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Subgroup: Increase Water Supply

Chapter # 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.

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 80,000 acre-feet per year. These include 17 groundwater, one surface water, and six seawater desalination plants.

Information on AB2717 desalination handbook to be inserted

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 were awarded for research and development studies, pilot and demonstration projects, full-scale plant construction, and feasibility investigations. In the 2006 funding cycle and additional $25 million were awarded.

Currently there are 5 new groundwater desalting plants and 13 plant expansion in the design and construction phase for a total of about 80,000 acre-feet per year in new capacity. There is one seawater desalting plant (Sand City) in the design and construction phase at this time. Several seawater desalting pilot plants have begun operation or are being designed as part of desalting feasibility studies. [Paragraph to be further updated]
Potential Benefits of Desalination

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. Following completion of the initial studies, a pilot plant is in development stages to be located somewhere in western Contra Costa County. In Marin County, the Marin Municipal Water District is studying the feasibility of constructing 15,000 acre-feet per year seawater plant. Pilot plant operations have been completed to determine pretreatment and operating parameters for a full scale plant.

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 several 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. Pilot testing by Cal Am at Moss Landing and Pajaro/Sunny Mesa CSD at the former National Refractories plant are forthcoming.

The City of Santa Cruz and the Soquel Creek Water District jointly constructed and are now operating a pilot plant to determine the feasibility of a 2.5 to 5.0 million-gallon-per-day (mgd) seawater plant to be shared by the two agencies.

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 objective was 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 112,000 acre-feet per year. The City of Huntington Beach has certified an EIR for a 50,000 acre-feet per year plant to developed by Poseidon Resources Inc. 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.

[These three paragraphs to be continuously updated until publication]

The status of the five projects is shown below.

Carlsbad – A 50 mgd plant located adjacent to the Encina Power Station is planned for construction by Poseidon Resources Inc. Permits and hearings on the project are underway. The production capacity of the plant is fully subscribed.

Huntington Beach – A 50 mgd plant located adjacent to the AES power plant is planned for construction by Poseidon Resources, Inc. EIR certified by city and next steps are in permitting.

Dana Point – A 20-mgd plant proposed by Municipal Water District of Orange County. A feasibility study is underway that includes testing a sea water well intake and a possible SWRO pilot test project.
Long Beach – A 9 mgd plant proposed to use a unique two staged Nanofiltration membrane process design. Pilot testing has been underway since 2001 and alternative intake and discharge methods are being studied with a Proposition 50 grant.

West Basin – A 20 mgd plant proposed by West Basin MWD. Pilot testing has been underway since 2002. A 0.5 mgd demonstration plant is proposed using, in part, a Proposition 50 grant.

The above will be updated as further information is developed.

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

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 #1 (Desalting in California for New Water Supply) shows, as of 2008, the number and capacity of groundwater and seawater desalting plants in operation, design and construction, and planned or projected for construction. While not all of these are likely to be constructed, it is assumed that they, or an equivalent number, will be operational by 2025.

<table>
<thead>
<tr>
<th>Feedwater Source</th>
<th>Plants in operation</th>
<th>Plants in design &amp; construction</th>
<th>Plants planned or projected</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. of plants</td>
<td>Annual capacity</td>
<td>No. of plants</td>
</tr>
<tr>
<td>Groundwater</td>
<td>17</td>
<td>78,500</td>
<td>5</td>
</tr>
<tr>
<td>Seawater</td>
<td>6</td>
<td>1,500</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>23</td>
<td>80,000</td>
<td>7</td>
</tr>
<tr>
<td>Cumulative</td>
<td>29</td>
<td>102,300</td>
<td>47</td>
</tr>
</tbody>
</table>

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.

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 desalted water to levels that are comparable, and in some instances competitive, with other alternatives for acquiring new water supplies. Proposition 50, in 2005 and again in 2006, are funding a number of research and development programs directly related to desalting in California. 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 318,000 acre-feet per year in increased seawater desalting capacity is about $1.7 billion. Table #2 (Desalting total water costs) shows the range in total unit water cost 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).

<table>
<thead>
<tr>
<th>Type of desalting plant</th>
<th>Total water cost ($ per acre-foot)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groundwater</td>
<td>$500-900</td>
</tr>
<tr>
<td>Wastewater</td>
<td>$500-2000</td>
</tr>
<tr>
<td>Seawater</td>
<td>$900-2500</td>
</tr>
</tbody>
</table>

[to be updated]

Major Issues Facing 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.

**Carbon Footprint – [To be added]**

**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.

**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 desalination 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.

**Recommendations to Facilitate Desalination in California**

[To be developed]

**Selected References**

[To be developed]