Chapter 3
Domestic Applications

The United States has about 750 desalination plants (with individual capacities greater than 25,000 gpd) with a combined capacity of about 212 mgd, or, about 1.4 percent of the 15 billion gallons of freshwater consumed each day for domestic and industrial purposes. Between 70 percent and 80 percent of this capacity is provided by reverse osmosis plants located in 44 States. Although this country ranks second in the world in the number of desalination plants, it ranks fourth in capacity with almost 10 percent of world production. The largest non-Federal plant in the United States is the RO plant operated by the city of Cape Coral, Florida (33). About 70 percent of the desalination plants in this country are used for industrial purposes. There are also more small RO units (i. e., producing less than 25,000 gpd) than large plants in the United States, but their combined capacity is relatively low. These units are used by hospitals, small industries, pleasure boats, merchant ships, off-shore drilling rigs, and the military.

Desalination technologies can be cost-effective not only to obtain freshwater from brackish and seawater, but also to remove contaminants from drinking water supplies, sewage wastewater, industrial feedwater and wastewater, and irrigation drainage water. In fact, desalination technologies may be more widely applied in this country to decontaminate water than to remove salt. As problems and concerns about water quality increase in the future, the use of desalination technologies, along with other water- treatment techniques, will increase. Legal, environmental, and sociopolitical factors in some areas of the country may also encourage the desalination of brackish groundwater, rather than transfer of surface waters from other counties or States. Therefore, desalination should be included as a viable option in any evaluation of water-supply alternatives.[2]

The current and potential uses of desalination technologies for desalination and water treatment are evaluated in the following discussion.

[1] There are many tens of thousands of desalination plants with individual capacities of less than 25,000 gpd. The combined capacity of these smaller plants is probably small relative to the combined capacity of larger plants.

[2] Over the long-term desalination could become very important if predictions of global warming and other climate modifications resulting from increased levels of atmospheric carbon dioxide prove to be true. For example, increased desertification could create severe water shortages in semiarid and warmer regions of the world, and elevated sea levels could increase the degree of saltwater intrusion in many coastal aquifers.

INDUSTRIAL FEED- AND PROCESS-WATER TREATMENT

Industry consumes about 8 billion gallons of freshwater per day (69). Although water requirements vary significantly from one use to another, high-quality water is needed for manufacturing many products including textiles, leather, paper, pharmaceuticals and other chemicals, beverages, and dairy and other food products. In fact, the majority of desalination capacity in the United States is used by industries to treat feedwater, processwater, or wastewater prior to its discharge or reuse.

Water treatment for different industries varies, but typically involves conventional water treatment techniques (e. g., filtering, softening, etc.). More sophisticated water treatment systems used by industries incorporate RO, ED, IX, or a combination of these and other treatment processes. For example, ultra-pure, deionized water is used by the electronics industry for manufacturing integrated circuits and pharmaceuticals, and for medical applications, electroplating, electric power ***generation,*** and some petroleum processes (42,55).

INDUSTRIAL WASTEWATER TREATMENT

There are over 200,000 industrial facilities and commercial establishments that discharge an estimated 18 billion gallons of wastewater daily. About three-fourths of this wastewater is discharged into adjacent waterbodies, while the remaining quarter is discharged into municipal sewage treatment systems (52). Desalination technologies can be used to remove and concentrate contaminants in wastewater, thereby reducing potential problems associated with its disposal or reuse.

Although not widely used now for treating industrial wastewater, the attractiveness of RO, ED, and other desalination techniques will probably increase as regulatory restrictions on wastewater discharges become increasingly stringent under EPA's National Pollutant Discharge Elimination System. This trend will also intensify as the cost of membrane processes decreases. Especially in areas where water supplies are limited, industries will increasingly treat and reuse their wastewater (42,55). In some states, "zero discharge' requirements have forced some industries to use VC distillation in combination with RO to minimize or eliminate wastewater discharges.

In some cases, industries (e. g., photographic, electroplating, pulp and paper, etc.) may use desalination technologies to recover valuable chemicals. However, recovery of potentially useful material from wastewater is often not economic because of low material concentrations in the wastewater. Furthermore, the adverse economic effects of faulty wastewater treatment and recovery processes can be significant. If recovery is practiced, industries generally favor segregating, treating, and reusing waste streams from individual processes rather than treating the combined flow from all processes. Whether or not desalination technologies would be used in such recovery processes would depend primarily on the nature of the waste streams (55).

DRINKING WATER PRODUCTION

About 140, or 20 percent, of the desalination plants (with capacities of greater than 25,000 gpd) in the United States are used to treat brackish groundwater for municipal drinking water supplies. Florida alone has a total of about 70 such plants.[3] Most of these systems rely on RO. With future improvements and cost reductions in membrane technologies, desalination will become increasingly attractive for supplying drinking water to some small (e.g., with populations of 10,000) to midsized (e.g., with populations of a few hundred thousand) communities in the West and along our coasts where brackish groundwater supplies are often adequate and waste concentrate disposal is economically feasible.[4] However, high costs may limit the use of seawater desalination in the United States for some time to come.

Many large metropolitan areas in the United States (i.e., with populations of greater than a million) have fewer problems obtaining adequate supplies of drinking water at reasonable costs, than smaller communities. There are several reasons for this. First, there are significant economies-of-scale associated with developing large supplies of water from conventional sources (e.g., reservoirs, freshwater aquifers, etc.) even if this involves transporting the water over long distances, and treating it prior to use. These costs are normally less than comparable costs associated with desalinating brackish groundwater. Second, many metropolitan areas are located on major rivers or near larger surface supplies of freshwater. Finally, many larger cities have factored future water supply needs into long-term growth scenarios,

In the West, rapidly growing metropolitan areas are having increasing problems finding freshwater as available surface and groundwater supplies are

[3]Florida also has another 42 municipal plants with production capacities of less than 25,000 gpd.

[4]These numbers are based in part on an unpublished evaluation of potential sites for demonstrating different desalination techniques conducted by the Office of Water Research and Technology in the late 1970s. A 1 mgd plant will supply the water needs for about 7,000 people using just under 150 gpd over a typical year. In some areas of the country and during hot, dry weather domestic water peak demand may be another 30 percent higher (26).

developed for other purposes. Some cities are gaining the rights to additional water through the purchase of irrigated farmland. Some, such as Tucson, have implemented conservation programs. Many cities reuse sewage water from their municipal treatment plants for landscape irrigation; several cities recharge their drinking water aquifers with well-treated sewage water.

Desalinating Existing Water Supplies

About 1,000 smaller municipal water systems and probably many more private systems in arid or semi-arid regions of the country rely on water supplies—typically groundwater—with concentrations of salt and other dissolved solids (e. g., magnesium/calcium sulfates and carbonates) that can reach 2,000 or 3,000 ppm. In many cases this water is not treated prior to delivery (1 1,36). Most brackish groundwater is especially suited to desalination because it usually has low levels of naturally occurring organics, and it tends to be of more uniform quality than surface waters (36).

Desalination costs decrease significantly as the capacity of desalination plants increases to a few million gallons per day.[5] For some small to mid-size communities with ample supplies of brackish groundwater, the use of desalination technologies will become increasingly attractive for three reasons. First, the costs of membrane processes will probably continue to decrease over the next decade or so in response to technical and nonstructural improvements, and continued industry competition. Second, the costs of developing conventional supplies of freshwater will increase as nearby sources are used for other purposes, and environmental and legal complications increase. For example, in some parts of southern Florida it is now more economical to desalinate and treat relatively small volumes of brackish groundwater using RO or ED than to import fresh surface water from inland areas (19). Groundwater desalination also avoids potential political problems associated with transferring water from other political jurisdictions. And third, increasingly stringent drinking water regulations will probably require increased levels of water treatment,

For small towns with populations of a few thousand people, water treatment costs (whether conventional processes or desalination) are unusually high. Furthermore, many small towns with poor quality drinking water are located in economically depressed areas, leaving them unable or unwilling to pay for water treatment. Some economies-of-scale may be realized if several adjacent communities jointly treat their water at a common plant. Smaller utilities (i.e., serving fewer than 500 customers) may be eligible for technical and financial assistance from the Federal and some State governments. Extremely small towns and those families with private wells may have to resort to private point-of-use treatment or bottled water if existing drinking water supplies are inadequate or of low quality.

Smaller desalination plants may be used for water supplies on oil rigs and at remote construction sites in coastal areas of the United States to supply drinking water. Vapor compression units could be used for seawater distillation, and RO and ED units for desalinating groundwater from brackish aquifers or seawater wells.

Incrementally Developing Drinking Water Supplies Via Desalination

Many rapidly growing communities, particularly mid-sized coastal communities, are now experiencing or anticipate drinking water shortages as their populations grow. In many cases small increments of capacity from conventional water sources (e. g., small diversions, additional wells, etc.) can be developed relatively cheaply. However, in other cases developing conventional supplies may require developing large-capacity reservoirs. A large increment of capacity may have lower costs per volume of water, but the full capacity may not be needed until many years later. In some cases, surface water supplies can not be developed soon enough to meet rising demands. If brackish water supplies are available, it may be more economical to develop several increments of desalination capacity over time, rather than developing larger than necessary water supplies from conventional sources.

[5]Domestic water use in the United States is about 120 to 150 gallons of water per person per day. So, a plant producing 3 mgd would supply the water needs of about 20,000 people,

Supplementing Water Supplies During Droughts Via Desalination

During droughts and other unpredictable emergencies that might occur once every 10 or 20 years, drinking water supplies can be limited for many months. Unfortunately, reserve capacity, whether it is provided through desalination or conventional sources, is very expensive if it is used only during emergencies or when water supplies fall below a critical level (but before an emergency situation arises).[6] Conservation seems to be the most appropriate and economical method for dealing with most unpredictable, short-term shortages. Although conservation does provide some elasticity in water demand, the more water that is conserved during normal use, the less elastic the demand will be during times of shortage. In some cases cross-connections with neighboring communities can alleviate any short-term water disruptions.

Further Treatment of Surface Water Supplies

With increasing population and industrial growth in this country over the last 200 years the quality of surface supplies has gradually declined, thereby increasing the need to treat water before it is used. In fact, the 1986 amendments to the Safe Drinking Water Act will require increasing levels of water treatment to meet more stringent water quality standards now being developed by EPA. In response to these regulations public utilities will be increasing their use of RO, ED, and perhaps IX (in addition to, or in place of, other conventional water treatment processes) to remove dissolved minerals, heavy metals, low-molecular-weight dissolved organics (some of which are transformed to trihalomethanes, or THMs, during chlorination), and microorganisms.

Decontaminating Groundwater

About 50 percent of this country's population uses groundwater for all or a portion of its potable water. Recent studies show that groundwater can easily be contaminated by migrating chemicals from a variety of sources including landfills, surface impoundments, septic tanks and cesspools, injection wells, mining activities, livestock feed lots, and the use of pesticides, herbicides, and fertilizers on agricultural lands. Although only an estimated 1 to 2 percent of the Nation's groundwater is known to be contaminated with potentially toxic chemicals (51), the levels of contamination maybe somewhat higher near large metropolitan centers, industrial areas, and agricultural regions. In addition, groundwater contamination is likely to increase with time as previously disposed of chemicals continue to spread throughout our aquifers.

In the past when groundwater has been found to be contaminated, water has often been acquired from uncontaminated sources. However, as different sources of clean water are used for other purposes RO, ED, and perhaps IX, may be used increasingly to remove organic and inorganic contaminants from groundwater supplies.

[6]For example, in a New York City study of options for supplying water during periodic droughts it was assumed that a 300 mgd desalination plant would begin operating when the water supply in the city's reservoirs dropped below 50 percent of their total storage capacity. The plant would stop operating when the storage capacity reached 80 percent. Even under these conditions the plant would be used only about 20 percent of the time at a very high cost (53).

MILITARY USES

The U.S. Navy has used shipboard distillation units for drinking water and boiler feed water for the last several decades. However, RO units are now being tested on several classes of ships in our fleet. The Navy is also evaluating the technical and economic feasibility of using RO instead of, or in combination with, ion exchange for the pier-side production of potable water and boiler feedwater at some of its land-based facilities. A preliminary evaluation indicates that RO could be the preferred alternative at 10 of 15 naval bases studied (45). Small 25 gpd RO units operated with hand pumps are now being developed by the Navy for use on its life rafts (88).

Both the Army and the Marine Corps have upgraded the water production capabilities of some field and hospital units with the acquisition of 900 skid-mounted RO units with water production capacities of about 15,000 gpd. In addition, the Army is now developing a trailer-mounted 70,000 gpd unit. These units are capable of processing untreated freshwater, brackish water, seawater, and water contaminated with nuclear, biological, and chemical warfare agents. Along with RO, these units incorporate other possible treatment processes including coagulation of suspended material, filtration, disinfection, and ion exchange. The smaller units can be dropped by parachute; the larger units can be airlifted or transported on a ship. The Army has also developed a water purification barge consisting of two 300,000 gpd RO units capable of treating brackish or seawater and pumping the treated water ashore while anchored 2,000 feet offshore (44).

POINT-OF-USE/POINT-OF-ENTRY, OR AT-HOME, WATER TREATMENT

About 44 million people in the United States obtain their drinking water from private water supplies, the bulk of which comes from wells. Some of this well water, especially in arid and semiarid regions of the United States, is brackish. Many small water supply systems and private wells are also contaminated with bacteria (49). The occurrence of potentially hazardous industrial and agricultural chemicals in drinking water aquifers is also on the increase (51). For many small public and private systems with brackish (or contaminated) drinking water, treating water with RO or ED at a centralized facility may be either impractical or prohibitively expensive.

Alternatives to treating contaminated groundwater at a centralized plant include developing new wells or surface water sources, connecting to neighboring water supplies of higher quality, hauling water from nearby sources, purchasing bottled water for drinking and cooking, point-of-entry (POE) treatment as water enters the home, or point-of-use (POU) treatment of drinking and cooking water with small distillation or RO units in the home (60). In this latter area, the Water Quality Association estimated that 1985 residential sales of POU treatment devices at more than $700 million (85). Considering the increased level of public concern about drinking water quality, it is quite likely that POU, and perhaps POE, water treatment will increase in the coming years.

Ion exchange water “softeners’ have been used for many decades for POE treatment of water containing large quantities of dissolved calcium and/or magnesium. With these units the calcium and magnesium is replaced by sodium as the water flows through the chemical resins in the water softener; however, the total mineral content of the water remains the same. Soft water reduces the amount of calcium carbonate precipitation inside a home’s water pipes and faucets. However, there is some question about possible adverse health effects (e. g., increases blood pressure) associated with drinking high-sodium water. Whole-house water softening units cost between $300 and $1,000 (depending on their capacity), plus the cost of installation and periodically changing the resins.

Dissolved minerals and many other inorganic/organic contaminants can be removed from drinking/cooking water by RO or distillation of the tap water. These counter top, under-the-sink, or stand-alone units typically cost from about $80 to $800, depending on the sophistication and capacity of the unit (which typically range from 5 to 15 gpd). Most contaminants and dissolved solids can be removed by RO units; however, the effectiveness of the units decreases with time. These units require from 5 to 10 gallons of water for each gallon of water processed. Water production costs range from .$0.06 to $0.25 per gallon. small distillation units ako remove most contaminants and dissolved solids. Electricity costs for distillation typically run about $0.25 per gallon.[7]

[7]After purchasing the unit, the monthly cost for a family of four using two gallons of water per day for drinking and cooking at a cost of $0.25 per gallon would be about $1 5/month. Bottled water generally costs about $1 per gallon, or about $60/month for a family of four. In Washington, D.C. municipal drinking water for a family of four costs about $24/month.

Granular activated carbon (GAC) water filters can be used for POE treatment, or attached to a faucet spigot for POU treatment of cold water. GAC filters will remove some particulate material and many organic contaminants (especially, low-molecular weight, volatile organics, including tri-halomethanes) and chlorine from water.[8] But, GAC filters have little, if any, effect on salt and other dissolved minerals and inorganic contaminants.[9] Faucet filters cost about $20 per unit; falter elements that should be replaced on a monthly basis cost about $5 per element. Under-the-sink and whole-house GAC filters can cost as much as a few hundred dollars depending on their size; replacement frequency depends on the filter size and the level of water use.

All types of POU treatment units require some periodic cleaning and/or parts replacement, which is usually performed by the homeowner. The lack of control over monitoring for treatment effectiveness and assuring routine maintenance is a major concern that regulatory agencies have about POU treatment. In fact, EPA regulations (for volatile organics) state that POU treatment systems may be used by public water systems only on a temporary basis (or perhaps over a longer term under an extended EPA exemption) to avoid unreasonable public health risks from polluted water. But, POU treatment can be used at the discretion of homeowners who are particularly concerned about the quality of their water. In fact, the market for POU water treatment equipment is growing at a rate of about 15 to 20 percent per year.

Where centralized water treatment costs are prohibitive, EPA does allow a utility to install water treatment equipment in homes or commercial buildings at the water's POE. However, it is presently unclear how much POE treatment will be used in the future. GAC may be used to remove dissolved organic contaminants and chlorine, but GAC has little effect on other types of contaminants, Distilling or treating all incoming water with RO is prohibitively expensive; RO also produces a great deal of waste water which would need disposal. Furthermore, water with a very low mineral content, regardless of the technique used, can corrode metal pipes. IX is now only used in homes for water softening. All POE equipment would also require periodic maintenance by the utility operating the water system.

‘Breathing volatilized organics while showering is thought to be a major exposure pathway for low molecular weight organics in water. If funher research proves this to be the case, then POE water treatment with GAC may become increasingly important.

[9]GAC provides surfaces for bacterial growth when water is not running through the filter. Although considerable bacterial growth can occur, pathogens are apparently not released at infectious doses. In fact, in a 2-year EPA study people using GAC filters did not show any significant increase in gastrointestinal illnesses over non-users. However, it is recommended that users run water through GAC filters for 30 seconds prior to water use to flush out any bacteria (60).

MUNICIPAL WASTEWATER TREATMENT

Wastewater from sewage treatment plants is one of the largest potential sources of water where fresh-water supplies are limited. In fact, about 60 to 90 percent of potable water delivered to city residents in the United States is discharged into sewage collection systems. After it has been treated to remove contaminants and to kill pathogens, the water can then be reused for potable purposes, agricultural and landscape irrigation, industrial reuse, and streamflow augmentation.

If municipal wastewater were used for ground-water recharge or directly reused for potable purposes, RO or ED could be used to remove the 200 to 500 ppm of salt and other dissolved solids that are typically added to water by domestic use. Other treatment processes that could also be used include: chemical addition, flocculation, lime clarification and recarbonation, equalization, multimedia fitration, ammonia stripping, granular activated carbon adsorption, ultra-filtration, and disinfection with chlorine and/or ozone. The reclamation of municipal wastewater for agricultural, industrial, and other municipal uses is supported by the Federal Government[10] as well as some States.

[10]Under Section 201 of the Clean Water Act EPA encourages the construction of revenue-producing facilities that reclaim municipal wastewater. In addition, under Section 1444 (a)(2) of the Safe Drinking Water Act EPA can support projects investigating and demonstrating the health implications involved in the reclamation, recycling, and reuse of waste waters for potable purposes. For example, EPA contributed $7 million to support Denver's $30 million wastewater treatment test facility and research program.

The potential for advanced treatment and reuse of municipal wastewater was recognized in the early 1960s (15). For example, the City of New York estimated that 100 million gallons of potable water could be obtained by further treating effluent from an existing secondary sewage treatment plant (16, 53). Treated wastewater from sewage has been used as potable water in emergencies in Chanute, Kansas, and Ottumwa, Iowa, and on a continuous basis since the late 1960s by the city of Windhoek, Nambia (48). Whether reclaiming municipal wastewater is economical would depend largely on site-specific conditions.

Indirect reuse of treated municipal wastewater for potable purposes is becoming increasingly attractive to many municipalities, especially in the West. For example, in 1977 the Orange County Water District began injecting treated waste water from a sewage treatment plant into its water supply aquifer to prevent the intrusion of saltwater, and to allow indirect reuse of the treated water. In addition to other treatment processes, the District uses a 5-mgd RO plant as an integral part of its overall 15 mgd treatment and injection operation (l). There are many other communities throughout the country that indirectly reuse some treated wastewater which is mixed with stream flows and storm runoff. These combined flows enter drinking water reservoirs or specially constructed basins where the water percolates into drinking water aquifers.

Treatment and direct reuse of municipal wastewater for potable purposes is also being explored. In 1985 the Denver Water Department completed construction of a l-mgd treatment facility, which includes RO, to demonstrate direct wastewater reuse for potable purposes. Current treatment costs are about $2.50 per 1,000 gallons. If this facility can be operated successfully from a health, safety, and economic standpoint over the next 4 to 8 years, Denver will consider building a full-scale facility for treating up to 100 million gallons of wastewater per day. This could provide over 15 percent of Denver's water needs (40,46). Many countries and cities throughout the United States are closely tracking Denver's experiences. However, significant public reluctance to drink treated wastewater may delay direct reuse.

DESALINATING IRRIGATION WATER

About 81 percent of all water that is consumed in the United States goes for irrigation, most of it in the West. Each time river water is used for irrigation salt is leached from the soil as the excess water migrates into surface and groundwater supplies. In many cases, the salty water is intercepted by subsurface drainage systems, which may empty back into rivers. More salt is added to many rivers in the West from natural, salty seeps. For example, the salinity of the Colorado River increases from about 50 ppm in its headwaters, to approximately 750 ppm at Hoover Dam near Las Vegas, NV, to about 850 ppm at Imperial Dam near Yuma, AZ. High concentrations of salt in irrigation water typically lead to reduced crop yields; poor germination of seeds; stunted plant growth; increased fertilizer requirements; the necessity to plant less profitable, more salt-tolerant crops; and the eventual loss of farmland due to salt build-up (30).

In theory, irrigation water could be desalinated (prior to use) to improve its quality and to increase crop yields. Studies of hypothetical situations conducted in the late 1960s and early 1970s indicated that the market value of crop yields did increase significantly as the salinity of the irrigation water decreased. For example, in one study crop yields ranged in value from about $270 per acre-foot for low quality water (i.e., 1,500 ppm dissolved solids) to about $870 for water of highest quality (i. e., 50 ppm). However, desalination costs ranged from about $500 per acre-foot for 1,500 ppm water to $1,100 per acre-foot for 50 ppm water, or about $1.60 to $3.50 per 1,000 gallons. In the vast majority of cases the costs of desalination greatly exceeded the calculated value of increased crop yields (38).[11]

[11]The estimated cost of desalinating irrigation water depends largely on assumptions used in the calculations. Some papers written in the late 1960s and early 1970s indicated that the cost of desalinated water would be "at least an order of magnitude greater than the value of the water to agriculture. Other papers were much more optimistic. Part of this optimism was usually reflected in overly optimistic assumptions used in calculating hypothetical costs and benefits (79,93). For example, some models assumed low cost power from dual-purpose nuclear plants, Federal financing at interest rates of 3 3/4 percent,

In the early 1970s research conducted in the San Joaquin Valley, California, demonstrated the technical feasibility of using ED and RO to desalinate agricultural drainage water (from irrigation operations) containing 3,000 to 7,000 ppm of dissolved solids (38). Over the last few years the California Department of Water Resources has continued studying different alternatives for treating agricultural drainage water at a test facility at Los Banes, in the San Joaquin Valley (88). Current estimates for costs of desalinating agricultural drainage water, including disposal, range from about $2 to $4.50 per 1,000 gallons (3). These costs greatly exceed present costs of irrigation water in the West which typically range from less than $0.01 to about $0.15 per 1,000 gallons. (See box B in ch. 4.)

In another related area, the Westlands Water District in the San Joaquin Valley is now exploring the technical and economic feasibility of using biological treatment techniques to remove selenium, and other contaminants (but not salt) from some of its agricultural drainage water that formerly flowed into Kesterson Reservoir, a wildlife refuge (92). The centerpiece of this District-financed, 4-year, $6.6 million drainage water treatment project, is a 0.5-mgd prototype selenium removal plant that is scheduled to operate for 18 months beginning sometime in 1989. The treated water will be disposed of in concentrate ponds operated by the State of California to produce solar energy. According to present plans, untreated irrigation drainage water will also be injected at a rate of 1 mgd into saline aquifers located at a depth of about 5,000 to 6,000 feet (27).

To meet our treaty obligations to Mexico, the Bureau of Reclamation is constructing a 72-mgd RO plant at Yuma, AZ, to desalinate irrigation drainage water before it is discharged into the lower Colorado River for later use in Mexico. This plant is described in more detail in chapter 8 on international involvement in desalination.

Because of the large volumes of water required for normal open-field irrigation, desalinating salty river water for irrigation purposes, or desalinating irrigation drainage water for agricultural reuse is generally not economical at this time in the United States, except possibly for high-value crops grown in greenhouses.[12] In other words, it costs more to grow crops under typical agricultural conditions with desalinated water than they are worth on the market. In most cases, it is more economical to import crops from regions of the country where water is naturally more abundant.[13] Because of the many water-rich agricultural regions of the United States, desalinating irrigation water will probably not be economical for agriculture in this country for the next few decades (at the very least), except in highly specialized situations. It is also doubtful whether most irrigators in the West can afford to develop new surface water supplies given the current market conditions without some level of government assistance.

If the cost of developing new water supplies from other surface sources greatly exceeds the cost of desalinating irrigation drainage water, it may be economical for some metropolitan areas to desalinate and decontaminate irrigation drainage water for potable purposes. For example, several municipalities in southern California are now considering the possible use of treated agricultural drainage water to supplement existing drinking water supplies.

desalting facility lifetimes of 30 years, 100-year lifetimes for associated facilities, and irrigation efficiencies and crop yields that were higher than average.

[12] Using desalinated water for open field irrigation is generally not economical at this time anywhere else in the world. However, desalinated water is used for irrigation purposes in some areas of the world (e.g., Saudi Arabia). In most of these situations the water is subsidized by the government for reasons of national security and economic independence.

[13] Researchers in this country and overseas are cultivating naturally salt-tolerant plants, developing salt-tolerant plants through plant breeding and biotechnology, and developing marketable products from these plants. Although such efforts may marginally increase the potential use of high salinity river water or irrigation wastewater, the full potential of such research is not known at this time.