal molds, continues in use today. Centrifugal casting, combined with increased knowledge of metallurgy, produced a pipe with considerably more tensile strength than pit cast pipe. However, some of the early centrifugally cast pipe had very thin walls and broke easily.

In 1948 a metallurgically different cast iron pipe, having the favorable characteristics of both steel and cast iron, was invented. Called ductile iron, it is less brittle than its predecessors, collectively called gray iron, and has superior strength, flexibility, and impact resistance. National standards for this pipe were first published in 1965. In the last 3 or 4 years, virtually all cast iron pipe produced has been ductile iron.

Boston began using ductile iron in 1968 and has used it exclusively since 1970. At the end of 1979, at least 73 miles, or 7 percent, of the system was ductile iron. New Orleans and Washington have only small amounts of ductile iron mains.

Because cast iron has been so long lasting, older cities may have mains of each type. Louisville, for example, had some mains from every year since 1862 still in service at the end of 1976. Boston had some mains that were installed in 1853, and officials estimated that about 20 percent of the system was installed before 1900. About half of the cast iron mains in New Orleans were installed between 1904 and 1908 and most of the remainder from 1909 to 1950. Washington's present system went into service in the late 1800s, and most of the original mains remain.

Ways of joining cast iron pipe

Methods of joining pipe have also changed over the years. Until about 1935, the common joint for cast iron pipe was the "bell and spigot." The straight (spigot) end was inserted in the larger (bell) end, and the space between was caulked with lead. If the pipe moved, the lead worked loose. In an 1851 report, the city of Boston noted an improved bell with a groove cast in it which would fill with lead to better hold the joint. From about 1920 until about

1955, some cities used a sulphur compound in place of lead. This material was cheaper and easier to use. Some water company officials stated, however, that it produced an extremely rigid joint which contributed to cast iron main breaks. Also about 1920, a bolted mechanical joint developed for the natural gas industry began to be used for water mains. Next, a rubber ring gasket began to be used in place of the lead or sulphur caulking on bell and spigot pipe. Since 1955, new cast or ductile iron pipe has been installed with a rubber gasket that fits in a groove in the bell. This method produces a watertight joint with a good deal of flexibility.

TUBERCULATION--THE RESULT OF INTERNAL CORROSION

Internal corrosion is the most common cause of loss of carrying capacity of unprotected cast iron water mains. Even minor pitting can reduce pressure by increasing the friction against which the water must be moved. As the process continues, the products of corrosion build up, resulting in a condition called tuberculation. (See photograph on p. 13.) In extreme cases, the pipe interior can become almost completely clogged. In addition, incidences of discolored water can occur if pressures are suddenly increased or flow directions are changed, causing the tubercules to flake off.

Causes of tuberculation

Water company officials have known for over 100 years that certain waters would corrode the interior of unprotected iron mains. Such waters are called "soft" because they contain few minerals and "aggressive" in relation to unprotected iron pipe. 1/ Aggressive waters are found in many areas of the country. For example, both Boston and Seattle have highly corrosive water. Since 1976, Boston's wholesale water supplier has been adding a corrosion-inhibiting chemical to the water. By the end of 1980, the Seattle Water Department will start to construct facilities for the same purpose.

1/The action of aggressive water on unprotected ferrous pipe is called electrochemical corrosion. Although not considered a major factor, iron-consuming bacteria can also cause tuberculation. These organisms collect iron and colonize at unprotected areas on the pipe interior at points of low flow, such as dead ends.

Preventing tuberculation

Attempts to prevent tuberculation apparently began as soon as the problem was identified. Boston's water department report for 1858 discussed the laying of cast iron mains coated with "Dr. Smith's patent preparation" (coal tar varnish, also called bitumen) to prevent internal corrosion. When a section of 20-inch main laid in 1858 was taken up in 1876 or 1877, the extent of tuberculation was found to be much less than in unprotected pipes. Bitumious coatings to prevent internal corrosion came into general use in the late 1860s. The process was not entirely successful, however, because a gap in the coating could expose a spot to corrosion.

Today, about 90 percent of all gray and ductile cast iron pipe manufactured for water use is lined with cement mortar to prevent internal corrosion. Experiences reported as early as 1836 showed that this procedure would prevent tuberculation, and cement-lined sheet metal pipe was introduced in the United States in 1850. Progress was slow, however. New cast iron pipe with a factory-installed cement mortar lining was first used in Charleston, South Carolina, in 1922 to combat the extremely aggressive water of that city. Other cities began to use such pipe as the need for new pipe arose or acceptance of the new process grew. For example, Boston first used new cement-lined pipes in 1927 and Washington, D.C., in 1942. AWWA first published a tentative standard for new cement-lined cast iron pipe in 1932.

Rehabilitating tuberculated water mains

Although mechanical methods of removing tuberculation from buried water mains were reported as early as 1851, simply cleaning has not proved lasting because the exposed metal retuberculates very quickly. In the early 1930s a practicable method was developed for cement lining pipe in place, and the first field application of cleaning and lining took place in Jersey City, New Jersey, in 1933. The first AWWA standard was published in 1939 as part of another standard. Originally, only mains 16 inches and larger in diameter could be lined in place. Today, mains as small as 4 inches in diameter can be done.

Cleaning and lining involves removing tuberculation with metal scrapers and applying a thin coating of cement mortar. The process usually restores the main to its original capacity and can add 50 to 100 years to the service life. Cement

lining will also eliminate complaints of discolored water caused by corrosion. Tests have also shown that cement lining can stop leakage.

Many cities have undertaken cleaning and lining programs as alternatives to re-laying mains. Washington began cleaning and lining in 1944 and Boston in 1965.

Cleaning and lining is usually more economical than pipe replacement. One cleaning and lining company estimated that pipe rehabilitation is often less than half the cost of replacement. Boston's estimated average cost for cleaning and lining in 1979 was $56 per foot compared to $122 per foot to replace mains. However, prices vary considerably, depending on site-specific factors such as the size, location, and type of valves; the population density of the street; the number of services that need temporary connections, and the type of existing paving.

To get some idea of how much cleaning and lining was going on nationally, we contacted three large companies specializing in this work. During 1969 through 1978 these three firms cleaned and lined over 1,400 miles of cast iron water mains in a total of 235 municipalities or water

TUBERCULATION IN CAST IRON WATER MAIN INSTALLED IN BOSTON IN 1899 AND REMOVED IN 1980. (Main was damaged during removal.)

districts in 36 States and the District of Columbia. Although only a small fraction of the estimated 400,000 miles of cast iron pipe in the United States, this figure indicates considerable activity by water companies to rehabilitate rather than replace their systems.

EXTERNAL CORROSION

External corrosion of cast iron water mains does not appear to be a major problem. When it does occur, external corrosion can be caused by aggressive soils such as are found in salt marshes, peat bogs, or areas filled with cinders, garbage, or other potentially corrosive materials or by electrolysis from stray direct electrical currents, such as those found near rapid transit lines. The latter can be severe even in nonaggressive soils.

According to the Cast Iron Pipe Research Association, most of the soil in the United States is not corrosive to cast iron pipe. A survey by this association completed in 1970 showed that only 5 percent of 121,500 miles of pipe in 229 cities in 48 States was affected by corrosion. Pipe age ranged from new to 149 years old. An earlier survey, in 1960, by the American Standards Association (now the USA Standards Institute) disclosed that of 83,000 miles of cast iron pipe installed by 110 utilities, less than 2 percent was in areas where serious corrosion had been encountered.

Other factors also limit the potential damage from external corrosion. Since about 1860, cast iron water mains have been coated with a thin bituminous layer to prevent internal corrosion, a process which also helps to retard external corrosion. When soil corrosion does occur, the products become a protective barrier that retard further corrosion. Both soil and electrolytic corrosion can be prevented by proper installation practices. The basic AWWA installation standard requires a layer of clean fill around new pipes. Another standard, adopted in 1972, suggests wrapping pipe with loose polyethelene film to prevent corrosion. (See photograph on p. 16.)

REPLACING CAST IRON WATER MAINS

No industry standard exists stating that cast iron water mains should be replaced when they reach a certain age. AWWA has not issued any guidelines for main replacement based on age, and an AWWA official stated that the 50- to 100-year useful lives used by many utilities to plan maintenance and improvement programs are completely arbitrary. A consulting engineer, a project manager with the National Association of

Regulatory Utility Commissioners, and officials from three water companies also knew of no set age when mains should be replaced.

Usually, mains that fail in service are fixed with various repair devices or by recaulking joints. Sometimes the section that failed is replaced. Decisions to replace long lengths of mains are based on an assessment of the condition of the main rather than on age alone. Sometimes, otherwise sound tuberculated mains must be replaced because their capacity would be inadequate even after cleaning and lining.

Source: Cincinnati Water Works

INSTALLING DUCTILE IRON PIPE WITH POLYETHELENE WRAP TO PREVENT EXTERNAL CORROSION

CHAPTER 3

WATER DISTRIBUTION MAINS--HOW BAD ARE THEY AND WHAT ARE CITIES DOING ABOUT THEM?

A popular scenario depicts drinking water distribution systems, particularly water distribution mains, in many older cities as aged, on the verge of collapse, and in need of immediate replacement. Yet, the systems in Boston, New Orleans, and Washington, D.C., in spite of advanced age, generally were providing adequate supplies of drinking water to all users, and no system seemed to be in danger of collapse.

None of the cities was without problems. Annual breaks per 1,000 miles of distribution mains were low in Boston, moderate in Washington, and high in New Orleans compared with 11 other cities. Main breaks and joint leaks in all three cities appeared to be influenced as much by environmental and installation conditions as by the age of mains, a situation which prevailed in other cities also. Boston and Washington had tuberculated mains, while New Orleans Sewerage and Water Board officials did not believe their mains were badly tuberculated.

Water department officials in Boston, New Orleans, and Washington, D.C., expressed overall satisfaction with their system's present abilities to deliver water for all uses. To provide for the future, Boston officials planned to continue replacing or rehabilitating deteriorated mains. New Orleans officials did not feel a main replacement or rehabilitation program was needed and have geared their operations to repairing the large number of main failures that occur each year.

In Washington, a considerable amount of money has been spent since 1960 on water distribution main improvements. Much still needs to be done, but water department officials said these needs are not being met because of budgetary restrictions. According to these officials, the city will have to step up main improvement programs and all other maintenance activities if the system is to operate satisfactorily in the future. These officials expressed optimism about being able to get main replacement and rehabilitation projects approved in the future. In the past, however, water department priorities have not always coincided with those of city reviewing officials.

DISTRIBUTION MAIN FAILURES--BREAKS AND LEAKS

Breaks and leaks in water distribution mains, especially in older cities, receive considerable attention in the news media and other forums because they are often spectacular events involving flooding, traffic disruption, customer inconvenience, and property damage. Failure rates vary considerably from city to city. Total failures during 1969 through 1978 averaged less than 1 per week in Boston, about 37 per week in New Orleans, and almost 5 per week in Washington. The annual number of failures per 1,000 miles of mains averaged 44 in Boston, 1,278 in New Orleans, and 176 in Washington over the 10 years. Main breaks alone averaged 36 in Boston, 680 in New Orleans, and 116 in Washington. In comparison, main breaks in 11 other large cities ranged from 43 to 1,290 per 1,000 miles of mains per year. (See app. 1.)

Types of main failures

Breaks occur when a main fractures; leaks occur when joints are not tight. This distinction sometimes becomes fuzzy because officials casually refer to a break as a leak since water is leaking or call a gushing stream of water a break although it results from a loose joint. Main breaks are usually circumferential (across the main) or longitudinal (along the main). A leak, technically speaking, occurs only when a joint fails for some reason. Other types of failures include splits in the main at connection taps and damage by adjacent construction.

Causes of main failures

A circumferential break usually occurs when external pressure is placed on the main causing it to shear across its diameter. Generally, the break involves some shifting of the soil as a result of subsidence, faulty backfill, freezing and thawing, or vibrations from traffic and nearby construction. A sudden surge in water pressure can also be a factor. Longitudinal main breaks can result from latent defects in the main, localized external corrosion, or any of the factors previously described. Leaks occur when joints work loose.

New Orleans officials cited subsidence of the area's largely organic soils as a major cause of main failures. The movement of this soil causes the cast iron to break or the joint to leak. 1/ In Boston, the majority of breaks were circumferential, but officials could not generalize as to why they occurred. Washington officials felt that main failures were largely dictated by manufacturing and installation practices at the time the mains were laid.

In colder areas, main failures tend to increase in the winter months when freezing and thawing cause the soil to move and the mains to expand and contract. From 1969 through 1978, 63 percent of the main failures in Boston and 65 percent of those in Troy, New York, occurred in the 6 months from October through March. In Indianapolis, main breaks in 1977 were 70 percent higher than the previous 5-year average, an increase which an official attributed to a severe, cold winter. In 1976 and 1977 Cincinnati made over 50 percent more main repairs than the previous 5-year average. Again, an official attributed the increase to severe cold. A New York City study 2/ showed that for a 6-year period, 35 percent of the breaks in Manhattan occurred in the 3-month period from December 15 through March 15. In Washington, a 1968 study of 6 years of main failures also concluded that failures increase in winter months.

Vibrations from street and subway traffic and damage from nearby construction can also cause main failures. A New Orleans official and the New York City study cited traffic vibrations as a cause of breaks. In Boston, vibrations have contributed to joints loosening on mains laid close to subway lines.

1/Most of New Orleans' cast iron mains, which comprised 69 percent of the system at the end of 1978, were installed between 1904 and 1941. Since 1947, New Orleans has been using asbestos-cement pipe. At the end of 1978, this material comprised 27 percent of the system and had been almost failure free. A New Orleans Sewerage and Water Board official attributed this performance to the greater flexibility of the rubber joints rather than to the material itself.

2/"Report of Select Committee on Water Main Breaks in the City of New York, November 1977."

Sulphur-compound joints had contributed to cast iron main breaks in Cincinnati, Indianapolis, Louisville, and Washington. New Orleans and Boston did not use this material. Nearby construction had also caused main breaks in Boston and Indianapolis.

In Boston, some external corrosion has occurred in small pockets of corrosive soil or when cinders were used to backfill around the mains, and stray currents have caused electrolysis along subway lines and near a subway power-generating station. External corrosion has also contributed to main failures in Cincinnati, Indianapolis, Louisville, Troy, and Washington. However, only in Indianapolis was external corrosion considered a major factor in cast iron main breaks.

Main failures do not always increase with age

Considerable evidence exists to show that main failure rates do not always increase with the age of mains. In Boston in 1978, about 45 percent of the failures occurred in the portion of the system installed before 1900. However, a Washington water department study of main failures for the 6-year period July 1, 1962, to June 30, 1968, showed mixed results for 759 failures. Six-inch mains averaging 80 years old failed about 1.7 times as frequently as they occurred in the system. However, 8- and 12-inch mains averaging 30 and 45 years old, respectively, failed less frequently than they occurred in the system and at about the same rate.

New Orleans has also been experiencing problems with newer mains in one section of the city. These cast iron mains were installed in the 1940s by another governmental body and turned over to the Sewerage and Water Board about 10 years later. According to a board official, the specifications were not as rigid as the board's.

A Louisville Water Company study of main breaks in the 13 years from 1964 to 1976 also showed that breaks do not always follow age. Mains installed from 1926 to 1930 failed nearly four times as often as those installed from 1862 to 1900. The newer mains comprised only about 6.6 percent of the system but accounted for 31.7 percent of the failures. In contrast, the older group of mains comprised 6.7 percent of the system and had 8.8 percent of the failures. A company official attributed the high failure rate of the newer mains to a combination of early centrifugally cast gray iron pipe, which has very thin walls and breaks easily, and sulphur-compound joints.

In Indianapolis, a high percentage of circumferential breaks have occurred in newer cast iron mains. For example, in 1978, 85 percent of such breaks occurred in mains installed from 1939 to 1969 although these mains made up only 52 percent of the system. Further, in recent years about 15 percent have occurred in small cast iron mains installed in the 1950s and 1960s which comprise only 1 percent of the system.

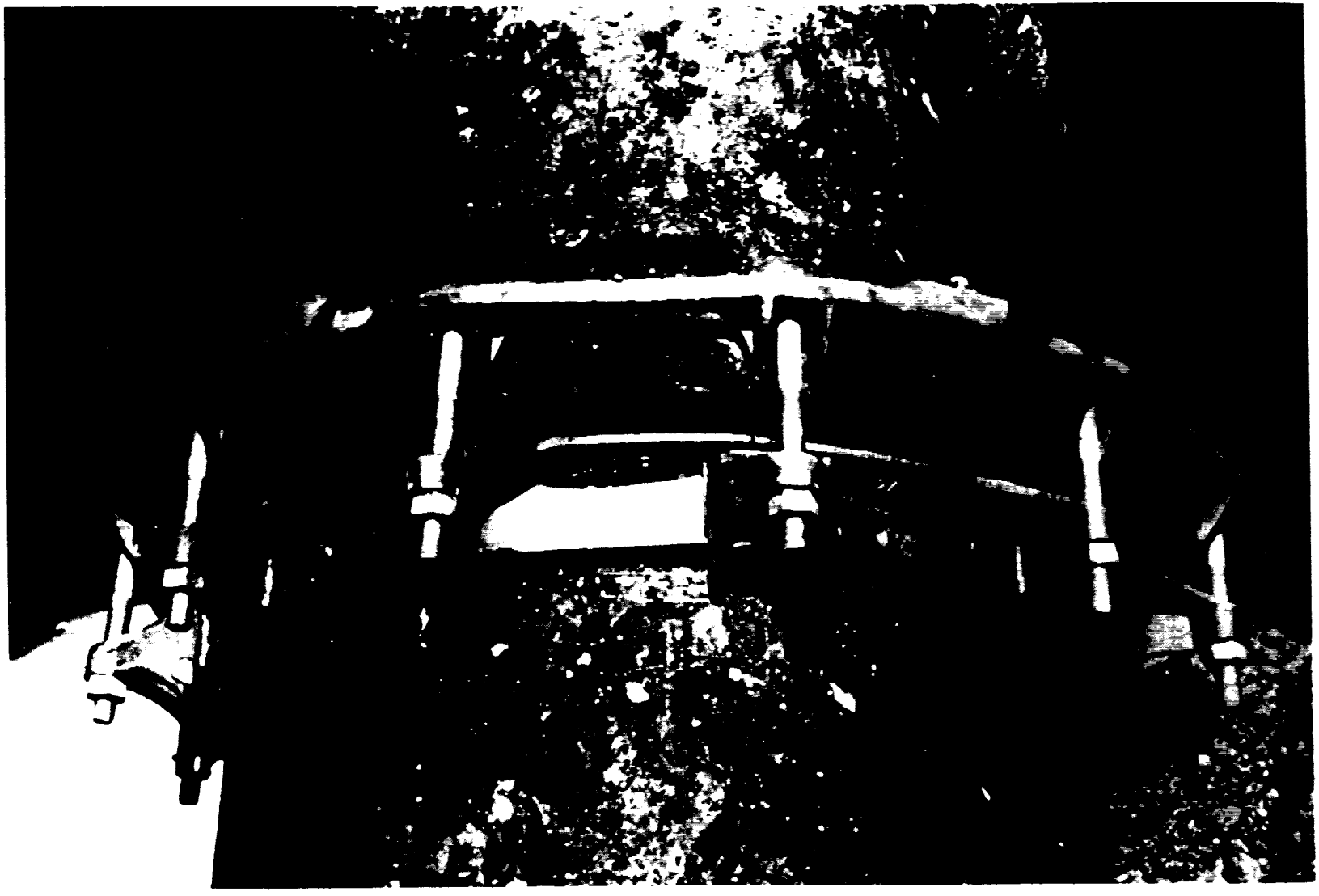
Repairing water main failures

Repairing water main breaks and joint leaks involves excavating the site, assessing the damage, making the repair, backfilling the excavation, and repaving the street. A section of main may have to be replaced if it is badly deteriorated in addition to being fractured. Often, however, breaks can be repaired by placing a clamping device over the break. Leaking lead joints frequently only need to be recaulked or have the lead driven in. Clamping devices can also be used to secure joints. New Orleans, for example, had a practice of clamping all lead joints when they were being repaired or when streets were being rebuilt. (The photograph on p. 22 shows the use of a joint clamp by the Cincinnati Water Works.)

In Boston and New Orleans, main breaks and leaks generally were being repaired as they were indentified. In Washington, a backlog existed of main breaks and leaks to be repaired. According to water department officials, funding restrictions and staffing reductions in recent years had severely reduced all maintenance activities.

PRESENT CONDITIONS AND FUTURE NEEDS

Water department officials in Boston, New Orleans, and Washington all considered their distribution systems in good shape and generally capable of supplying enough water for all uses. In Boston and Washington, large percentages of the distribution main systems will have to be replaced or rehabilitated if the systems are to operate satisfactorily in the future. Boston had plans for meeting these needs. In Washington, restrictions on capital outlays and operating and maintenance expenditures have delayed implementation of main replacement and rehabilitation plans. In New Orleans, officials did not believe a main replacement or rehabilitation program was needed. These officials believed that the key to successful future operations was to continue to respond quickly to the large number of main failures which were expected to continue because of soil subsidence.



Source: Cincinnati Water Works

CLAMP USED TO REINFORCE LEAD-CAULKED BELL-AND-SPIGOT JOINT IN CAST IRON PIPE

Boston

The Boston distribution system is often depicted by the news media and in other forums as aged, poorly maintained, and in danger of immediate collapse. However, Boston officials believed the system was generally in good shape, and they conveyed no sense of impending doom in our discussions with them. As shown in the previous section, the main break rate in Boston was the lowest of 14 cities for which we obtained data.

Many improvements were made in the system in the past. City annual reports from the late 1800s on show a regular pattern of replacing deteriorated mains or re-laying mains with larger sizes to improve customer service and fire protection. Using these annual records, we calculated that from May 1, 1881, when the system included 355 miles of mains, to December 31, 1979, when it included 1,080 miles, an additional 1,056 miles were laid and 406 miles were removed or abandoned in place. A net total of 74 miles was also added to the system as a result of transfers to and from other jurisdictions. Apparently the oldest mains were not always the ones replaced, and some mains were installed and replaced during the period because the city still has mains installed as early as 1853. About 227 miles of the system were installed with cement linings and another 70 miles cleaned and lined since 1965. 1/

Despite this considerable activity, more needs to be done. In 1979 the commission set a goal for the year 2000 of replacing or cleaning and lining all mains that would be 100 years or older by that date. Meeting this goal will require servicing 210 miles of mains, or about 20 percent of the system mileage at the end of 1978. The plan called for phasing the work equally over the period at about 10 miles, or 1 percent of the system, annually. Decisions on whether to replace or rehabilitate mains will be made as projects are undertaken.

1/Some of the main re-laying and cleaning and lining was done by the Boston Redevelopment Authority, the city's urban renewal agency. A commission official believed that the water department did not always pick up the total amount of footage done by this agency. In addition, no mileage data was available on re-laying or cleaning and lining done in 1978. Accordingly, the figures shown are somewhat understated and the percentage of the system unlined is overstated.

During 1979, the first year of execution, 5.9 miles of mains were replaced and 5.8 miles of cleaning and lining were contracted for--just about 1 percent of total system mileage. The 1980 plan provides for continuing these programs by relaying or cleaning and lining a total of about 39 miles of mains (about 3.6 percent of the system) in 1980 through 1982.

New Orleans

In spite of the large number of main breaks and joint leaks experienced each year, New Orleans considered its system in good condition. Although nearly all main failures occurred in approximately 70 percent of the system composed of cast iron pipe, board officials saw no need for a wholesale replacement program. They believed that the key to continued successful operations was quick response to failures which were expected to continue into the foreseeable future.

The board has taken certain actions intended to help reduce or at least stabilize failure rates. For example, to combat the problem of lead joints working loose in the unstable soil, a clamp is placed around each joint when it is repaired and also when streets are being rebuilt, even if the joint is not leaking. In addition, the board had begun to use plastic pipe to replace deteriorated sections of cast iron pipe with good results.

The board also had a program of replacing 4-inch cast iron mains with 6- or 8-inch-pipe mains to improve fire protection flows. This work was being done as part of street reconstruction work and was expected to continue.

Board officials did not think the system's unlined cast iron mains were badly tuberculated. This judgment was based on visual inspections of the interiors of mains removed during repairs and the fact that the water, after treatment, will not corrode cast iron. A cleaning and lining program was planned in 1969 but never implemented; it was dropped in 1972 as unnecessary.

Washington, D.C.

Washington water officials described the system as adequately designed and in good shape with ability to deliver safe, potable water as good as anywhere in the Nation. Their evaluation indicated a bleak future, however. These officials believed that the operating and maintenance level is barely adequate to keep the system functioning and that continued staffing reductions will eventually create a

crisis situation whereby the public will not receive even minimal service. A water department official believed that any further reduction in operation and maintenance activities could endanger the health of the community.

During 1960 through 1978, the city spent about $28.6 million on capital outlays for its water distribution mains and about $3.3 million on other parts of the system. However, a Department of Environmental Services official advised us that capital outlays in the last 10 years have been restricted to absolutely essential projects and that nothing has been done to really improve the system. Some projects have been delayed and delayed again. For example, a cross-town main to provide backup service for a large section of the city has yet to be completed although the need for this main was first recognized in 1946 in House Document 480, Future Water Supply for the District of Columbia and Metropolitan Area, and reemphasized in a 1968 consulting engineer's study of the system.

Portions of this main have been built. However, according to water department officials, the primary objective cannot be met until the main is completed. The design phase for the remaining sections is finished, and construction funds are being requested in the fiscal years 1981 ($30.4 million) and 1982 ($17 million) capital outlay budgets.

Much work still needs to be done. Much of the system is tuberculated. In mid-1970 the entire system had to be flushed to eliminate discolored water. Subsequently, an experimental program of swabbing mains by forcing polyurethane cubes through under water pressure was tried. This procedure, while still only a temporary solution, was more successful than simple flushing but was discontinued in fiscal year 1975 due to staffing limitations.

According to a 1972 water department study, about 328 miles, or 23 percent of the system, had been either installed lined or cleaned and lined. This study concluded that about 35 percent of the system needed attention: 43 miles of mains needed to be replaced, 202 miles needed to be cleaned and lined, and 246 miles needed to be swabbed out to remove loose tuberculation. The study proposed doing this work over a 20-year period. None of the work had been done, however, as of May 1980, again because of funding restrictions. A water department document furnished us in April 1980 indicated a need to swab 800 miles of mains (about 57 percent of the system) but showed no provisions in fiscal years 1980 and 1981 to do so.

The water department was in the process of identifying system needs to the year 2020 by using computer analysis of each pressure zone. One pressure zone study was completed in 1978 and recommendations made for improvement projects. Department officials expected to complete similar studies for the remaining six zones in 1980.

Water department officials expressed optimism at being able to get capital projects approved in the future. However, this appears doubtful given the limited success in the past. In a prior report 1/ we concluded that individual agency and citywide capital improvement project planning did not always coincide because the city had not set priorities to guide the agencies in their capital planning.

Staffing reductions since 1968 had generally reduced all maintenance activities. Within the city government, repairs and maintenance of water mains, valves, hydrants, and water meters are the responsibility of the Water Services Division of the Bureau of Water and Sewer Services. (This bureau is in turn a component of the Water Resources Management Administration of DES.) Due to budget cuts, attrition, and reorganization, the staffing of the Water Services Division had been reduced from 285 in 1968 to 175 in 1979 although division officials believed that 96 more employees were needed to effectively meet responsibilities. In May 1979 the Water Distribution Branch of this division had a backlog of 1,700 work requests. We estimated that 77 staff years of effort would be required to eliminate this backlog.

CONCLUSIONS

Contrary to the popular impression that older water distribution systems are already past the point of no return, the systems in Boston, New Orleans, and Washington were all providing enough water for all uses.

Breaks in water distribution mains were low in Boston, moderate in Washington, and high in New Orleans compared to 11 other cities. Breaks and leaks appeared to result as much from environmental and installation conditions as from the age of mains and were not, in and of themselves, a good measure of system condition. Instead, these factors had to be considered in the overall contexts of how the systems performed and what the systems operators thought these factors indicated.

1/Letter report to the City Administrator, Washington, D.C., April 17, 1979.

Problems seemed to be under control in Boston and New Orleans. Boston water officials plan to continue a main replacement and rehabilitation program that has been ongoing, if not very well publicized, since the late 1800s and to continue cleaning and lining that has been ongoing since 1965. In New Orleans, water officials planned no large-scale main replacement program in spite of the large number of main failures experienced annually. Rather, they planned to continue gearing operations to fix them.

The Washington system, while presently able to supply water for all uses, needs immediate attention to protect its future, according to water department officials. About 35 percent of the distribution mains were identified in 1972 as needing replacement, cleaning and lining, or swabbing to remove loose tuberculation. However, little had been done because of funding restrictions. In 1980 over half the mains needed swabbing, but funds were not available to do it.

CHAPTER 4

CONTROLLING UNACCOUNTED-FOR WATER AND LEAKAGE

One approach that water companies can and do take to conserve water and keep rates at reasonable levels is to attempt to keep unaccounted-for water, including leakage, at a minimum through aggressive metering programs and surveys intended to discover leakage and unauthorized uses.

UNACCOUNTED-FOR WATER DEFINED

AWWA defines unaccounted-for water, also frequently called unbilled or non-revenue-producing water, as the difference between the amount of water delivered to a distribution system and the metered or estimated use by customers during a given period. Some variations exist in what water companies include in the unaccounted-for water category. Generally, however, this category includes authorized uses such as firefighting, street cleaning, water main and sewer flushing, and public charitable use; unauthorized uses such as illegal hydrant openings and theft; and water not accounted for due to meter underregistration and leakage.

According to AWWA, unaccounted-for water, including leakage, must be evaluated on a case-by-case basis, and an acceptable total could range from 5 to 35 percent of water pumped or purchased in fully metered systems. A fair average might be 10 to 20 percent. Because it is undetected, leakage is not accurately quantifiable, and the amount reported for any system is usually an estimate. AWWA advocates metering all users to establish good controls over system operations, including unaccounted-for water, and to distribute costs equitably. AWWA also suggests leak detection surveys when unaccounted-for water figures are high or increasing or leakage is suspected.

COMPARISON OF UNACCOUNTED-FOR WATER PERCENTAGES

Unaccounted-for water was about 40 percent of total use in Boston, 30 percent in New Orleans, and could not be determined in Washington, D.C. In comparison, unaccounted-for water in two other cities--Indianapolis and Louisville--averaged only 13 and 17 percent, respectively, for a number of years.

In our opinion, this limited comparison indicates that the requirement to be self-sufficient out of water use rates probably provides strong motivation for managers to control unaccounted-for water. Other factors which come into play include the cost of water and the cost effectiveness of reducing unaccounted-for water.

For example, the water companies which had the lowest unaccounted-for percentages were profit motivated. The Indianapolis Water Company is an investor-owned corporation, and the Louisville Water Company, a corporation owned by the city of Louisville, also seeks to operate at a profit.

The Sewerage and Water Board of New Orleans is an independent municipal entity, and its water department must be financially self-sufficient out of revenues. However, its officials were not alarmed by the 30 percent unaccounted-for water because the water supply (the Mississippi River) is plentiful, the cost of treating the unaccounted-for portion is considered bearable, and increasing efforts to reduce the percentage might not be cost effective.

The Boston Water and Sewer Commission, which was established in 1977 as a financially independent entity, inherited its unaccounted-for water percentage from a city operation which was not required to be financially self-sufficient. The commission is attempting to reduce unaccounted-for water through leak detection surveys and improved metering.

Washington, D.C., water department operations are a function of city government and are not required to be financially self-sufficient out of water use rates. Little accountability existed for water consumption, and accurate figures or even good estimates of water billed, consumed, accounted for, or leaking were not available. In early 1980 the Mayor's office began a study of these problems.

METERING AS AN AID IN CONTROLLING UNACCOUNTED-FOR WATER

The costs of unaccounted-for water must ultimately be borne by consumers through water rates or taxes. In an unmetered or partially metered system, management's ability to allocate costs equitably to all users or to establish reasonable controls over inventory--water--is severely hampered. To eliminate these problems, AWWA advocates metering all users. AWWA believes that charging a flat rate per connection--the usual alternative to metering--has become

inequitable because changes in living standards have produced an increasing diversity among domestic users in the use and demand for water. AWWA also believes that the increasing costs of developing water supplies and treating and distributing water have made the tighter control of operations by metering more important.

Many cities have a policy of metering each customer's use. For example, Boston, Cincinnati, Indianapolis, Louisville, New Orleans, Troy, New York, and Washington all do. Other large cities, such as Chicago, New York City, and St. Louis, do not have such a policy.

In practice, not every customer is metered in cities which have a policy of universal metering. For example, according to the Boston Water and Sewer Commission's 1979 Capital Improvement Plan, about 6,000 residential and about 300 public properties in Boston were unmetered at the end of 1978. In New Orleans, instances of unauthorized, unmetered use had also been identified. The Washington system also is not fully metered.

Legal requirements for metering also differ. In Massachusetts, all communities obtaining water from the Metropolitan District Commission are required by statute to meter all customers. On the other hand, metering may be prohibited by legislation. For example, an official of the California State Department of Water Resources told us that thousands of gallons could be conserved every year if the Central Valley area in California were metered. This official said, however, that municipal charters in that area prohibit metering because users fear it would result in rate increases.

The recent experience of the Troy, New York, Department of Public Utilities illustrates how metering can reduce water consumption. In 1971 Troy began a metering program which was completed in 1974. From 1971 to 1976, water use decreased over 25 percent--from over 24 to under 18 million gallons per day--and has held about steady since. A water department official attributed this decrease in consumption to metering.

DETECTING LEAKAGE

Undetected leakage can be a major contributor to unaccounted-for water, although the amount of leakage reported for any system is usually an estimate. Sometimes the estimate of leakage is merely the difference between the total water billed and the sum of all other estimates of unaccounted-for use.

A certain amount of leakage is unavoidable and, according to AWWA, the amount can vary considerably depending on the age of the mains, amount of pressure in the system, and soil conditions. Estimates of unavoidable daily leakage range from 1,000 to 3,000 gallons per mile of main.

Many cities hire consulting engineers who specialize in leak detection. One such firm conducted leak detection surveys in 67 municipalities and water districts in 20 States and the District of Columbia in 1978. In addition to identifying leakage, these surveys also identify other types of unaccounted-for water such as unmetered use, overregistering input meters, and underregistering consumption meters.

Leak detection experts use a variety of methods to identify leakage. Usually, however, the term "leak survey" refers to a comprehensive study done by subdividing the system and controlling and measuring the flow in the subdivision for at least 24 hours. The night flow rate is compared with the day rate. If the night rate represents a high percentage of the day rate, leakage may exist. The source of the high night rate is identified by further subdivision and testing.

MANAGEMENT OF UNACCOUNTED-FOR WATER

Details of conditions in the three main cities in our review follow.

Boston

The Boston distribution system has frequently been reported as leaking about 50 percent or more of all water flowing through the system. However, these reports appear to have been based on erroneous assumptions that all unaccounted-for water was leakage when, in fact, a number of factors were involved.

In 1977 the newly created Boston Water and Sewer Commission inherited a large unaccounted-for and unbilled water percentage from the predecessor city water department. In 1974 through 1976, the 3 years before the establishment of the commission, unbilled and unaccounted-for water averaged about 50 percent of wholesale water purchases. According to commission consultants, the major causes of unaccounted-for water were undermetering, leakage, and unmetered public use. Undermetering was estimated at 20 to 30 percent of purchases and leakage at 15 to 25 percent. City use was estimated at about 3 percent.

In 1978 a combination of lower total consumption than in 1977, about the same metered billings, and billing the city for its estimated use lowered the unaccounted-for portion to about 44 percent of purchases. In 1979, according to preliminary estimates, a combination of reduced total consumption, increased metered billings, and slightly increased billings to the city will further lower the unaccounted-for portion to about 40 percent of purchases. Authorized but unbillable uses such as firefighting, blowoffs, and main flushing could account for another 3 percent of total purchases and reduce the unaccounted-for portion to about 37 percent.

Controlling unaccounted-for water in Boston is particularly important from a financial standpoint. In 1979 the commission paid $240 per million gallons to the Metropolitan District Commission, a State agency. Thus, an unaccounted-for water figure of, say, 50 percent has the effect of doubling the amount for water purchases to be included in the rates. Accordingly, any actions to reduce the total amount of water purchased or to increase the amount of water sold benefit all customers--except, of course, those who may have been getting water illegally.

The city was making some attempts to reduce unaccounted-for water before the commission was established in 1977. From July 1976 through June 1977, the city water department installed 5,400 new water meters and in 1976 reinstituted regular leak detection surveys.

In 1979 the commission established an accelerated program to replace residential meters because officials believed many meters were underregistering, not registering at all, or not accessible for reading. In addition, some residences were suspected of being unmetered. This program was expected to continue for a number of years.

Also in 1979 the commission began a program to test and replace, if necessary, the meters of the 100 largest industrial consumers because these large meters can underregister by 10 to 50 percent. Eighteen of 54 meters tested in 1979 were underregistering a total of 1 million gallons per day (mgd). The commission planned to complete the initial testing program in 1980 when a total of 200 industrial meters will have been tested.

Leak detection surveys from 1976 through 1979 identified estimated leakage of 8.3 mgd. About 70 percent of this amount was occurring in the pipes connecting the mains to the users, while about 20 percent was occurring in the mains themselves.

The surveys also identified a number of previously unaccounted-for uses. For example, a meter recording flow into the system was found to have overregistered by about 160 million gallons in a 2-month period. In another instance, water use at a large industrial plant was being estimated at 95,000 gallons per day, but investigation disclosed that actual use was about 570,000 gallons per day.

Boston's average daily consumption has been decreasing in recent years. For many years, average daily use had exceeded 140 mgd, peaking at 150.8 mgd in 1976. By 1979 it had decreased to about 137.4 mgd--about the same level as 1966. The reduction was attributed to such factors as the increased leak detection program, the monitoring of meters recording flow into the system, and the main re-laying and cleaning and lining programs.

New Orleans

In 1978 the Sewerage and Water Board of New Orleans metered and sold, or provided free to public and charitable users, 70 percent of water pumped; categorized 29 percent as unmetered free use; and allowed 1 percent for leaks in piping fixtures. Unmetered free use included firefighting; street cleaning; sewer, gutter, and drain flushing; cleaning public buildings; treatment plant consumption; leakage in the distribution system; and unauthorized uses, such as illegal hydrant openings in the summer. The board did not estimate individual amounts for any of the items classified as unmetered free use.

Board officials did not consider the volume of unmetered free water to be of extraordinary concern because the Mississippi River provides an unlimited supply and because the cost per customer of all unmetered free use was relatively small. Using 1978 data, officials pointed out that the average direct cost per customer of all unmetered free use was about $4.50. Reducing such use to, say, 20 percent would only save each customer $1.50 annually and, in their opinion, might not be cost effective.

The board has not had a routine program to check or repair its approximately 143,000 meters. Instead, meters have been replaced when a malfunction was reported by a customer or a board employee. In recent years, about 10,000 meters have been replaced annually. The board has also installed meters for new services and to provide separate services for apartment complexes which had a single service for all tenants. Board officials considered that, generally, its meters have been registering within its tolerances.

While the board has not estimated the amount of total system leakage, it has had for many years leak detection surveys done to aid in controlling leakage. Sections of the city are surveyed each year, and the entire city is surveyed every 5 years. Surveys since 1965, when combined with the 1 percent estimate of leakage in piping fixtures, indicate average annual leakage of about 7.5 percent of water pumped. Actual leakage probably is higher since leaks identified in the surveys represented only a small percentage of total leaks and breaks repaired.

Washington, D.C.

An accurate figure or even a good estimate of water billed, consumed or accounted-for was not available at the time of our review. Existing reports, when prepared, were either 100 percent estimated or contained a high percentage of estimated figures. For example, the fiscal year 1977 annual water consumption report summary showed more water accounted for than was reported pumped. Due to inaccurate and incomplete information on metered consumption, municipal use, the amount of water billed, and revenues collected, a fair estimate of unaccounted-for water was impossible to obtain.

Little or no water consumption accountability existed in Washington because according to water department officials, decreased staffing and funding had caused meter replacement and maintenance to be drastically curtailed or suspended. From fiscal years 1974 to 1979, 19 of 93 (20 percent) of the authorized positions in the meter branch were abolished. Water department officials believe the current personnel level is not sufficient to handle the workload.

According to water department officials, about 60 percent of the 130,000 meters probably were not registering accurately. In recent years, only about 700 new meters had been bought by the city.

A 1979 water department study (using 1979 dollars and water use rates) estimated that improvements to residential and commercial meters could produce a total annual net revenue increase of $10 million by 1990. A majority of the system's approximately 108,000 residential meters are over 40 years old. The study recommended replacing rather than rebuilding these obsolete meters over a 10-year period. (The department repaired about 8,057 of these meters in fiscal year 1977 and 9,711 in fiscal year 1978.) The replacement program was expected to generate net increased annual revenue of $3.5 million by 1990.

This study also recommended replacing the 20,000 commercial meters over a 4-year period to produce net increased annual revenue of $6.5 million by 1984. These meters, which handle about 43 percent of the total water use, are owned by the customers. Until 1978 the water department had no systematic program for testing them. About December 1978 the department began a program to call in meters for testing. Based on the test results, the department estimated that the 20,000 meters were underregistering by about 32 percent. The 1979 study recommended that the water department replace all 20,000 meters and assume ownership to increase water accountability and revenues. In early 1980, the Mayor's office began a study of the city's water accountability problems. The fiscal year 1981 budget request includes funds to get the commercial remetering program started, with implementation to extend over 8 years.

Washington, D.C., for many years has had studies done by outside engineers to identify leakage and report on overall system condition. However, according to water department officials, the lack of sufficient maintenance staff has resulted in a priority system for fixing leaks and breaks which does not include the quantity of water lost as a factor.

We computed a rough estimate of system leakage based on leak detection surveys and known leaks awaiting repair. Water known to be leaking amounted to about 2.5 billion gallons per year, or about 5 percent of total water consumption. However, because of incomplete records on metered consumption, municipal use, and revenue collections, the city had no idea of the extent of underground leakage.

CONCLUSIONS

As much of the Nation faces pressures to develop new drinking water sources, controlling unaccounted-for water can help ensure that existing sources are being used efficiently and could possibly eliminate or defer the need to develop new sources or expand existing ones.

Unaccounted-for water cannot be eliminated entirely, and attempts to reduce it beyond a certain level may, as in New Orleans, not be cost effective. Nevertheless, the extent to which individual water distribution systems have been or are attempting to control it can be a measure of the operator's concerns about conservation and good management. Apparent needs for outside financial aid could then be evaluated in light of whether a particular water distribution system has been effectively managing its inventory--water.

Our work indicates that controlling unaccounted-for water may receive greater attention in systems required to be financially self-sufficient or to operate at a profit. This seemed to be the case in Boston after the creation of the Boston Water and Sewer Commission, and in New Orleans, Indianapolis, and Louisville. Conversely, controlling unaccounted-for water received less attention in Boston under the old city operation in which deficits were funded from real property taxes and in Washington, D.C., where no attempt was made to achieve financial self-sufficiency.

CHAPTER 5

FEDERAL AID FOR URBAN WATER DISTRIBUTION SYSTEMS MAY NOT BE WARRANTED

Many Federal, State, and local officials are proposing extensive Federal programs to help cities finance water system repairs and improvements. Such programs, if enacted, could add billions of dollars to the Federal budget and may not be necessary for water distribution systems.

FEDERAL AID FOR URBAN WATER SUPPLY-- POLICY AND PRACTICE

Current Federal policy, as set out in the Water Supply Act of 1958 (Public Law 85-500), recognizes that the States and local interests are primarily responsible for supplying water for municipal and industrial use but that Federal agencies are to cooperate in these activities. While no comprehensive Federal grant program, like the construction grants program for wastewater treatment projects, has been established to develop, treat, and distribute water supplies for urban areas, there has been considerable Federal involvement in water supply projects both before and since 1958.

Nationally, from 1935 to 1943, Work Projects Administration (WPA) 1/ forces constructed or improved nearly 500 water treatment plants, installed or repaired more than 19,700 miles of water mains, and made many other water system improvements. 2/ (For perspective, the 19,700 miles of mains installed or repaired is nearly five times the total mileage in Boston, New Orleans, and Washington at the end of 1978.) In Boston, according to city records, WPA forces laid about 28 miles of distribution mains. In some instances, Federal Emergency Relief Administration funds were used to pay for the mains. In New Orleans, the Federal Government provided about 77 miles of mains, 512 valves, and 598 hydrants through WPA projects and various war and public housing agencies of the 1940s.

1/Called the Works Progress Administration from May 6, 1935, to July 1, 1939.

2/"Final Report on the WPA Program 1935-43," Greenwood Press Publishers, Westport, Connecticut, 1976, pp. 50-51.

Although there has never been a Federal program specifically intended to help large cities solve their water supply and distribution system problems, a considerable amount of largely unrestricted Federal moneys has been available for this purpose. For example, from 1960 through 1978, Boston used about $4.4 million of HUD urban renewal funds, as well as about $14.7 million of city and State funds, to relay and clean and line distribution mains as part of site preparation projects. 1/

According to the June 1980 report of the Subcommittee on Urban Water Supply of the President's Intergovernmental Water Policy Task Force, 2/ about $10.1 billion of unrestricted Federal moneys was available, and about 2 percent was used for water supply and distribution systems in fiscal year 1977, the latest year for which fairly complete data was available. About $6 billion of the $10.1 billion went to urban areas--cities over 50,000--but the amount used for water projects was unknown.

According to the subcommittee report, the largest unrestricted source of potential water system funding for urban areas is the General Revenue Sharing (GRS) Program. In fiscal year 1977 about $79 million (1.2 percent) of total GRS funds of $6.55 billion went to water projects. Similarly, about 2 percent (about $64 million of $3.18 billion) of HUD's Community Development funds went to water projects. Nearly 23 percent ($73 million of $321 million) of various Department of Commerce Economic Development Administration grant funds went for water projects.

1/These figures were supplied by officials of the Boston Redevelopment Authority as a "best estimate" since records of specific fund uses within projects were not required to be kept. The city auditor's records for 1966 through 1977 showed that about $10 million was spent during this period for laying and cleaning and lining mains and for water meters. We could not find out, however, whether this amount was included in or in addition to the $14.7 million.

2/"Urban Water Systems: Problems and Alternative Approaches to Solutions," Subcommittee on Urban Water Supply of the President's Intergovernmental Water Policy Task Force, June 6, 1980.

Proposed Federal aid for water systems

A number of bills have been introduced in the 96th Congress to provide more Federal aid to municipally owned water supply and distribution systems. Some include aid to rehabilitate urban infrastructures generally. Financing mechanisms include grants for repairs, or to pay the interest on bonds sold to finance repairs, and subsidized and unsubsidized loans. Another would redistribute funds presently available to the Water and Power Resources Service, the Soil Conservation Service, and the Corps of Engineers to provide $4 billion annually for block grants to States and localities which could be used to build, maintain, repair, or replace water supply and distribution systems. This program would require 25 percent State and local participation, and funds would be allocated based on a formula considering State population and land area.

Still another bill would provide Federal aid for a number of specific locations for such activities as feasibility studies and constructing water supply and distribution systems. The costs of feasibility studies would be borne entirely from Federal funds, while the construction costs would eventually have to be repaid.

In January 1980 the Assistant Secretary of the Army (Civil Works) advised the members of the House Committee of Public Works and Transportation that Federal participation in these single-purpose municipal and industrial water supply and distribution projects would set a precedent by which the Federal budget could be strained in future years by tens of billions of dollars of expenditures which have been traditionally the prerogative and responsibility of local governments. He further advised the committee that the administration was studying whether Federal involvement in this area should go beyond the traditional role of providing water supply storage in connection with projects serving other needs. The Assistant Secretary was referring to the work of the Subcommittee on Urban Water Supply of the President's Intergovernmental Water Policy Task Force.

FINDINGS OF SUBCOMMITTEE ON URBAN WATER SUPPLY

In its June 1980 report, the subcommittee reached a number of conclusions on urban water system capital needs for the next 20 years and suggested several possible approaches the Federal Government could take to help meet these needs. The subcommittee also stated its belief that selecting and implementing any one or combination of policy approaches

should occur in conjunction with a more detailed study of urban water resource problems to reduce uncertainties as implementation proceeds. The subcommittee said such a study should, among other things, (1) relate urban water supply problems and solutions to other urban infrastructure problems, (2) inventory on a case-by-case basis urban water system needs, and (3) provide for reviewing and correcting the approach or approaches selected.

According to the subcommittee, there are 756 urban water systems--those serving 50,000 or more people. Most of these systems are financially self-supporting from consumer payments and receive little or no assistance from other sources. About 73 percent are publicly owned and 27 percent are investor owned. Sixty-eight percent, or 513, of the systems serve populations between 50,000 and 100,000; 31 percent, or 232, serve between 100,000 and 1,000,000; and 1 percent, 11 systems, serve over 1,000,000.

The subcommittee reported that urban water system capital expenditures over the next 20 years could range from $75 to $110 billion in 1979 dollars. This included replacing and rehabilitating distribution systems at $50 to $80 billion, servicing growth at $5 to $8 billion, upgrading water quality at $425 million, and new source development at $20 to $25 billion.

According to the subcommittee, 11 percent (82 of the 756) of urban water systems currently have operating deficits. However, the subcommittee pointed out that an operating deficit may or may not indicate a financial problem because some cities may choose to subsidize water consumers from taxes while others may choose to require water consumers to pay rates which subsidize the city's general expenditures.

The subcommittee reported that about 20 percent of urban water systems could reasonably be expected to experience investment shortfalls in the next 20 years. However, it noted that some observers felt this number may be higher, while others felt that the evidence did not support a number as large as 20 percent. An investment shortfall was defined as the amount a system would be unable to finance with revenue increases up to a doubling of rates. In dollars, the subcommittee reported that the investment shortfall most probably would range from $10 to $13 billion and could range from $5 to $26 billion but pointed out that the entire estimating process was both difficult and uncertain without a city-by-city analysis.

The subcommittee identified five possible policy approaches. These approaches ranged from maintaining the status quo by continuing full local responsibility for water supply to changing Federal policy to allow direct Federal construction of single-purpose water supply projects including constructing, reconstructing, repairing, and rehabilitating distribution systems. (See app. II.)

INDUSTRY POSITIONS ON FINANCIAL INDEPENDENCE OF WATER COMPANIES

AWWA has for many years strongly held that the public can best be served by self-sustaining enterprises adequately financed with rates based on sound engineering and economic principles. In May 1977, the AWWA Board of Directors adopted a policy statement against governmental grants to water utilities because AWWA believed they would destroy the financial and managerial independence necessary to self-sustained, businesslike operations.

NAWC has taken a position similar to AWWA's. NAWC represents investor-owned water companies that provide about 20 percent of the Nation's water supply. NAWC believes that Federal aid programs to publicly owned water utilities, which are not available to private ones, discriminate against the latter because their Federal taxes subsidize the programs.

Both AWWA and NAWC believe that a program of federally guaranteed loans would be acceptable to help financially stressed companies comply with the provisions of the Clean Water Act (Public Law 92-500, as amended) and the Safe Drinking Water Act (Public Law 93-523).

POSITIONS OF FEDERAL AID PROPONENTS

Usually, Federal, State and local officials who propose Federal financial aid to rehabilitate water distribution systems picture them as on the verge of complete collapse and beyond the financial abilities of communities to fix. Frequently, anecdotal situations are cited to justify Federal aid. For example, reports that Boston was losing 50 percent of its water through leakage, coupled with the Boston Water and Sewer Commissions's intention to replace or clean and line 20 percent of the system by the year 2000, were used to justify the need for Federal aid. As discussed in chapter 4, the 50 percent leakage figure was not accurate.

HOW MUNICIPAL WATER SYSTEMS ACHIEVE FINANCIAL SELF-SUFFICIENCY

Although the organizational forms may differ, the goal is the same--to operate the water system as a public utility required to be financially self-sufficient from its own sources of revenues, principally rates charged for water use. The water systems in Boston and New Orleans are run by independent governmental entities required to be financially self-sufficient. This form of organization has also been used in other places, such as Miami, Houston, and Los Angeles. Louisville uses a slightly different organization. The Louisville Water Company is a corporation owned by the city of Louisville, Kentucky. The company operates as a business corporation and pays annual dividends to the city. Other cities--Cincinnati, Ohio, for instance--have retained their water systems as a part of the city government but set up separate funds dedicated to water system operations. The Cincinnati city charter requires rates to be sufficient to cover all water system costs and prohibits using revenues for any purpose other than the water system.

Simply requiring a water system to be financially self-sufficient is not enough. Rates must be set at a level which will allow accomplishing what system managers believe needs to be done, as is the case in Boston and New Orleans. However, according to a recent Urban Institute report on the city of Cleveland, Ohio, 1/ this does not always happen.

The Urban Institute reported that the Cleveland Water Department had a $250 to $500 million backlog of water system construction projects, most of which were for pipe repair or replacement. The conclusion was drawn that the backlog did not result from Cleveland's general financial problems because the water system was financed not from tax revenues but by user charges which could be raised without voter approval. The report blamed the backlog on a combination of challenges to rate increases by suburban areas which purchase more than half of the water and the reluctance of the City Council to approve needed rates increases.

The table below compares annual water charges in the large cities we studied. Rates charged in Washington, D.C., were the lowest in the metropolitan area.

1/Nancy Humphrey, George E. Peterson, and Peter Wilson, "The Future of Cleveland's Capital Plant," The Urban Institute, Washington, D.C., 1979, p.55.

Annual Water Charges
for Residential Customer Using 100,000 Gallons of Water
at Rates in Effect for 1980 (Note a)

	Effective date of rate	Annual water bill
Boston	April 1, 1980	$101.00
Cincinnati	July 1, 1978	47.20
Indianapolis	January 4, 1979	135.02
Louisville	January 1, 1980	84.00
New Orleans	March 1, 1980	93.12
Troy, N.Y.	January 1, 1980	90.00
Washington, D.C.	July 1, 1976	52.70

a/Boston, Troy, and Washington charge all users the same rate per gallon for water regardless of meter size or quantity used and have no minimum charge. The other cities use varying pricing structures. In these cases, we used the lowest rates applicable to residential customers.

The following sections describe how Boston and New Orleans have achieved water system financial self-sufficiency and how Washington, D.C., has not.

Boston

Boston provides an interesting case study of how a financially troubled water (and sewer) system can be turned around, but not without some resistance to the rates required to do so.

At the city's request, the Massachusetts Legislature created the Boston Water and Sewer Commission in 1977 as an independent, nonprofit subdivision of the State government to put the city's water distribution and sewage collection operations on a financially sound basis. Both departments had been incurring deficits which, until June 30, 1974, were covered in subsequent years' property tax levies. This placed the financial burden for water and sewer department deficits on property taxpayers to the benefit of tax-exempt private and public entities.

The enabling legislation transferred all operating personnel, assets, and liabilities of the city water and sewer departments to the commission, except liabilities for tort actions which occurred before the changeover. The commission was also required to pay the city about $25.2

million in water and sewer department deficits outstanding at June 30, 1977. About $10.2 million of the deficits applied to the water department.

The first commission-established rates, for 1978, resulted in a combined water and sewer rate increase of about 49 percent over 1977 city charges for a residential customer using 100,000 gallons of water annually. Water charges went up 17 percent from $102 to $119, while sewer charges, which had not been changed since 1961, increased 300 percent from $13 to $53. Annual water charges for large-volume users increased as much as 90 percent because the commission was required by law to charge all customers the same rate per gallon rather than a lower rate with increasing use as the city had.

The rate increase, combined with startup problems in billing and public relations, produced considerable dissatisfaction among some consumers and local political leaders. The dissatisfaction intensified when the commission ended 1978 with an excess of revenues over expenses. When the commission initially decided on a combined water and sewer rate decrease of 11.6 percent for 1979, reactions included demands for a 23 percent decrease by a consumer advocacy group and the Mayor, demands to make the rates subject to City Council or State Public Utilities Commission approval, and demands to abolish the commission. Eventually, the commission decreased water rates for 1979 by 15.2 percent and sewer rates by 9.3 percent, or 13.4 percent combined.

Operations for 1979 also resulted in a surplus which was applied to 1980. Rates were set again effective April 1, 1980, for the balance of the year. Water rates were not changed while sewer rates were increased 12 percent. At 1980 rates, the residential customer using 100,000 gallons annually will pay $101 for water, or about 1 percent less than at 1977 city rates.

Capital improvement plans

If the latest plans and projections are carried out, the Boston Water and Sewer Commission will have spent about $113 million from 1978 through 1989 for capital improvements to its water distribution system as shown in the following table.

Boston Water and Sewer Commission
Water Distribution System Capital Improvements
1978-89

Purpose	1978-79	Included in 1980-82 Capital Improvement Plan	Projected by commission consultants 1983-89 (note a)	Total 1978-89
	(thousands)			
Distribution main replacement and cleaning and lining	$10,784	$17,078	$67,842	$ 95,704
Metering	1,148	2,521	6,095	9,764
Other programs	0	1,726	6,084	7,810
Total	$11,932	$21,325	$80,021	$113,278

a/Estimated on the basis of 1982 dollar activity inflating at the rate of 10 percent per year, compounded.

All projects were or will be paid for from water rate revenues in the year undertaken with one small exception. About $625,000 in 1980 will be financed with borrowed funds because the commission considers the projects "extensions and improvements" rather than "renewals and replacements" to be financed from current income.

New Orleans

Since May 1, 1967, each of the Sewerage and Water Board operating departments--Water, Sewerage, and Drainage--has been a financially self-supporting entity with its own sources of funds. Previously, the water department had to cover its own costs and those of the sewerage department as well. The water department cannot operate at a deficit, and any annual surplus is carried forward to the next year. Rates charged for water provide most water department revenues.

While the board has never had, and does not plan, a large-scale water distribution main replacement program (at the end of 1979 only about 73 miles had been replaced), it had spent or was planning to spend a considerable amount of money on capital improvements to the water system as a whole, as shown below.

Sewerage and Water Board of New Orleans
Water Department Capital Improvements
1960-84

Type of capital improvement	Time period 1960-66	1967-79	1980-84	Total
	(thousands)			
Waterworks (intake and treatment) system	$ 3,767	$21,816	$27,457	a/$ 53,040
Water distribution system	13,051	16,192	20,274	49,517
Water department share of electrical power projects and general budget items	856	12,441	9,470	22,767
	$17,674	$50,449	$57,201	a/$125,324

a/Includes a $2.5 million Federal grant for an additional water supply facility to take water from the Mississippi River, awarded under the Coastal Energy Impact Program authorized by a 1976 amendment to the Coastal Zone Management Act (16 USC 1451, et seq.). About $1.5 million was received in 1979, and the balance will be received in later years. The estimated total cost of this new water intake is about $7.5 million.

The $57.2 million capital improvement program planned for 1980-84, which includes $20.3 million to be spent on the distribution system, will be financed with $31.2 million of current revenues, a $25 million revenue bond issue, and about $1 million in Federal grant funds. To cover the costs of the cash financing of capital improvements, the costs of past and future debt service, and projected increases in annual operating and maintenance expenses over the 5 years, the board adopted a new rate schedule effective March 1, 1980. Rates will be increased in five steps (15, 15, 15, 15, and 10 percent) in 1980 through 1984.

According to the board's consultants, these rates will produce water sales revenues of about $147.5 million--about $51 million more than would have been produced at the rates in effect from January 16, 1978, to February 29, 1980. About 94 percent of the increased revenues will be used for capital improvements. Over the 4 years and 10 months of the rate

program, the annual bill for a residential customer using 100,000 gallons of water will increase from $86.52 to $168, about 94 percent, or 22 cents a day.

Washington, D.C.

Water system operations in Washington are a part of the city government rather than independent of it as in Boston and New Orleans. While water rate revenues can only be spent on the water system, there is no requirement that rates be set to make the system financially self-sufficient.

Since September 1976, the Temporary Commission on Financial Oversight of the District of Columbia, created under Public Law 94-399, has been directing efforts to improve the city's financial management. Although progress had been made, in early 1980 the city announced a projected deficit for fiscal year 1980. Estimates of the deficit ranged from $84.5 to $175 million. To try to combat the problem, the Mayor imposed citywide restrictions on hiring, overtime, and equipment and material purchases. As of April 1980, the total impact of these actions on the water system had not been calculated. However, purchases of equipment and materials for the water distribution system were canceled or prohibited.

Management and financial structure

The city Department of Environmental Services has overall responsibility for the water, sewer, and stormwater systems. No single operating group within DES has total responsibility for the water system, and budget requests are by organizational unit rather than by function, such as distributing water.

Water use revenues include payments from residential and commercial customers and the Federal Government. Since July 1, 1976, all customers have been charged at the same rate regardless of the quantity used. Federal payments for water are in addition to the Federal payment in lieu of taxes.

In addition, the city budgets and accounts for some water functions for which it has no responsibility. Although the city is in the business of distributing water which the Washington Aqueduct Division of the Army Corps of Engineers collects and treats, the city does not actually pay for the water. Rather, the aqueduct's budget is included in the city

budget appropriated by the Congress, and its expenses recorded as those of the city. The aqueduct also wholesales water to Arlington County and the city of Falls Church, both in Virginia, but the payments are made to the city of Washington.

The DES budget (as well as all other city funds) must be appropriated through a process that includes review and action by the Mayor, the Council of the District of Columbia, the President (through the Office of Management and Budget), and the Congress. The Congress is the appropriating body for the city.

The city formerly had separate water and sewer funds which were abolished at the beginning of fiscal year 1976. From then through fiscal year 1979, water and sewer transactions were handled through the city general fund and later reclassified to a combined water and sewer fund for published financial statements. City statements of accrued revenues and expenses indicate that the water system had revenues in excess of expenses totaling $7.5 million for the period July 1, 1975, through September 30, 1979. Because of the city's current financial problems, it was unclear whether these funds could have been spent on the distribution system.

The water use rate was increased substantially effective July 1, 1976--about 46 percent for a residential customer using 100,000 gallons annually. For fiscal year 1980 the city established an enterprise (business-type) fund for the combined water and sewer operations. The fiscal year 1981 budget request contains a proposal to raise the rate about 17 percent to balance the water system budget. However, this increase will not provide for any new programs except for the commercial remetering project discussed in chapter 4.

CONCLUSIONS

Long-standing Federal policy has recognized that supplying and distributing drinking water for municipal and industrial use is the prerogative and responsibility of State and local governments. However Federal, State, and local officials have proposed modifying this policy to provide Federal aid to help large cities rehabilitate and improve their water supply and distribution systems. In our opinion, such a policy change may not be warranted.

Both AWWA and NAWC believe that water systems should be financially self-sustaining entities supported from charges to customers, and we found nothing to lead us to conclude otherwise. The Subcommittee on Urban Water Supply of the President's Intergovernmental Water Policy Task Force, while speculating that 20 percent of the Nation's urban water systems might experience capital investment shortfalls in the next 20 years, cautioned that the estimating process was both difficult and uncertain without a city-by-city analysis.

The subcommittee work also indicates that most urban water systems are served by financially self-sustaining water systems, a policy which both AWWA and NAWC espouse. The water systems in two of the three cities we studied--Boston and New Orleans--are operated by such entities and did not need outside financial aid from the standpoint of not being able to set rates at a level that enables them to finance annual operations and their rather ambitious capital improvement objectives. Boston could have, we suppose, struggled along maintaining or adding to its over $10 million distribution system deficit. Instead, city and State leaders acted to put the water (and sewer) system on a financially sound basis. Admittedly, the rate charges necessary to accomplish this were not met with enthusiastic approval in all quarters, but people generally do not like to pay more for anything one day than they did the previous. New Orleans and Louisiana leaders faced the same problem a number of years ago. Despite the large capital improvement program, a New Orleans residential customer using 100,000 gallons of water annually will pay only 22 cents a day more for water in 1984 than in 1980.

Washington, D.C., on the other hand, had large unmet capital improvement and maintenance needs which appeared to have resulted from city-imposed budgetary restrictions rather than from a decision that rates could not be set to cover the costs of capital improvements and annual operations.

If, as the subcommittee reported, most urban water systems are operated by financially self-sustaining entities, there should be little need for Federal aid. Some systems could, like Cleveland, be only nominally self-sustaining and not charging rates rates based on sound engineering and economic principles as AWWA recommends.

In any event, we believe that the case for additional Federal aid for urban water distribution systems is not convincing and that legislation to alter Federal policy to provide such aid should not be enacted until the needs are clearly established.

COMPARISON OF WATER MAIN FAILURES IN 15 CITIES

	Year reported	System mileage	Main breaks per year		Main breaks and joint leaks per year	
			Number	Per 1,000 miles of mains	Number	Per 1,000 miles of mains
Boston	1969-78	1,080	39	36	47	44
Chicago	1973	4,148	223	54	-	-
Cincinnati	1969-78	3,866	-	-	808	209
Denver	1973	1,793	280	156	-	-
Houston	1973	3,988	5,144	1,290	-	-
Indianapolis	1969-78	2,010	167	83	215	107
Los Angeles	1973-74	6,800	290	43	-	-
Louisville	1964-76	2,439	300	123	-	-
Milwaukee	1973	1,800	421	234	-	-
New Orleans	1969-78	1,519	1,033	680	1,942	1,278
New York City	1976	6,310	476	75	-	-
San Francisco	1973	1,176	125	106	-	-
St. Louis	1973	1,373	106	77	-	-
Troy, New York	1969-78	150	25	167	27	180
Washington, D.C.	1969-78	1,406	163	116	248	176

Source: Data for Boston, Cincinnati, Indianapolis, Louisville, New Orleans, Troy, and Washington, D.C., was obtained in our review and are averages for the period shown.

Data for the remaining cities was taken from the "Report of Select Committee on Water Main Breaks in The City of New York," November 1977.

Data not shown was not available.

URBAN WATER SYSTEMS: PROBLEMS AND ALTERNATIVE APPROACHES TO SOLUTIONS 1/

EXECUTIVE SUMMARY

This report summarizes the results of the work of the Subcommittee on Urban Water Supply of the President's Intergovernmental Water Policy Task Force. Pursuant to its charter, the Subcommittee has:

- o Commissioned an inventory of existing Federal programs which either presently assist or have the potential of assisting urban water system rehabilitation or new construction;
- o Identified and evaluated institutional and financial problems surrounding supply and distribution of municipal water; and
- o Identified and assessed policy and program changes at the Federal, State and local level in order to address the problems.

Based on this work, the Subcommittee made findings and developed alternative policy approaches, as set forth below.

Findings

The principal findings of the Subcommittee are that:

(1) Urban water system capital expenditures needed over the next 20 years are estimated to total $75-$110 billion. This includes replacement and rehabilitation of distribution and treatment systems at $50-$80 billion, servicing growth at $5-$8 billion, upgrading to improve drinking water quality at $425 million, and new source development at $20-$25 billion.*

(2) Rough estimates suggest that as many as two out of ten urban water systems might experience capital investment shortfalls over the next 20 years. An investment shortfall is that portion of the capital investment estimated to be needed which a system is judged unable to finance based on its projected expenditures and on revenue increases up to a doubling of rates. The historical significance of such a ratio of shortfall is unknown.

(3) The most probable estimate of urban water system capital investment shortfall over the next 20 years, based on rough order-of-magnitude estimating techniques, is between $10-$13 billion. The shortfall could range between $5-$26 billion, since estimates are both difficult and uncertain without a city-by-city analysis.

*All estimates are in 1979 dollars. No adjustments have been made for inflation.

1/Subcommittee on Urban Water Supply, The President's Intergovernmental Water Policy Task Force, June 1980.

(4) Of the total estimated national shortfall, about one-half is attributed to distribution system needs and one-third to new source development needs.

(5) Municipally-owned and operated water systems are four times as likely as privately-owned systems to experience shortfalls. Regional public systems are twice as likely to experience shortfalls as private systems. Publicly-owned systems currently account for 73 percent of all urban systems and serve 81 percent of the population of urban areas.

(6) Federal categorical programs which supply assistance specifically for water supply purposes have limited applicability to urban water supply problems. Farmers Home Administration programs are focused on communities smaller than those classed here as urban (over 50,000 population). Federal water resource development agency programs of direct construction, by policy, do not develop projects for single-purpose water supply.

(7) Some Federal assistance programs do provide substantial sources of funding assistance which could be directed to water supply. Use of such assistance for water supply purposes depends upon whether State and local governments are able to give such use a high priority relative to other needs for the funds. Economic Development Administration programs, HUD community development programs and Treasury's General Revenue sharing programs provide very large resources which could be used for water supply purposes. In FY 1977, nearly $10 billion went to State and local governments from these programs; about two percent of these funds appear to have been allocated to water supply purposes. Of the $10 billion total, only $6 billion was available to urban areas (cities over 50,000), of which the amount utilized for urban water supply is unknown.

Alternative Policy Approaches

On the basis of the above findings, the Subcommittee has identified five possible policy approaches to address the problems identified. These approaches are:

(1) Status Quo - This approach would retain existing financial, regulatory, and institutional relationships to continue full local responsibility for water supply.

(2) Modified Policies and Programs - Modify existing policies and programs to increase Federal technical and planning assistance and condition existing direct Federal, grant, and loan programs that are used for urban water supply on State review of urban water system utility rate and investment policies.

(3) Federal/State Water Banks - Create Federal/State water banks to make capital investment funds more easily accessible to urban water systems. Conditions could be attached to loans requiring conservation to reduce future capital investment needs and to establish self-sustaining rates and investment practices. Interest subsidies also could be provided for particularly distressed urban areas.

(4) Financial Assistance - Implement increases in existing programs or add new programs of Federal financial assistance providing grants, loans or loan guarantees, conditioned upon the establishment of conservation programs to reduce future capital investment needs and establishment of self-sustaining rate and investment practices.

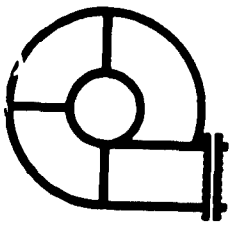
(5) Single Purpose Water Supply - Remove existing policy prohibitions against single purpose water supply in Federal water projects and allow direct Federal construction of single purpose water supply projects. Change Federal policy to permit the inclusion in Federal projects of wellfields, purification and distribution facilities, as well as reservoir source development and major conveyance projects. Change Federal policy to permit repair and rehabilitation, as well as major reconstruction of such facilities. States would determine, with local input, water supply priorities, and costs would be repaid over time in accordance with the 1958 Water Supply Act.

These alternative approaches are not mutually exclusive. The elements and conditions of one approach can be combined with those of another. A more detailed explanation of the five policy approaches and a table showing the premises upon which each approach is based appear in Chapter V.

Finally, the subcommittee believes that selection and implementation of any one or combination of policy approaches by policymakers should occur in conjunction with a more detailed study of urban water resource problems to reduce uncertainties as implementation proceeds.

APPENDIX II

Such a study should address needs outlined in Chapter VI and: (1) relate urban water supply problems and solutions to other urban infrastructure problems; (2) inventory on a case-by-case basis urban water system needs; and (3) provide a basis for review of, and "mid-course" correction to, the approach or approaches selected.



ERNEST N. MORIAL, President
RENE A. CURRY, President Pro-Tem.

Sewerage & Water Board OF NEW ORLEANS

STUART H. BREHM, JR.
Executive Director

CITY HALL · CIVIC CENTER
NEW ORLEANS, LA., 70165 · 586-4588

August 22, 1980

Mr. Henry Eschwege, Director
Community & Economic Development Division
United States General Accounting Office
Washington, D.C. 20548

Dear Mr. Eschwege:

After receipt of your letter of August 8 and the attached draft of the Comptroller General's report to the Congress-ADDITIONAL FEDERAL AID FOR URBAN WATER DISTRIBUTION SYSTEMS SHOULD WAIT UNTIL NEEDS ARE CLEARLY ESTABLISHED", I had this draft reviewed by our engineering forces.

The comments we have are set forth on the attached memorandum from the General Superintendent to me, dated August 19.

I think the comments offered by the Superintendent on chapter 3 with particular references to pages 17 through 19 are very important because it is quite possible, as you have pointed out in the draft, that the water leaks that we are reporting as water main breaks may well not be carried by other cities in that manner which would account for the higher number reported for New Orleans than on the adverage for other cities.

[GAO NOTE: On September 15, 1980, a Sewerage and Water Board official agreed that our draft report did distinguish between main breaks and total main failures--the sum of main breaks and joint leaks. Accordingly, we made no changes in the report as a result of the comments in this paragraph.]

Members of the Board: SIDNEY J. BARTHELEMY · JAMES L. BEVERLY · PHILIP C. CIACCIO · RUSSELL L. CUOCO · RENE A. CURRY · HENRY A. DILLON, JR. JANICE MARTIN FOSTER · JOSEPH I. GIARRUSSO · WILLIAM A. HOLTON, JR. · J. THOMAS LEWIS · HARRY McCALL, JR. · MRS. R. KING MILLING · ERNEST N. MORIAL
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GAO NOTE: Page and other references have been changed to agree with those in the final report.

APPENDIX III

I do not think the matter of self-sustaining rates to fund operations and maintenance and capital replacement can be overemphasized.

In the past 10 years we have been increasingly aware that those water systems operating with cost recovery revenues which fund O & M and Capital Replacement, secure much better bond ratings for major capital work than those water systems

which operate out of general funds sometimes to the detriment of a more cosmetic type public works facility such as parks, playgrounds, etc.

Sincerely,

Stuart H. Brehm, Jr.
Executive Director

SHB/dme
Enclosure
cc: G. Joseph Sullivan

SEWERAGE AND WATER BOARD OF NEW ORLEANS

Inter-Office Memorandum

RECEIVED
AUG 20 1980
S. & W. BD.
SECT'Y EXEC.
DIR.

Date: August 19, 1980

From: GENERAL SUPERINTENDENT

To: MR. STUART H. BREHM

SUBJ: DRAFT OF REPORT"ADDITIONAL FEDERAL AID FOR URBAN WATER DISTRIBUTION SYSTEMS SHOULD WAIT UNTIL NEEDS ARE CLEARLY ESTABLISHED".

REF: (A) YOUR MEMO DATED 8/12/80
(B) HENRY ESCHWEGE'S LETTER TO YOU DATED 8/8/80 FORWARDING SUBJECT REPORT

The subject report concerning the Board's water distribution system is complete as it was compiled over a period of six months by a team of two men researching our records, job reports, and the Board's annual reports over the years. However, I would like to submit the following comments:

pg ii line 1 "Usually mains are replaced where they are beyond repair or too small"
add "economical" before repair.

line 5 ". . . called ductile iron, started being used in the late 1960's because it is stronger"
add after stronger "and has the favorable characteristics of both steel and cast iron"

line 9 ". . . with cement mortar lining to prevent corrosion"
add "and the discoloration of the water".

Ch 3
pg 17 This chapter compares the main breaks in New Orleans with 12 other major cities and concludes that the breaks in New Orleans are higher than average. This is understandable for the repairs of leaks were treated as breaks and the cast iron mains in New Orleans are subject to many leaks, due to the fact that the unstable organic soils in this area afford little resistance to traffic vibrations which are transmitted to the pipe causing the lead caulking to work loose in the joint and the pressure forces it out. In our repairs, the lead is replaced and clamps

MR. STUART H. BREHM
SUBJ: DRAFT OF REPORT, ETC.

AUGUST 19, 1980
PAGE TWO

are placed around the bell-spigot to hold the lead in place. In recent years, rubber gaskets have replaced the lead, thereby eliminating the leaking problem. However, 95% of the cast iron pipe installed in our system has lead joints.

[GAO NOTE: See note on page 19.]

pg 18 "Types of failures" The above elaboration should be included in this section.

pg 19 Footnote 1/ states in part "Another official felt that some of the failures reported in cast iron mains could be in the cast iron fittings used with the asbestos-cement pipe".

This is an erroneous statement for very seldom do we have any failures in the cast iron fittings. Failures in asbestos-cement pipe are caused primarily in collar breaks or the blow-out of rubber gaskets that were not properly seated.

pg 41 The AWWA Board of Directors adopted a policy statement against government grants to water utilities, because AWWA believed they would destroy the financial and managerial independence necessary to self-sustained business like operations.

Analyzing the pros and cons of Federal Aid we must agree with AWWA, for until our system is on the verge of collapse, more efficiency is derived by operating in a self-sufficient manner free of government interference.

G. JOSEPH SULLIVAN

GJS:gaw
cc: Messrs. Haney, St. Germain

GOVERNMENT OF THE DISTRICT OF COLUMBIA
DEPARTMENT OF ENVIRONMENTAL SERVICES
WASHINGTON, D. C. 20004

AUG 29 1980

Mr. Arthur R. Goldbeck
Senior Group Director
General Accounting Office
2nd Floor, District Building
14th and E Streets, N.W.
Washington, D.C. 20004

Dear Mr. Goldbeck:

This is in response to your draft of a proposed report titled, "Additional Federal Aid for Urban Water Distribution Systems Should Wait Until Need are Clearly Established" submitted recently to this agency for review and comment.

I have reviewed the report and the conclusions they reach are factual. Lack of funds to maintain and operate the water system have been due to overall D.C. policy of budget restrictions.

The water funding should be independent and based entirely on the needs to properly operate and maintain the system and supported by the rate to the users; in other words, financially independent and dedicated.

Mayor Barry's recent decision to allow increases in the water and sewer programs is to be commended and it should be emphasized that it is a great move forward. The fact that this decision pre-dated the GAO report is an issue that should be emphasized.

[GAO NOTE: We take no credit for influencing the Mayor's decision to increase water system funding, nor are we prepared to characterize its potential impact.]

I believe Harold Stearn, Deputy Administrator, Water Resources Management Administration, made the comment that any further reduction in operation and maintenance activities could, "not would," endanger the health of the community. The rationale for this comment was based on the fact that more and more valves would be inoperative, therefore, longer sections of watermains would be out-of-service in the event of a watermain break and the lack of water to residences for longer period of times could endanger the health of people affected.

We do have plans to replace and rehabilitate distribution mains. However, capital outlay and operating and maintenance budget restrictions have delayed implementation of these plans.

The problems of our water distribution infra-structure as identified by this report are real. However, the course of action the Barry Administration is taking clearly demonstrates that we are on the correct path for recovery.

This includes but not limited to minimizing unaccounted-for-water, accurate metering, billing and a business-like attitude regarding the realization of revenues.

Should you wish to discuss this further, please let me know.

Sincerely yours,

William B. Johnson
Acting Director

DEPARTMENT OF THE ARMY
OFFICE OF THE ASSISTANT SECRETARY
WASHINGTON, D.C. 20310

REPLY TO
ATTENTION OF

10 SEP 1980

Mr. Henry Eschwege
Director, Community and
Economics Development Division
U.S. General Accounting Office
Washington, D.C. 20548

Dear Mr. Eschwege:

This is in reply to your letter to the Secretary of Defense of August 8, 1980, regarding your draft report on "Additional Federal Aid For Urban Water Distribution Systems Should Wait Until Needs Are Clearly Established," GAO Code 085460, OSD Case #5506.

The comments presented below address two aspects of your draft report: one is its treatment of the June 6, 1980 Report of the Subcommittee on Urban Water Supply, and the other is the appropriate basis for assessing the merits of water conservation measures, which is dealt with in Chapter 4.

Report of the Subcommittee on Urban Water Supply

It would not take much space, and would enormously increase the usefulness of Appendix II of the GAO report, if this Appendix were to consist of a verbatim reproduction of the Executive Summary of the report of the Subcommittee on Urban Water Supply rather than the summary of the policy approaches identified by the Subcommittee. Moreover, as it now stands, the title of Appendix II is incorrect -- the Subcommittee has not made any recommendations -- and there are inaccuracies in the summary statements of several of the policy approaches. The Department of the Army urges GAO to include the entire Executive Summary.

GAO's use of the term "financially self-sustaining entities" gives the reader the erroneous impression that,

GAO NOTE: All suggested changes were made. Page references have been changed to agree with those in the final report.

Mr. Henry Eschwege

in every urban area, the water system is, for operating purposes, institutionally, financially and politically independent of the city government. This is not the case. To correct this error, I recommend you rewrite three sentences.

The first sentence in the first paragraph on page iv of the Digest should be replaced by the following:

> The Subcommittee also found that most urban water systems are financially self-supporting from consumer payments and receive little or no assistance from municipal government or other sources.

Similarly, the first sentence, next to last paragraph on page iv of the Digest should be rewritten as follows:

> If, as the Subcommittee reported, most urban water systems are financially self-sustaining, there should be little need for Federal aid.

The first sentence of the first complete paragraph on page 38 incorrectly states that about 1.4% of unrestricted Federal monies were used for water supply and distribution systems in Fiscal Year 1977. The correct figure is approximately 2%, as shown on page II-8 of the report of the Subcommittee on Urban Water Supply.

The second sentence of the first paragraph in the section on page 39 entitled "Findings of the Subcommittee on Urban Water Supply" is incorrect and should be rewritten as follows:

> The Subcommittee also stated its belief that selection and implementation of any one or combination of policy approaches by policymakers should occur in conjunction with a more detailed study of urban water resource problems to reduce uncertainties as implementation proceeds; such a study should among other things, (1) relate urban water supply problems and solutions to other urban infrastructure problems; (2) inventory on a case-by-case basis urban water system needs; and (3) provide a basis for review of, and mid-course correction to, the approach or approaches selected.

Mr. Henry Eschwege

This same wording also should replace the sentence starting on the second line on page iv of the Digest.

The sentence starting on line 10 of page 49 -- "The Subcommittee recommended that urban water system needs be inventoried on a case-by-case basis before changing Federal policy on water system financing" -- is false and should be either dropped or corrected. An alternative wording for this sentence would consist of three sentences as follows:

[GAO Note: This sentence was dropped from the final report.]

The Subcommittee did, however, articulate five policy approaches for consideration by policymakers: the "status quo" approach and four "new initiatives" approaches. The Subcommittee also stated its belief that selection and implementation of any one or combination of policy approaches by policymakers should occur in conjunction with a more detailed study of urban water resource problems to reduce uncertainties as implementation proceeds. Such a study should, among other things, (1) relate urban water supply probems and solutions to other urban infrastructure problems; (2) inventory on a case-by-case basis urban water system needs; and (3) provide a basis for review of, and mid-course correction to, the approach or approaches selected.

Assessing Water Conservation Measures

Chapter 4 discusses control of unaccounted-for water and leakage. Although not stated explicitly, the report appears to be consistent with definition of water conservation used by the Army Corps of Engineers -- Water conservation is any beneficial reduction in water use or in water losses. The discussion recognizes that the benefits and costs should be considered in such decisions regarding control measures. We believe that this concept is essential to efficient management of water systems and that it is applicable to all measures that reduce demand or reduce losses, including pricing, leak detection, and metering.

Sincerely,

for Michael Blumenfeld
Assistant Secretary of the Army
(Civil Works)

United States Department of the Interior

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

Mr. Henry Eschwege
Director, Community and
Economic Development Division
U.S. General Accounting Office
441 G Street, N.W., Room 6146
Washington, D. C. 10548

9 SEP 1980

Dear Mr. Eschwege:

This letter is in response to your request for comments on the General Accounting Office Draft Report - "Additional Federal Aid for Urban Water Distribution Systems Should Wait Until Needs are Clearly Established." The report deals primarily with the need for Federal assistance to cities for work on municipal water distribution systems. The Water and Power Resources Service (Water and Power) has expertise in the design and construction of pipelines and could provide technical and planning assistance in that area if recommendation 2 of Appendix II is adopted. Their area of jurisdiction is limited to the 17 Western States, and their involvement would have to be limited to that area unless their authority is expanded.

While the report does not specifically deal with development of water supplies, it does mention water supply systems in several instances. Water and Power is deeply involved in providing water supplies for municipal and industrial (M&I) purposes. In 1978 Water and Power projects provided 524 billion gallons of water to 16.6 million people in the 17 Western States. If recommendation 5 in Appendix II is adopted, it should be noted that Water and Power has the authority to plan and construct M&I water supply projects. They are multipurpose projects in order to accommodate other purposes such as recreation, flood control, fish and wildlife enhancement, environmental concerns, and other water needs. Each project requires specific Congressional authority for feasibility studies and construction. The project costs associated with providing M&I water supplies from these projects are fully reimbursable, with interest. As with the technical assistance, their area of jurisdiction is limited to the 17 Western States.

Sincerely,

Assistant Secretary -
Policy, Budget and
Administration

GAO NOTE: These comments do not relate to the substance of our report. They do, however, discuss the ability of the Water and Power Resources Service to support two of the policy options suggested by the Subcommittee on Urban Water Supply of the President's Intergovernmental Water Policy Task Force. (See app. II.)

UNITED STATES WATER RESOURCES COUNCIL

SUITE 800 • 2120 L STREET, NW WASHINGTON, DC 20037

AUG 27 1980

Mr. Henry Eschwege
Director
Community and Economic
Development Division
U.S. General Accounting Office
441 G Street, NW. - Rm. 6146
Washington, DC 20548

Dear Mr. Eschwege:

I would like to thank you for the opportunity to review the draft report on "Additional Federal Aid for Urban Water Distribution Systems Should Wait Until Needs are Clearly Established." The report is a good summary of the state of urban water supply systems. Those who prepared the report should be complimented for making distinctions between popular impressions and subtle, but important, aspects of understanding the nature of the problem--unaccounted for water does not necessarily mean water lost to leakage, system financial self-sufficiency does not necessarily relate to organizational independence from a governmental unit, and the prime factor in pipe failure rates is not necessarily age.

I would like to offer the following comments for your consideration in preparing the final report:

1. Lack of maintenance of water supply systems may be an indicator of a larger problem of the deteriorating condition of the urban capital infrastructure. As such, water supply investment may be an indicator of more pervasive problems in many urban communities.

2. The role of the States in providing assistance to urban water supply systems has not been thoroughly addressed. While recognizing that many States are under considerable financial pressures, an assessment of possible State roles should command as much attention as that of possible Federal roles. I would note, for example, that the Commonwealth of Massachusetts has recently authorized a $10 million program for assistance to local communities for water supply systems rehabilitation. While this is not a large amount given the magnitude of the problem, it does indicate the willingness of a State to move toward financial assistance programs.

[GAO NOTE: Neither of the above areas was within the scope of work of this report.]

MEMBERS: SECRETARIES OF AGRICULTURE, ARMY, COMMERCE, ENERGY, HOUSING AND URBAN DEVELOPMENT, INTERIOR, TRANSPORTATION; ADMINISTRATOR, ENVIRONMENTAL PROTECTION AGENCY-OBSERVERS: ATTORNEY GENERAL; DIRECTOR, OFFICE OF MANAGEMENT AND BUDGET; CHAIRMEN, COUNCIL ON ENVIRONMENTAL QUALITY; TENNESSEE VALLEY AUTHORITY; BASIN INTERAGENCY COMMITTEES; CHAIRMEN AND VICE CHAIRMEN, RIVER BASIN COMMISSIONS

Again, my thanks for the opportunity to comment on your fine report.

Sincerely,

Gerald D. Seinwill
Acting Director

(085460)

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