Volume 2

Chapter 6 Desalination

Sweetwater Authority customers benefit from this desalination facility that treats brackish or saline groundwater. About 24 groundwater desalting plants operate in California and provide water for municipal purposes. The total capacity of these plants is approximately 79,000 acre-feet per year. (DWR photo)

Chapter 6 *Desalination*

Desalination is a water treatment process for the removal of salt from water for beneficial use. Desalination is used on brackish (low-salinity) water as well as seawater. In California, the principal method for desalination is reverse osmosis. This process can be used to remove salt as well as specific contaminants in water such as trihalomethane precursors, volatile organic carbons, nitrates and pathogens.

Only desalination for municipal purposes, that is, desalination used by public and private water agencies is considered in the following discussion. Desalination by industrial and commercial entities is not considered since those applications of desalting generally involve treating fresh water to a higher standard to meet a specific need. Desalination plant capacity for this paper is expressed in terms of the fresh or potable water capacity of the plant. Total costs are given in dollars per acre-foot of fresh potable water produced.

Current Desalination in California

Desalination began in California in 1965. The last decade has seen a rapid rise in installed capacity. This is primarily due to dramatic improvements in membrane technology and the increasing cost of conventional water supply development. Currently there are about 24 desalting plants operating in California that provide water for municipal purposes. The total capacity of these plants is approximately 79,000 acre-feet per year. These include 16 groundwater, one surface water, and seven seawater desalination plants.

In recognition of the increasing use of desalting in California, Assembly Bill 2717 (Hertzberg, Chapter 957, Statutes of 2002) called for DWR to establish a Desalination Task Force to look into:

- Potential opportunities for desalination of seawater and brackish water in California
- Impediments to using desalination technology
- What role, if any, the State should play in furthering the use of desalination

The Task Force completed its mission in October 2003 after six months of deliberations. DWR prepared recommendations (see Box 6-1) with significant input from the Task Force comprised of representatives from 27 organizations.

In November 2002, California voters passed Proposition 50, the Water Security, Clean Drinking Water, Coastal and Beach Protection Act of 2002. Chapter 6(a) of that proposition authorized $50 million in grants for brackish water and ocean water desalting projects. In the 2005 funding cycle, grants totaling $25 million have been awarded for research and development studies, pilot and demonstration projects, full-scale plant construction, and feasibility investigations.

Currently there are six new groundwater desalting plants and one plant expansion in the design and construction phase for a total of about 29,500 acre-feet per year in new capacity. There are no seawater desalting plants in the design and construction phases at this time.

Potential Benefits of Municipal Desalination in California

From San Francisco Bay to San Diego, there are numerous studies investigating the feasibility of desalting seawater.

Northern California – In the San Francisco Bay Area, agencies are jointly funding planning studies for a seawater desalination capacity of approximately 120,000 acre-feet per year. In Marin County, the Marin Municipal Water District is studying the feasibility of constructing a 15,000 acre-feet per year seawater plant. A pilot plant is now in operation to test pretreatment processes.

Central California – In the Monterey Bay area, the SWRCB has mandated a 10,730 acre-feet per year reduction in groundwater pumping from beneath the Carmel River. To replace this water and provide for water needs outside of the Monterey Peninsula area there are two competing proposals to construct regional seawater desalination facilities. Both of the proposals are for plants of about 20,000 acre-feet per year in capacity. The city of Marina is planning an expansion of their seawater desalting plant and the cities of Santa Cruz and Cambria are investigating the feasibility of using seawater desalting.

Southern California – In November 2001, the Metropolitan Water District of Southern California (MWD) issued a Request for Proposal (RFP) under its Seawater Desalination Program. The current objective is 150,000 acre-feet per year of sustained production. Through a competitive process, selected projects will be eligible for financial assistance up to $250 per acre-foot. Currently, five projects are under consideration that, if constructed, could produce about 127,000 acre-feet per year. As lead agency, the city of Huntington Beach is circulating an Environmental Impact Report for a 50,000 acre-feet per year seawater desalting facility. The San Diego County Water Authority is investigating the feasibility of a 50,000 acre-feet per year seawater desalting facility near the San Onofre power plant.

The benefits of desalination are:

- Increase in water supply
- Reclamation and beneficial use of waters of impaired quality
- Increased water supply reliability during drought periods
- Diversification of water supply sources
- Improved water quality
- Protection of public health

Box 6-1 Desalination Task Force Recommendations Summary (2003)

The Task Force recommendations are organized into three categories: General Recommendations, Energy and Environment Related Recommendations, and Planning and Permitting Related Recommendations.

General Recommendations:

1. Since each desalination project is unique and depends on project-specific conditions and considerations, each project should be evaluated on a case-by-case basis.
2. Include desalination, where economically and environmentally appropriate, as an element of a balanced water supply portfolio, which also includes conservation and water recycling to the maximum extent practicable.
3. Ensure equitable access to benefits from desalination projects and ensure desalination projects will not have disproportionate impacts particularly to low-income and/or ethnic communities.
4. The State should create mechanisms that allow the environmental benefits associated with transitioning dependence on existing water sources to desalinated water to be realized.
5. In conjunction with local governments, assess the availability of land and facilities for environmentally and economically acceptable seawater desalination.
6. Results from monitoring at desalination projects should be reported widely for the broadest public benefits. Encourage opportunities to share information on operational data. Create a database and repository for storing and disseminating information.
7. Create an Office of Desalination within the Department of Water Resources to advance the State's role in desalination.

Energy and Environment Related Recommendations:

8. Ensure seawater desalination projects are designed and operated to avoid, reduce or minimize impingement, entrainment, brine discharge and other environmental impacts. Regulators, in consultation with the public, should seek coordinated mechanisms to mitigate unavoidable environmental impacts.
9. Identify ways to improve water quality by mixing desalinated water with other water supplies.
10. Where feasible and appropriate, utilize wastewater outfalls for blending/discharging desalination brine/concentrate.

continued

The primary benefit of desalting is to increase California's water supply. Seawater desalting creates a new water supply by tapping the significant supply of feedwater from the Pacific Ocean.

Table 6-1 shows, as of 2005, the number and capacity of groundwater and seawater desalting plants in operation, design and construction, and planned or projected for construction. The projects in the planned and projected capacity are assumed to be operational by 2030. While not all of these are likely to be constructed, it is assumed that they, or an equivalent number, will be operational by 2030.

In addition to the above, there is additional new water supply possible from desalting oil field production water in the San Joaquin and Salinas valleys and brackish agricultural drainage water in the San Joaquin and Imperial valleys. These are not quantifiable at present.

Desalting wastewater increases the range of beneficial uses for which recycled municipal wastewater can be used. Of the 1,200,000 acre-feet per year (see the Recycled Municipal Water narrative) in reclaimed water projected for 2030, approximately 150,000 acre-feet per year will include desalting in the treatment process.

Desalting groundwater allows groundwater of impaired quality to be adequately treated for potable use. Approximately 170,000 acre-feet per year in capacity is currently planned or projected to be constructed. Groundwater desalting may or may not be a new water supply depending upon the water portfolio or balance in the area or region where it occurs. It is, however, providing water from a source that is not currently being used for beneficial purposes.

Potential Costs of Desalination

Recent technological advances in various desalination processes have significantly reduced the cost of desalinated water to levels that are comparable, and in some instances competitive, with other alternatives for acquiring new water supplies. Desalination technologies are becoming more efficient, less energy demanding and less expensive. Significant progress and innovation in membrane technologies such as reverse osmosis (RO) has helped reduce costs. The RO process has been proven to produce high quality drinking water throughout the world for decades.

The estimated capital cost to achieve 415,000 acre-feet per year in increased seawater desalting capacity is about $2 billion. Table 6-2 shows the range in total unit water cost

Box 6-1 continued from previous page

11. Compare reasonable estimates of benefits, costs and environmental impacts for desalination with those for other water supply alternatives realistically available to that area.
12. Recognizing the importance of power costs to the costs of desalination, consider strategies that will allow project sponsors to access non-retail power rates.
13. Clarify the applicability of non-retail energy pricing for desalination facilities.
14. Study the energy intensity and rates currently paid for energy used to provide water from various sources including desalination.
15. Study the potential for developing renewable energy systems in California, in conjunction with desalination implementation strategies.
16. Identify ways that desalination can be used in a manner that enhances, or protects the environment, public access, public health, view sheds, fish and wildlife habitat and recreation/tourism.

Planning and Permitting Related Recommendations:

17. To improve communication, cooperation, and consistency in permitting processes, encourage review processes for each desalination project to be coordinated among regulators and the public.
18. Evaluate all new water supply strategies including desalination based upon adopted community General Plans, Urban Water Management Plans, Local Coastal Plans, and other approved plans that integrate regional planning, growth and water supply/demand projections. Environmental reviews should ensure that growth related impacts of desalination projects are properly evaluated.

Table 6-1 Desalting in California for new water supply

	Plants in Operation		Plants in Design & Construction		Plants Planned or Projected	
Feedwater Source	No. of Plants	Annual Capacity	No. of Plants	Annual Capacity	No. of Plants	Annual Capacity
Groundwater	16	79,100	6	29,500	6	61,700
Seawater	7	1,500	1	300	13	415,100
Total	23	80,600	7	29,800	19	476,800
Cumulative			30	110,400	49	587,200

1. Capacity in Acre-feet per year. No. of Plants is the number of new plants.
2. Design & Construction – Construction underway or preparation of plans and specifications has begun for new plants or plant expansions.
3. Planned – Planning studies underway for new plants or plant expansions.
4. Projected – Projected new plants or plant expansions.
5. Sources: "Water Desalination Report", and Worldwide Desalting Plants Inventory series by International Desalination Association.

that can be expected from plants desalting groundwater (or brackish), wastewater, and seawater. These costs are based on the expected lifetime of the plant (20-30 years).

Major Issues in Desalination

Historically, the cost of desalting has been the major issue regarding desalting, with energy use a close second. As desalting costs have declined and the cost of traditional water supplies has increased, desalting is increasingly being considered. As a result, two additional issues have increased importance, environmental impacts and permitting (particularly for coastal plants).

Cost and Affordability – Desalination has historically been prohibitively expensive. The improvements in technology and the rising cost of conventional water supplies has made desalination competitive with importing water and recycled municipal wastewater in a number of cases. The cost will be influenced by the type of feedwater, the available concentrate disposal options, the proximity to distribution systems, and the availability and cost of power. The higher costs of desalting may, in some cases, be offset by the benefits of increased water supply reliability and/or the environmental benefits from substituting desalination for a water supply with higher environmental costs (e.g. Carmel River, Monterey Bay area).

Environmental Impact and Permitting – Brackish water desalination plants have fairly routine environmental and permitting requirements. Coastal desalination plants face much closer scrutiny. With a location within the coastal zone, and with the need for water intakes and outfalls, there are many reviewing agencies, organizations, and permitting requirements.

Seawater Intakes – Existing seawater intakes for power plant cooling are proposed as the source of supply for almost all of the currently proposed plants. In general, these existing intake systems have been shown to have fairly significant impacts on the coastal zone. A number of coastal power plants that use once-through cooling water from the ocean may cease operation or convert to a "dry" cooling system. In addition, some plants are not in continuous operation. These may limit the potential capacity of seawater desalting on the coast.

Concentrate Discharge – Desalination plants of any type produce a salt concentrate that must be discharged. The quantity and salinity of that discharge varies with the type of desalting plant and its operation. Brackish water plants in California discharge their concentrate to municipal wastewater treatment systems where they are treated and blended with effluent prior to discharge. For brackish water plants, this type of discharge is likely to continue. Inland desalting plants without a discharge to the ocean may be limited by the type of discharge options available. Seawater desalination produces a concentrate approximately twice as salty as seawater. In addition, residuals of other treatment chemicals may also be in the concentrate. The plants currently being planned are to utilize existing power plant outfall systems to take advantage of dilution and mixing prior to discharge. The availability of power plant cooling systems to dilute the concentrate prior to discharge to the ocean will also be affected by the future of coastal power plants as discussed in the prior section.

Energy Use – Desalination's primary operation cost is for power. A 50 mgd seawater plant (approximately 50,000 acre-feet per year assuming operating 90% of the time) would require about 33 MW of power. Forecasted seawater desali-

Table 6-2 Desalting total water costs[1]

Type of Desalting Plant	Total Water Cost - $ per Acre-Foot
Groundwater	$250-500
Wastewater	$500-2,000
Seawater	$800-2,000

[1]Unit costs obtained from a variety of sources including agency reports, technical journals, and general periodicals, and are not based on a standard costing procedure.

nation of about 187,000 acre-feet per year would require about 123 MW of power. The reduction in unit energy use has been among the most dramatic improvements in recent years due to improvement in energy recovery systems.

Growth-inducing Impacts – The availability of water has been a substantial limitation on development in a number of locations, primarily coastal communities. Since desalination on the coast is now a much more affordable option in comparison to the past, the lack of water may no longer be as strong a constraint on coastal development.

Recommendation to Promote Desalination in California

DWR should lead the development of a consensus process, involving appropriate stakeholders, to identify criteria and prioritize the implementation of Task Force recommendations, given the expected expenditures, using existing and new funding sources (see Box 6-1, Desalination Task Force recommendations).

Selected References

Water Desalination Task Force (AB 2717 [Hertzberg, Chapter 957, Statues of 2002])

"Water Desalination - Findings and Recommendations", Department of Water Resources, October 2003

Draft Desalination Issues Assessment Report, Center for Collaborative Policy, California State University, May 2003

"Seawater Desalination and the California Coastal Act", California Coastal Commission, March 2004.

"Seawater Desalination: Opportunities and Challenges", National Water Research Institute, March 2003.

"Tapping the World's Largest Reservoir: Desalination", Western Water, January/February 2003