City of Santa Cruz Invests in Desalination Technology

Materials for this article were collected from the ***scwd^2 Desalination Program*** *website*: http://scwd2desal.org/

Desalination is any process that removes salts from a variety of sources, including: seawater, brackish (water that is saltier than fresh water), river, and brine (water that is nearly saturated with salt). With improvements in technology, desalination processes are becoming cost-competitive with other methods of producing usable water for our growing needs. Desalination of ocean water is common in the Middle East because of water scarcity, and is growing fast in the USA, North Africa, Spain, Australia and China. It is used also on ships, submarines and islands with limited sources of fresh water.

Desalination Technologies

A desalination process essentially separates saline (salty) water into two parts - one that has a low concentration of salt (treated water or product water), and the other with a much higher concentration than the original feed water, usually referred to as 'concentrate'.

Thermal and membrane technologies are the two major types of technologies that are used around the world for desalination. Both technologies need energy to operate and produce potable water. Within those two broad types, there are sub-categories (processes) using different techniques.

Thermal Technology

Thermal technologies have rarely been used for brackish water desalination, because of the high costs involved. They have however been used for seawater desalination and can be sub-divided into three groups: Multi-Stage Flash Distillation (MSF), Multi-Effect Distillation (MED), and Vapor Compression Distillation (VCD). The majority of plants that use thermal technology have been built overseas, primarily in the Middle East, where energy resources have been plentiful and inexpensive.

Membrane Technology

Membrane technologies can be subdivided into two broad categories: Electrodialyis/Electrodialysis Reversal (ED/EDR), and Reverse Osmosis (RO). ED/EDR is a voltage driven membrane process that was commercially introduced in the 1960s, about 10 years before reverse osmosis (RO). Although ED was originally conceived as a seawater desalination process, the electrical process works better for lower salinity water. The few ED units that are located in Texas are those that are used in low-salinity applications such as surface water desalination.

Reverse Osmosis (RO) was commercialized in the 1970s and currently is the most widely used method for desalination in the United States. The RO process uses

pressure as the driving force to push saline water through a semi-permeable membrane (a type of filter) into a product water stream and a concentrated salty water stream. Nanofiltration (NF) is a membrane process that is used for removal of salt ions such as Calcium, Magnesium, and Sulphate. RO, on the other hand, is used for removal of only Sodium and Chloride. RO processes are used for desalinating both brackish water and seawater.
The process is explained below:

Osmosis is a natural phenomenon by which water from a low salt concentration passes into a more concentrated solution through a semi-permeable membrane. The Reverse Osmosis process occurs when pressure is applied to the solution with the higher salt concentration solution, the water will flow in a reverse direction through the semi-permeable membrane, leaving the salt behind. An RO desalination plant essentially consists of four major systems:

- Pretreatment System
- Reverse Osmosis Process
- Concentrated Salty Water Disposal
- Stabilization

Desalination for City of Santa Cruz and Soquel Creek Water District

Both the City of Santa Cruz and Soquel Creek Water District evaluated their water needs and available sources through the SCWD Integrated Water Plan (IWP) and SqCWD Integrated Resources Plan (IRP). Both reports identified investigating desalination, in addition to conservation and curtailment, as the preferred option to address the communities' long-term water needs.

The primary water management challenge presently facing the City of Santa Cruz is the lack of adequate water supply during periods of drought. In normal and wet years, when rainfall and runoff are normal to abundant, base flows in the coast and river sources are restored by winter rains. Storage in Loch Lomond Reservoir is typically replenished to full capacity with runoff from the Newell Creek watershed and water diverted from the San Lorenzo River at Felton. Under these weather conditions, the water supply system is capable of meeting the City’s annual water requirements.

However, the system is highly vulnerable to shortage in below normal, dry, and drought years, when the San Lorenzo River and coast sources run low. In these year types, the system relies more heavily on water stored in Loch Lomond to satisfy demand, which draws down the reservoir level lower than usual and depletes available storage. In critically dry or multi-year drought conditions, the combination of very low surface flows in the coast and river sources and depleted storage in Loch Lomond reservoir reduces available supply to a level that cannot support even average dry season demands.

The City experienced severe water supply deficiencies in both the 1976-77 and 1987-92 droughts. In 1977, the City imposed severe water rationing in response to a critical shortage of water. During the 1987-92 drought, a water supply emergency was declared and either usage restrictions or rationing was imposed each year for five consecutive years. The 1976-77 event has since been established as the most severe drought of record, and is used by the City as a benchmark for assessing system reliability. If a critical drought similar to 1976-77 occurred today, shortages would be in excess of 40 percent.

In 1997, the City Santa Cruz initiated a new effort using a broader-based approach known as integrated water planning to consider all practical options for decreasing demand and increasing supply. As part of this effort, a series of background studies were undertaken on water demand, conservation, curtailment, and alternative water supplies. Work on the Integrated Water Plan began in March 2001 and was overseen by the City's Integrated Water Plan Committee (IWPC), which included three members of the City's Water Commission, three members of the City Council, and one ex-officio member.

The proposed Program, carried forward from the Integrated Water Plan (IWP), consists of three primary components:

- Conservation: a series of programs that reduce long-term water demand;
- Curtailment: mandatory rationing that would reduce the water demand and extend the water supply during dry or critically dry years (customer curtailment up to 15 percent in times of shortage);
- Additional Water Supply: investigate a 2.5 million gallons per day (mgd) desalination facility, with the potential for expansion as appropriate to a maximum of 4.5 mgd. Two operational strategies were identified: One would provide water supply during a drought to the City service area, and the second would continue to provide water to the City during droughts but would also provide water supply for its partner, Soquel Creek Water District (SqCWD), during non-drought periods.

A cornerstone of the IWP is to achieve the maximum practical water-use efficiency through conservation. Both State water law and the City's General Plan call for a strong emphasis on water conservation and elimination of water waste to maximize existing supplies, minimize the need for new water sources, and protect the environment. The City is also a signatory to the Memorandum of Understanding regarding Urban Water Conservation in California and is thus committed to the implementation of 14 water conservation best management practices, many of which are included in the City's Water Conservation Plan.

Similarly, SqCWD is experiencing shortfalls in water supplies. The SqCWD is entirely dependent on local groundwater, and does not take water from surface water or regional water supplies. The Aromas Red Sands (Aromas) aquifer and the Purisima Formation

represent the two primary groundwater resources in the Soquel-Aptos Groundwater Basin where the SqCWD wells pump groundwater.
Beginning in the late 1990s, SqCWD began evaluating depressed groundwater levels and saltwater intrusion, long-term water demand, conservation opportunities, the adequacy of water supplies and the preferred options for supplemental water supplies. Hydrogeologic studies indicate that, collectively, the SqCWD, the City of Santa Cruz, Central Water District, and other public and private groundwater users pump more water annually than is naturally recharged through precipitation. The current annual water use for the SqCWD exceeds the available water supply by 15 percent even during non-drought conditions. The current situation is not sustainable and groundwater monitoring indicates saltwater intrusion may be affecting the Aromas aquifer along the southern coast and the Purisima Formation aquifers.

Protecting SqCWD's groundwater resources involves monitoring and managing groundwater levels and storage, protecting groundwater quality, preventing groundwater overdraft, maintaining sustainable groundwater yields, and avoiding saltwater intrusion. To manage the basin within its safe sustainable yield, the SqCWD needs additional water supplies to supplement groundwater pumping to meet customers' needs and raise groundwater levels to prevent saltwater intrusion.

In early 2006, SqCWD adopted the Integrated Resources Plan (IRP) which recommends a flexible plan to address changing demand and water supply conditions. The IRP identified a regional seawater desalination plant with the City of Santa Cruz as the preferred conjunctive use project to be investigated. The IRP also includes implementation of demand and groundwater management to incorporate conservation and recharge protection policies.

For more information on the scwd^2 Seawater Reverse Osmosis Desalination Pilot Test Program please contact:

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