BY THE COMPTROLLER GENERAL

Report To The Congress

OF THE UNITED STATES

Desalting Water Probably Will Not Solve The Nation's Water Problems, But Can Help

Because of increased contamination of surface and ground water, the lack of freshwater is rapidly becoming a problem for many locations in the Nation. Desalting of water is a possible solution. This report discusses the need for the Office of Water Research and Technology to develop and implement a comprehensive, well-defined saline water conversion program plan aimed at achieving a practical, low-cost desalting method.

GAO recommends that the Secretary of the Interior present this plan to the Congress and also take actions to effectively implement it.

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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 is our report on the need for better management planning in the Saline Water Conversion Program. The report also summarizes the status of saline water conversion technology.

We are sending copies of this report to the appropriate House and Senate committees; the Director, Office of Management and Budget; the Secretary of the Interior; the Administrator, Environmental Protection Agency; and other interested parties.

Elmer B. Staats
Comptroller General
of the United States

COMPTROLLER GENERAL'S
REPORT TO THE CONGRESS

DESALTING WATER PROBABLY WILL NOT SOLVE THE NATION'S WATER PROBLEMS, BUT CAN HELP

D I G E S T

The Congress, ~~in 1952,~~ established the Saline Water Conversion Program to research and develop ways to convert ~~sea and~~ other saline water into useful water--a program responsible for much of the desalting technology in use in the world today. However, a practical, low-cost desalting method has not been achieved.

As the availability of freshwater for municipal and industrial purposes becomes more of a problem, many countries are beginning to consider various desalination processes. (See pp. 1 and 2.)

Years of research and development and expenditures of about $300 million have resulted in proof that desalting is technically feasible but costly. Current estimates of the cost per thousand gallons of water suitable for municipal purposes are about $4 for seawater and $1 for brackish water. These costs compare with up to 40 cents per thousand gallons for conventional sources.

While continuing to try to reduce desalination costs, the United States is working with other countries to improve desalination technology. It has an agreement with Israel to jointly develop a distillation process which uses less energy and to share the resulting technology. (See pp. 5, 9, and 13.)

The Saline Water Conversion Program has suffered from a lack of consistent management focus. Various Administration changes have contributed to uncertainty about what needs to be done, in what priority, and when it should be completed. Also, in the early 1970s, the Congress disagreed with the Administration's position that some Federal desalting efforts should be phased out. The threat of termination resulted in an unstable environment for those associated with the program. Uncertainties in program direction and reductions in Federal funding in recent years have diminished the effectiveness of the Federal desalination program. (See pp. 13 to 15.)

The western drought of 1976-77 rekindled support in both the legislative and executive branches for an expanded Federal desalting program. The Water Research and Development Act of 1978 (Public Law 95-467), considers desalting as just one part of a broad national program to help assure an adequate supply of good quality water for agricultural, industrial, and energy-producing needs. Also, it extends indefinitely the saline water conversion function within the Department of Interior's Office of Water Research and Technology. About $10.0 million was appropriated for the program in fiscal year 1979, and about $12.4 million has been requested for fiscal year 1980.

Early in its work GAO wrote to the Director, Office of Water Research and Technology, suggesting ways to improve program planning and management. The Director responded favorably and told GAO he had initiated efforts to establish a comprehensive, well-defined, goal-oriented plan addressing planning and management weaknesses. (See pp. 15 and 16.)

RECOMMENDATIONS

The Secretary of the Interior should

--present to the Congress a comprehensive, well-defined, goal-oriented Saline Water Conversion Program plan which clearly identifies program goals, plans for achieving the goals, and an assessment of the resources required and

--assure, to the extent that funds are made available, that the plan is effectively implemented and evaluated so that program objectives will be achieved. (See p. 17.)

AGENCY COMMENTS

Department of the Interior officials generally agreed with the conclusions and recommendations in the report; however, they felt the report needed amplification on several points. GAO has made report revisions where appropriate and has included Interior's written comments as appendix I.

Contents

ABBREVIATIONS

ED	electrodialysis
EPA	Environmental Protection Agency
GAO	General Accounting Office
OSW	Office of Saline Water
OWRT	Office of Water Research and Technology
PPM	parts per million
RO	reverse osmosis

CHAPTER 1

INTRODUCTION

The oceans contain 97.2 percent of the Earth's water, all of which is too saline for potable and almost all other purposes. The less brackish waters at inland sites and the frozen water of the polar region make up over 2.5 percent of the remainder of the Earth's water, leaving less than 0.5 percent to be used and reused for municipal, industrial, agricultural, and energy-producing purposes.

The Earth's freshwater supply is shrinking, not only as a result of increased demand due to population growth, but also as a result of increased mineralization and pollution of rivers, lakes, and underground reservoirs. In urban areas, populations add large amounts of wastes, including salts, to surface and ground waters making downstream waters less and less potable. In coastal areas excessive pumping of fresh ground water supplies frequently causes saltwater intrusion when the freshwater is pumped to the surface before it can be naturally recharged. When seawater fills the void, the usual result is a ground water supply that is too brackish for most uses. In the agricultural areas, the leaching action of irrigation water that is not transpired through growing plants moves down through the soil, carrying salts and other minerals which are deposited in ground water aquifers or eventually drain into rivers and lakes. Near industrial or mining areas, chemicals or mine acid can add to the problem.

As the availability of freshwater for municipal and industrial purposes becomes more of an emerging problem, many countries, including the United States are beginning to consider various desalination processes as alternatives for augmenting freshwater supplies. Even in this country, numerous communities are already forced to rely on water with a saline content above the Environmental Protection Agency's (EPA's) recommended drinking water limit of 500 parts per million (ppm) total dissolved solids. In some areas mineral and/or pollution levels are in the high unhealthy range.

The range of the quality of water found on the Earth is categorized as follows:

Type of Water	Definition
Fresh	Water containing less than 1,000 dissolved parts of salt per million parts of water.

Brackish	Water ranging from 1,000 ppm to the dissolved salt content of seawater. Mildly brackish--1,000 ppm to 5,000 ppm. Moderately brackish--5,000 ppm to 15,000 ppm. Heavily brackish--15,000 ppm to 35,000 ppm.
Seawater	Water containing approximately 35,000 ppm.
Brine	Water containing more dissolved salt than seawater, such as the Great Salt Lake or the Dead Sea.

The Federal saline water conversion program

Since 1952 the Department of the Interior has been conducting a research program for the development of processes for economically converting saline water into freshwater. In that year, the Congress passed the Saline Water Act (Public Law 82-448) and funded a program specifically to research and develop practical low-cost desalination processes.

At the inception of the program in the early 1950s, there was much optimism that desalting would provide relief in a very short time to an impending water crisis and offered long-range promise of opening up the world's deserts to extensive settlement and cultivation.

In the early years, the desalination program was authorized for a specific period of time and seemed to have a rather limited life. The initial program, funded as a $2 million, 5-year effort, was managed by a Saline Water Conversion Committee of the Department of the Interior. The intent was that Federal involvement would cease when desalination became commercially available. By 1955 the Secretary recognized that a greater effort would be needed and reorganized the saline water staff into the Office of Saline Water (OSW). The Congress authorized extension of the program in 1955, 1961, 1965, and 1972, in each case for a specific period of time. In 1974 the Office of Water Research and Technology (OWRT) was formed under a secretarial order by which the Secretary of the Interior abolished OSW and the Office of Water Research. The functions of both offices were consolidated into OWRT. The Congress authorized the present saline water conversion program under title II of the Water Research and Development Act of 1978 (Public Law 95-467) which does not provide for a termination date. Funding for the Saline Water Conversion Program is shown below.

Saline Water Conversion Appropriations 1953-80

Fiscal year	Amount (thousands)
1953	$ 175
1954	400
1955	400
1956	600
1957	550
1958	725
1959	1,183
1960	3,605
1961	3,795
1962	9,805
1963	9,600
1964	11,850
1965	16,150
1966	22,485
1967	29,851
1968	20,800
1969	25,556
1970	25,000
1971	28,573
1972	27,025
1973	26,871
1974	3,627
1975	5,907
1976	3,400
1977	7,571
1978	11,000
1979	10,075
1980 (Budget request)	12,365
Total	$318,944

Scope of review

During our review we obtained information from OWRT personnel at headquarters and their test facilities at Roswell, New Mexico, and Wrightville Beach, North Carolina. Also, we spoke with Bureau of Reclamation, Department of the Interior, and EPA officials. In addition, we obtained information from selected industry and State saline water officials in California, Delaware, Florida, Massachusetts, North Carolina, Texas, Virginia, and Wisconsin.

CHAPTER 2

CURRENT STATUS OF DESALINATION:

TECHNICALLY FEASIBLE, BUT COSTLY

While numerous advances in desalting technology have been made in the program's 26 years, almost all desalting experts agree that no processes are known today which offer prospects for making the 1952 dream of the deserts blooming a reality. Desalting has been established as a technically feasible and, in most cases, a reliable source of new water for specialized needs. However, because large quantities of water cannot be produced for the relatively low cost originally envisioned, desalination is far from being the panacea to the Nation's water problems. Although it is being used to supplement existing water supplies in numerous areas, it is unlikely to ever be widely utilized as a primary water source as long as any alternatives exist. Because all of the known processes use a lot of energy, the recent increases in energy costs compound the problem of achieving low-cost water and make the possibility of a dramatic breakthrough even more difficult.

In communities where only brackish or polluted water is available, desalination can benefit community health. For industrial purposes, it can produce ultrapure water; clean wastewater to be reused for recycling, cooling, or other purposes; or improve wastewater quality to meet governmental discharge requirements. However, the costs are high, and the decision to resort to desalination must be carefully weighed. All of the following conditions must exist before desalination can be seriously considered:

--A sufficient quantity of good quality water is not available.

--A higher quality water than that available is required.

--Sea or brackish water is available.

--The cost of desalting is less than the cost of importing available freshwater from another area or moving the use to another area of higher quality water.

--The money is available to pay for the desalted water.

The following sections of this chapter provide a brief synopsis on the status of desalting technology. Included are figures on desalting plant capabilities and some of the problems with their economics, OWRT's immediate plans in the desalting area, and comparative explanations of commonly used desalting processes. 1/

Desalting plants increasing worldwide; but low-cost desalting has not arrived

In 1977 about 1,500 land-based desalting plants were producing 25,000 gallons per day (gpd) or more, and over 350 plants, producing over 1 million gallons per day (mgd), were operating or under construction worldwide.2/ According to OWRT officials, however, these figures do not imply that low-cost desalting has arrived in that the energy crisis and environmental constraints have kept the processes from being economical for widespread domestic use. For example, in 1972 an OSW official noted that since the program's inception, the cost of desalting seawater with distillation had dropped from over $5 to about $1 per thousand gallons, and membrane processes, which were basically only laboratory curiosities in 1952, were converting brackish water for 50 cents per thousand gallons. Today, however, energy and environmental variables have pushed seawater desalting production costs up to the $4 per thousand gallons range and brackish water membrane processes up to the $1 range, as compared with up to 40 cents per thousand gallons from conventional sources.3/

The impact of increased costs can best be illustrated by recent events in the Florida Keys where a 3.6 mgd desalting system has been used for years to supplement an old 6 mgd supply pipeline which brings water in from the

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1/For a more detailed evaluation of the state of the art, we refer the reader to the 1978 report entitled "Desalting Plans and Progress, An Evaluation of the State-of-the-Art and Future Research and Development Requirements," done for OWRT by the Fluor Engineers and Constructors, Inc. For illustrated explanations of how the processes convert sea or brackish water to freshwater, see OWRT's "The A-B-C's of Desalting."

2/"Desalting Plants Inventory Report No. 6," U.S. Department of the Interior, OWRT, Oct. 1977.

3/These estimates do not include transmission, distribution, and amortization of capital costs.

Florida mainland. The desalting system includes a 2.6 mgd seawater distillation plant and a 1 mgd brackish water reverse osmosis (RO) plant. The distillation plant has been operating since 1967 and is the only seawater distillation plant producing water for municipal purposes in the continental United States. The RO plant has been operating since 1976. The two plants have been reliably producing the potable water required to supplement the water delivered from the mainland. However, in September 1978, citing high energy costs, such as the $1.7 million fuel bill for the single purpose distillation plant last year, the Florida Keys Aqueduct Authority announced that it plans to mothball the distillation and RO plants if a proposed new $80 million water system, including a 13-mgd capacity pipeline from the mainland, goes on line.

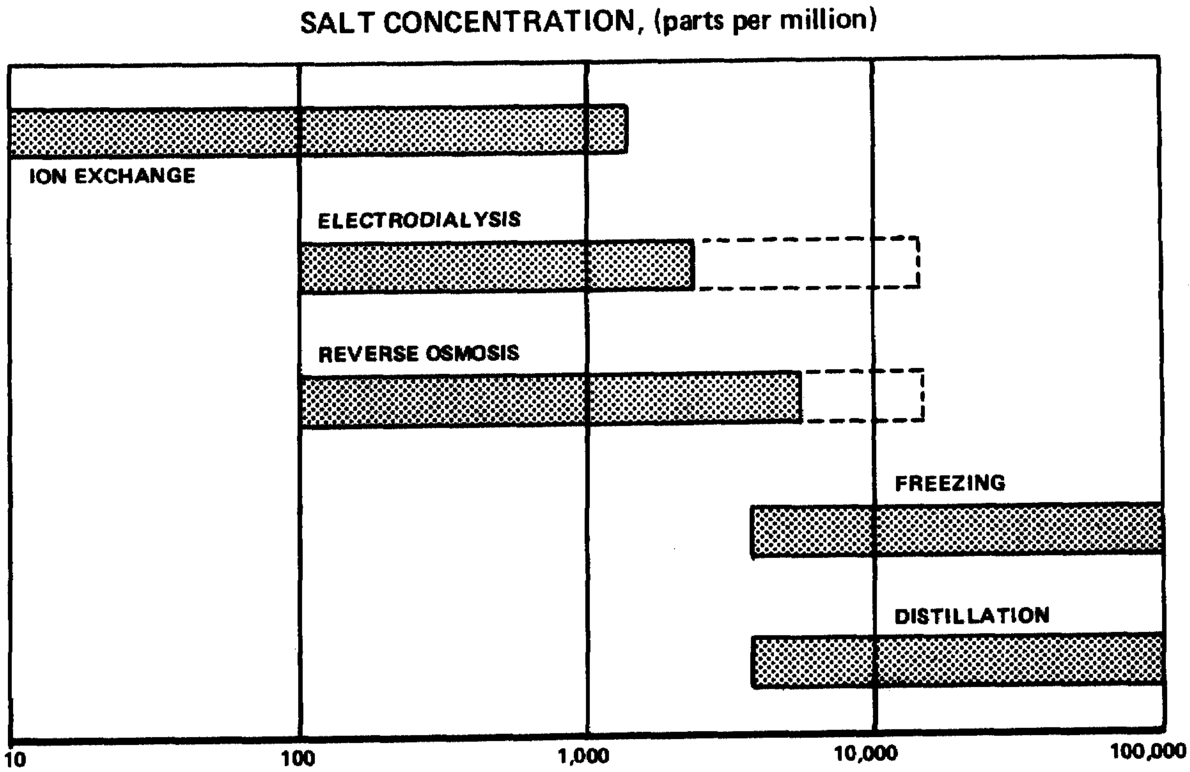
There are two basic types of desalination processes--phase-change processes and nonphase-change processes. In the phase-change processes, which include distillation and freezing, the physical state of the water molecules change. In all distillation processes, saltwater is boiled causing the steam or water vapor to rise leaving the dissolved solids behind. The water vapor is then cooled, and the steam condenses into freshwater. In all freezing processes a salt solution is cooled to its freezing temperature causing pure ice crystals to form. Impurities remain on the surface of the ice crystals. These impurities are washed from the surface and the ice crystals are melted to obtain pure water.

In nonphase-change methods, which include membrane and chemical processes, water is separated into pure water and concentrated brine. Membrane processes require use of a thin, film-like sheet or fine fibers as a selective separator allowing some substances to pass through it relatively freely but acting as an effective barrier to others. In chemical processes either the pure water or the salts undergo a chemical reaction to form a substance that can be readily separated.

Two commercially available membrane processes are RO and electrodialysis (ED). In RO, freshwater diffuses through the membrane leaving the salt behind while in ED, demineralization of saline solution takes place by the passage of salt through the membrane. The driving forces employed to cause separation in RO and ED are hydraulic pressure and electric current, respectively.

The only commercial chemical process is ion exchange. Put simply, the procedure works when synthetic resins react with the salts in the solution, changing dissolved salts in the original water to a more acceptable form.

The extent to which each process is effective depends upon the site characteristics. In selecting the most effective and economical process, consideration must be given to such things as the salt concentration of the water source, organic and inorganic makeup of the water, intended use of the water, brine disposal, and energy cost and its availability. Although no single process is most desirable for all locations and conditions, the following chart shows the generally accepted range of effectiveness for the various processes.



SOURCE: G. M. Wesner- Published by Culp-Wesner-Culp, Santa Ana, California. February, 1978.

The broken lines extending ED and RO toward acceptability of water over 35,000 ppm dissolved solids reflects recent advances being achieved or anticipated in membrane technology.

Distillation: energy intensive and not economically practical for domestic use

While distillation is the most widely used process in the world, accounting for 77 percent of the world's total plant capacity and 53 percent of the total number of plants, it is not used extensively in this country because the processes are generally not cost effective when compared to available alternatives. 1/ Distillation requires a great deal of energy to create steam and even when a series of changes is used to conserve energy (i.e., the incoming water to one unit is preheated by using it to cool the vapor in another unit) the energy consumption of distillation methods is still relatively high compared to other methods. Furthermore, high operating temperatures can cause scaling on heat exchange surfaces, which decreases the efficiency of the process. Corrosion may also be accelerated at elevated temperatures.

Because the costs are basically the same, regardless of the salt content of the water, generally little is gained by using distillation on anything but seawater or other highly saline waters. However, this technology would be used where very high purity product water is required or where the reuse of water is to be maximized to minimize the discharge. Because only freshwater is produced from the condensed vapor, distillation becomes the most viable alternative when ultrapure water is desired.

Although RO, a membrane process, cannot yet economically produce the high-quality (25 ppm or less total dissolved solids) water of distillation, it can produce potable water of 500 to 700 ppm from seawater at only 25 percent of the energy needs of a single purpose distillation plant. In instances where potable water is not required, such as for agricultural or cooling purposes, the use of a nonphase-change process, such as RO, would be even more economically justifiable.

Despite these problems, some progress has been made in distillation processes including more efficient designs, vacuum techniques to lower the boiling temperature, more corrosion resistant materials, and pretreating the feed water to prevent scale formation.

1/OWRT officials told us that cogeneration, using waste heat low-grade steam from power plants, offers the possibility of making distillation more economically attractive.

International agreements

At present, the United States has an agreement with Israel to jointly develop a distillation process that uses less energy and an agreement with Saudi Arabia to assist the Saudis to expand their distillation program.

A State Department official said the agreement with Israel was made because the Israeli's have patented a less energy-intensive process than any being developed in the United States, and we could not get this technology otherwise. An OWRT official said that under the agreement, the Federal Government can share the know-how with States or local bodies in the public domain. The United States is contributing a $20 million grant and technical and administrative expertise to the project.

Under the agreement with Saudi Arabia, the Department of the Interior is assisting the Saudi's in (1) establishing a saline water conversion research, development, and training center and (2) initiating programs to develop the technology for single unit distillation plants with capacities of up to 66 mgd of freshwater daily. An OWRT official working on the project said that the U.S. role is that of technical advisors. The Saudi Government pays all costs.

Freezing: studied for nearly 25 years but still in the experimental stage

Freezing has an inherent advantage over distillation in that less energy is required to achieve the phase change. In addition, low-temperature operations minimize corrosion and permit the use of less expensive materials. Also, freeze desalting has the potential for utilizing below freezing temperatures resulting from nondesalting processes. These low temperatures provide free energy for freeze desalting.

Supporters of the freezing process claim it could clean-up certain industrial wastes and reduce costs of seawater desalting. However, freezing is still in the research and development phase and is not at the point that it can provide large quantities of water on a commercial basis.

For example, an OWRT official said that if freezing was ready today, it would replace RO as the choice process for the 96 mgd Yuma, Arizona, desalting project being built by the Bureau of Reclamation. He said that if the freezing process was fully developed, it could get 95 percent recovery without a great deal of pretreatment. With the same quality of feed water, the RO process, in comparison, will only recover about 70 percent of the water. The reason for the great improvement potential is that the pretreatment requirements of phase-change processes are significantly diminished since the organic and inorganic materials are left behind when the phase change occurs.

Membranes: expensive but commercially available for brackish water and wastewater treatment

Membrane processes, according to a 1977 OWRT inventory, accounted for almost 50 percent of the 1,500 or so desalting plants of 25,000 gallons per day or larger worldwide but only 23 percent of the world's total plant capacity. However, the fact that about 70 percent of the 476 plants sold during 1975-76 were RO or ED plants reflects the growing market for membrane processes.

Since the energy requirements increase with the amount of dissolved salt, membrane processes are generally favored for brackish water rather than seawater conversion. The Fluor report shows an energy break-even point of the RO and ED processes at approximately 1,200 ppm with ED being more energy efficient below that level and RO being more energy efficient above that level. However, at present, supporters of both RO and ED claim that research and development on lower energy consumption is advancing for both brackish water and seawater processes.

The economies of membrane processes are highly sensitive to the amount of pollutants, such as suspended and dissolved solids, in the feed water. A leading manufacturer of RO membranes said that the cost of pretreating feed water can run as high as 95 percent or as low as 10 percent of total costs depending on the quality of the feed water and the size of the plant.

Both the RO and ED membrane processes were developed, to a great extent, under Federal programs. While ED has been available commercially longer, RO has received greater Federal support and has surpassed ED as being the most widely used process for the treatment of brackish water for domestic and industrial uses. Both processes are also being increasingly utilized to recover valuable by-products from industrial wastes. In addition, OWRT sees great potential in applying membrane processes, particularly RO techniques, for treatment of municipal and industrial wastes and agricultural return flows for water reuse, inplant quality control, or recycling.

Although membrane techniques are more effective for brackish water, potential exists for economic desalination of seawater. U.S. firms are building large scale seawater RO plants today and smaller scale ED units have reliably converted saline water within the seawater range. However, all the sales have occurred in the Middle East where the cost of energy is not considered as great a factor as in the U.S. market. Additional research and development advances are needed before large scale seawater conversion will be economical for large scale domestic use.

Ion exchange: a chemical process with limited applicability

While ion exchange has been used on waters up to 2,500 ppm, the cost crossover point for ion exchange relative to membrane processes is about 300 ppm. The use of ion exchange, after RO is currently finding favor in powerplants for boiler feed purification and with manufacturers of instrument components who require ultrapure water equivalent to distilled water in purity but at less cost. When special feed-water compositions are present, a combination of ion exchange and RO or ED may offer the least cost desalting system for treating poor quality municipal waters.

Brine disposal: a common problem for all processes

All desalting plants generate concentrated waste effluents of soluble salts or brine having little use or value, which must be disposed of. The possible ecological damage from brine disposal is a complicating factor. Whether the disposal problem is as disruptive as traditional water development depends on the particular location involved. Sites involving ocean disposal usually do not encounter as serious a problem as inland disposal. Possible inland disposal methods include evaporation ponds, transport by pipeline, deep well injection, and central stockpiling of dry salts. Each method has associated costs and environmental problems. Potential benefits received from economical recovery of chemicals from brine appear to be limited.

Further advances are required before all severely water-short areas will be able to consider desalting technology

With worldwide sales of desalting plants increasing dramatically each year, it seems that more and more of the world's municipalities and industries are becoming willing to pay for this reliable but expensive technology because it is the only source in some instances. It should be noted, however, that especially in this country, the total amount of freshwater produced by desalting is still quite small.

Total U.S. freshwater requirements are in the 350 to 450 billion gallons per day range. At the time of the 1977 desalting inventory, the U.S. desalting capacity was only about 120 million gallons per day, or just about 10 percent of the world's total desalting plant capacity. To put it in perspective, all the U.S. desalting plants together could not meet the current water needs for the Washington, D.C., suburban communities of Prince Georges and Montgomery Counties, Maryland.

Although costlier than traditional methods of obtaining or improving water supplies, desalting has proven to be a reliable means of providing the freshwater required to solve some of our Nation's severe local water problems. While it is extremely doubtful that desalting will ever be competitive with the more traditional methods of obtaining freshwater, a well-managed Federal research and development program can contribute toward advancing the technology. Hopefully, desalting technology will reach the point where the economics of the processes will allow all water-short U.S. municipalities and industries to consider desalting as a part of their water resources management programs.

CHAPTER 3

NEED FOR MORE DEFINITIVE PLANNING

IN THE SALINE WATER CONVERSION PROGRAM

Over the years the Federal Saline Water Conversion Program has suffered from a lack of direction and consistent management focus. Various administration changes have contributed to the uncertainty on what needs to be done, in what priority, and when it should be completed. In the early 1970s, the threat of program termination raised questions concerning the program's future and resulted in an unstable environment for all associated with the program.

More recently, the western drought of 1976-77 rekindled support for the program in both the legislative and executive branches. With the October 1978 signing of the Water Research and Development Act of 1978 (Public Law 95-467), OWRT, for the first time, has an "open ended" commitment to "* * * provide for the development of technology for the conversion of saline and other impaired waters for beneficial uses." In view of this long-term program commitment; the increased funding authorized by Public Law 95-467; and the new emphasis OWRT plans to put on water reuse, recycling, and other aspects of water resources management; it becomes very important that an effective saline water conversion program plan--including well-defined goals and objectives--be developed and implemented in a timely manner.

PROGRAM HISTORY: UNCERTAINTIES IN PROGRAM MANAGEMENT AND DIRECTION HAS HINDERED THE NATION'S DESALTING EFFORT

Uncertainties in program management and direction and reductions in Federal funding in recent years have hindered the effectiveness of the Federal desalination program. However, after many years of research and development and expenditures of about $300 million, the United States is generally recognized as the world leader in desalting technology. But this leadership is being threatened.

The program's goals and objectives have never been clearly defined, and, as a result, differing views of program goals and the level of effort required to reach those goals have always existed. The following examples show some of the changing views and program management direction.

--In 1952 the Department of the Interior indicated that the objective of the program was to administer and coordinate research with private entities.

However, there was little private interest, and by 1955, there was a need to increase the Federal role and use existing Federal scientific laboratories for research.

--In 1958 the Department supported a gradually accelerated research and test program while the Congress pressed for a program to expedite larger pilot plant work which could demonstrate the technical and economic feasibility of the processes.

--In 1961, while five demonstration pilot plants were being built, the OSW Director stated that since the emphasis had been on engineering development to date, increased emphasis would be placed on basic research.

--In 1965 the OSW Director stated that because of the emphasis the research program had received and the scientific information obtained, he would implement a transition from research and small plant engineering to a full-scale engineering program for large plants. But in 1969, a new Director chose to de-emphasize the big plant program.

<u>In the early 1970s the Congress disagreed with the administration's position that Federal effort for some processes should be phased out</u>

During its first 22 years, the Federal desalting program enjoyed support from both the legislative and executive branches of Government, and by 1973 OSW had developed several conversion processes which it considered commercially available and no longer in need of Federal development. Therefore, in fiscal year 1974, OSW, which had been receiving annual appropriations in the $25 million to $30 million range since 1967, began a drastic program reduction. Despite the welcomed prospect of reduced funding, Senate Interior and Insular Affairs Committee members disagreed with the Program Director's rationale that sales of desalting equipment justified phasing out further development.

OSW's rationale for reducing the program at that time was that certain processes had advanced through the research and development stage to the point where private industry could take over. OSW pointed to the commercial availability of distillation and membrane processes in particular.

According to the then OSW Director, the increased number of large-scale distillation plant sales justified speeding up the phase out of distillation projects. He cited as examples:

--Plants totaling 48 mgd were under construction in Hong Kong.

--An American company had bid successfully on desalting plants in the Virgin Islands totaling 4.5 mgd.

--Saudi Arabia was starting construction of a plant producing 37.5 mgd.

Based on numerous sales for municipal and industrial uses, OSW also considered two membrane processes--ED and RO--to be commercially available for brackish water desalting. Gillette, Wyoming, and Siesta Key, Florida, plus four Oklahoma cities had bought ED plants. In addition, two other cities and several industries had bought RO plants.

The Congress, however, took the position that a continuing Federal program was needed because the processes were too costly and the amount of freshwater produced from the saline water was too low.

During the period 1973-76, the administration's support of the saline water conversion program declined significantly, and in 1974 OSW was merged with the Office of Water Research to create OWRT. During this period, the Congress continuously authorized more funds for the program than requested by the administration.

According to most of the officials we talked with, the lack of an aggressive program with well-defined goals and objectives adversely affected the perspective that industry, researchers, and users had of the Nation's commitment to the program.

NEED FOR MORE DEFINITIVE MANAGEMENT PLANNING AND A CLARIFICATION OF THE FEDERAL ROLE

The problems and uncertainties in program management and direction discussed earlier in this report point out the need for more definitive management planning and a clarification of the Federal role.

Furthermore, the recent western drought highlighted the importance of new sources of water and rekindled program support in both the legislative and executive branches. This increased program interest is reflected in the Water Research and Development Act of 1978 (Public Law 95-467) signed by the

President on October 17, 1978. Title II of the act, for the first time, indefinitely extends the saline water conversion function within the Department of the Interior. Also, unlike previous bills which were passed specifically to provide for research and development in desalting technology, Public Law 95-467 considers desalting research and development as being just one means toward solving water management problems.

In view of the long-term program commitment, the increased funding authorized by Public Law 95-467, and the new emphasis OWRT plans to put on water reuse, recycling, and other aspects of water resources management, it becomes more important than ever before, that an effective saline water conversion program plan be developed and implemented in a timely manner. A comprehensive definitive saline water conversion program plan establishing specific objectives, milestones, and priorities for seawater, brackish water, and used water to be met by research, development, and demonstration is long overdue.

On May 12, 1978, during an early phase of our work, we wrote the Director, OWRT, suggesting ways to improve planning and management of the program. For example, specifying goals and milestones for measuring, monitoring, and guiding individual saline water conversion processes would provide program participants with badly needed management direction. With such goals, a manager could focus on the best way to utilize his funds and resources to achieve that goal within established timeframes. The goals would assist the administration and the Congress in measuring the progress, evaluating the effectiveness, and determining the future of program activities.

The Director responded favorably to our suggestions and said he had initiated efforts to establish a comprehensive, well-defined, goal-oriented plan addressing planning and management weaknesses. The Director recently told us that the plan should be completed in June 1979 and is expected to be operating by November 1979.

In addition, several factors need to be clearly defined. For example, the administration intends for conservation to be the cornerstone of the total water management concept--how does desalting fit in this picture? What role will it have in improving the Nation's water supply? Also, what will be the Federal Government's role in developing desalting technology? The areas where additional Federal Government aid to desalting research and development will be in the best interest of the U. S. taxpayer and where research and development should be handled by the private sector need to be clearly identified. OWRT officials recently told us that they plan to consult with the private sector to define Federal and non-Federal roles.

Another issue for clarification is how the water reuse emphasis in OWRT differs from the work EPA and other agencies involved in water research and development are doing. For example, there is a need to identify how much water will be reused and, more importantly from OWRT's perspective, to identify how much water reuse will require desalting technology.

CONCLUSIONS

We believe that a sound saline water conversion management plan should be developed and implemented. Further, there must be clear delineation for such things as the desalting role in total water management, the Federal Government's role in this effort, and the water reuse role intended for desalting.

Although incorporating these suggestions in a management plan will not necessarily guarantee program success, we believe that the approach will result in more effective program management--a key to ultimate program success. Such an approach should aid the administration and the Congress in (1) defining clearly the Federal Government's role in the desalting area, (2) measuring the program's progress, (3) evaluating its effectiveness, and (4) determining the priority of program activities. For example, going back 5 years, if the administration and the Congress were given a clearer picture of where the program was, relative to its ultimate program objective, perhaps the recent period of program uncertainties could have been averted.

RECOMMENDATIONS

We recommend that the Secretary of the Interior:

--Present to the Congress a well-defined, comprehensive, goal-oriented Saline Water Conversion Program plan which clearly identifies the program goals and objectives, plans for achieving the goals, and an assessment of the resources required.

--Assure, to the extent that resources are made available, the plan is effectively implemented and evaluated so that program objectives will be achieved.

AGENCY COMMENTS

The Department of the Interior officials generally agreed with the conclusions and recommendations in the report; however, they felt the report needed amplification on several points. We have made certain revisions to recognize Interior's comments and have included the comments in their entirety as appendix I.

United States Department of the Interior

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

MAR 6 1973

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

Dear ~~Mr. Eschwege~~ Henry:

This is in reply to your letter of February 26 in which you asked for our comments on a draft report to the Congress entitled, "Will Desalting Solve the Nation's Water Supply Problems? Probably Not, But it Can Help."

In a meeting with Mr. Carl Bannerman of your staff, officials of the Office of Water Research and Technology, and Deputy Assistant Secretary for Land and Water Resources, Dan Beard, we provided some comments orally. In general, we agree with the report and feel that it is substantially in support of work being carried out by this Department. Suggestions made in the report on the future conduct of the desalination program are worthy, and we will do our best to implement them.

The report refers to the need for a plan by which the program may be guided. This is the "road map" we recently completed and, while still in draft form, it should be ready for use later this year. The road map will, we expect, enable a carefully developed program to be formulated and followed by providing a coherent approach to specific targets with benchmarks for measuring accomplishments. Changes in our research and development efforts over the last year anticipated the road map and are consistent with it.

We feel it necessary to amplify several points that, in our judgment, are not satisfactorily discussed in the report. The first deals with numerous references and allusions to the high costs of desalinated water as compared with conventional water supplies. We feel the cost comparisons can be misleading since they are given without the necessary background.

Judgments made on the cost of water are more often made on the price of water, and price is often the sum of a number of political, social, and local economic practices. Even when an inquirer is more specific and indicates that cost is wanted and not price, the quotation will usually be the operation and maintenance (O&M) cost. O&M cost comparisons are valid when their limitations are understood and are for similar systems but can be misleading when comparing different systems. A high or low energy cost component of the O&M may be substantially cancelled by correspondingly low or high values of other factors which are not quoted in the O&M costs.

Meaningful comparisons of cost can only be made on the basis of total costs, but when this is done, the quoted costs are for conventional water systems which invariably are older and were constructed when costs and interest rates were lower; desalination plants' costs and interest rates, at current prices, are higher. It is more meaningful to compare new or proposed conventional plants and systems with new or proposed desalination plants and systems.

Comparisons that do not consider entire water supply projects result in misleading judgments. A fair comparison of conventional water versus desalinated water should include all costs from the point of raw water pickup to the point where processed water leaves the plant and sludge or brine is properly disposed of: acquisition and development of source, conveyance of the raw water to the treatment plant, rights-of-way and water rights, treatment plants, sludge disposal from a conventional plant, storage, site work, etc. All must be in the same-year dollars. Costs common to either of the alternatives, such as distribution, need not be included.

Natural water supplies, which are close-in, easily developed, and low cost, will grow even scarcer as the demand for water increases. Desalination is not normally an alternative when conventional sources are available, adequate, within reasonable transmission distance, and of easily treatable quality, but comparisons for these new projects will, in many cases, show desalination to be the preferred choice.

Cost may be becoming less the deciding factor as legal strictures assert greater precedence. Environmental regulations supersede cost considerations. Wastewater treated for reuse is being increasingly seen as a source of supply and becomes more desirable where discharge of effluents without extraordinary treatment would be unacceptable. But reuse in itself is an alternative for some water supplies and can offset like quantities of freshwater from conventional processes and sources. Desalination is the best means so far of converting wastewater into a reuseable resource. With growing shortages of easily developed water, public agencies having jurisdiction over water resources are less willing to share them so that water-short communities are left with only the costly alternatives. Water is basic to life and can command whatever price is necessary to get it.

The second point that needs to be discussed is the view that the distillation process is "energy intensive and not economically practical for domestic use." We believe we can show that for certain sites or problems, distillation could be the most feasible process when all factors are considered. It is well within our technical capabilities to produce a plant with energy consumption as low as the most idealized seawater reverse osmosis system. Distillation plants, coupled with power plants, can operate through the recovery of waste heat principally from cooling water, thus reducing thermal effluents while producing potable water or water for power plant reuse. In other cases, we feel it is possible to gain still greater economies through combining distillation with membranes when treating certain problem waters.

The report notes that the increasing number of sales of large distillation plants which occurred a few years ago was the justification to phase-out distillation R&D projects. Examples given were plants in Hong Kong, the Virgin Islands, and Saudi Arabia. It should be pointed out that aside for small special purpose plants for the pharmaceutical and chemical industries, and those located on ships and oil drilling platforms, there is only one large scale distillation plant in operation in the continental United States. The reason for that should not be attributed to the cost of energy or to the fact that distillation plants are energy intensive. We have not had a demonstration of a distillation plant designed for high production at low cost. All plants which have been built by OSW were designed as R&D tools and operated as pilot plants to produce data. Distillation, generally the preferred technology in the rest of the world, is heavily based on work which had been done by the Office of Saline Water. Distillation technology had not yet been established in the United States when the program was cut back. The leadership that had been provided by the U.S. was taken over by non-U.S. manufacturers abroad who continued to refine the process and subsequently have taken the lead in sales.

The road map, referred to above, will be used to help OWRT take a fresh look at this technology with today's realities in mind. A less than enthusiastic view of distillation in the report could act to inhibit our new look R&D program and seems to us to be a prejudgment. Limited work presently underway is very promising and offers definite possibilities for improving the process. Additional selective R&D could lead to domestic applications as well as to regaining the edge necessary to restore the U.S. to a leadership position in the world market.

Our last point is that we feel the report gives only partial recognition to the strides made in redirecting the desalination programs of OWRT by this Department, the Administration, and the Congress. The program has had the full support of this Department, and we are proud of the turn-around that has been made. The cut-back in the saline water program from approximately $27 million in 1973 to approximately $4 million in 1974, and bottoming out at nearly $3 million in 1976, created a program sag which naturally slowed down our efforts. The program is climbing back to respectable levels. Our budget request for saline water conversion R&D for 1980 exceeds $12 million, and is approximately $1.5 million more than the amount requested in FY 1978. This increase occurred at the same time that the Department of the Interior took substantial cuts elsewhere in its budget. We believe that this is a positive sign that the program has Departmental and Administration support and that we are backing a strong, well-planned and well-managed desalination program.

Notwithstanding these comments, we commend the report for its overall supportive position.

Sincerely,

SECRETARY

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