Water Quality Considerations for Integrating Desalinated Seawater from the Carlsbad SWRO Plant into Existing Regional Supplies

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February 8, 2018
Case Study of the City of Carlsbad and Surrounding Areas’ Experience with Integrating Desalinated Seawater Supply in Municipal Distribution Systems

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WERF-15-06
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Acknowledgements

Research Team

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  Arcadis
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- Chris Hill  
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Project Advisory Committee

- Wendy Chambers  Carlsbad Municipal Water District
- Dr. Robert Cheng  Coachella Valley Water District
- Dr. Christine Owen  Tampa Bay Water¹
- Nikolay Voutchkov  Water Globe Consulting
- Justin Pickard  Water Systems Consulting²

¹ Formerly of Tampa Bay Water
² Formerly of West Basin Municipal Water District
Acknowledgements

Partner Agencies

Carlsbad Municipal Water District
City of San Diego
Helix Water District
Olivenhain Municipal Water District
Otay Water District
Poseidon Water
Rincon del Diablo Municipal Water District
San Diego County Water Authority
Sweetwater Authority
Vallecitos Water District

THANKS!
SDCWA Service Area

Carlsbad SWRO Plant
50 MGD
(Poseidon Water)

Twin Oaks Valley WTP
100 MGD
(SDCWA)
Member Agencies that have their own surface water treatment plants typically purchase raw water exclusively.

Member Agencies that do not have surface water treatment plants purchase treated water exclusively.

Agencies that purchase treated water will sometimes receive 100% SWRO water.
Flow Analysis: Key Points

- SWRO water constitutes a significant percentage of treated water purchased by SDCWA Member Agencies.

- The % contribution of SWRO water can vary widely.

- Member Agencies that purchase treated water may receive 100% SWRO water.

SWRO water will have a significant influence on blended water quality.
Concentrate & Salinity Management Session, Part 1
Concentrate & Salinity Management Session, Part 1
Preliminary Data
Carlsbad SWRO Plant
TDS & Conductivity

TDS, Conductivity (mg/L, µS/cm)

0
100
200
300
400
500
600
700

12/23/15
01/20/16
02/17/16
03/16/16
04/13/16
05/11/16
06/08/16
07/06/16
08/03/16
08/31/16
09/28/16
10/26/16
11/23/16
12/21/16
TDS & Conductivity

![Graph showing TDS and Conductivity over time, with three different lines representing TDS, Conductivity, and TDS (MWD/Skinner). The x-axis represents dates from 12/23/15 to 12/21/16, and the y-axis represents TDS (mg/L) and Conductivity (μS/cm). The graph highlights the variations in TDS and Conductivity over the specified period.]
Chloride
Chloride & Temperature

The graph shows the relationship between chloride concentration (mg/L) and temperature (°C) over a period from December 2015 to December 2016. The data is represented by two lines, one for chloride and one for temperature. The chloride concentration ranges from approximately 0 to 120 mg/L, while the temperature ranges from approximately 0 to 110 °C. The graph indicates fluctuations in both parameters over time, with some periods showing a higher chloride concentration and others showing a higher temperature.
Chloride & Temperature: SWRO vs. MWD
Chloride & Temperature: SWRO vs. MWD

80 mg/L desirable for avocados*
100 mg/L tolerable for avocados*

* Escondido Growers for Agricultural Preservation (EGAP)
Chloride & Temperature: SWRO vs. MWD

100 mg/L tolerable for avocados*
80 mg/L desirable for avocados*

Thresholds exceeded during the summer when irrigation peaks

* Escondido Growers for Agricultural Preservation (EGAP)
Boron
### About Boron

#### What You Need to Know

- Poorly rejected by RO membranes
- Adverse impact on irrigated plants

<table>
<thead>
<tr>
<th>Reference Point</th>
<th>Boron Conc.</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seawater</td>
<td>~ 4.5 mg/L</td>
<td></td>
</tr>
<tr>
<td>California Standard</td>
<td>1 mg/L</td>
<td></td>
</tr>
<tr>
<td>SWRO Permeate</td>
<td>varies</td>
<td>Best case rejection: 80-90% (ideal)</td>
</tr>
<tr>
<td>Carlsbad WPA Limits</td>
<td></td>
<td></td>
</tr>
<tr>
<td>“Central Tendency”</td>
<td>0.75 mg/L</td>
<td>Acceptable in ≤ 50% of samples</td>
</tr>
<tr>
<td>“Extreme”</td>
<td>1.0 mg/L</td>
<td>Acceptable in ≤ 5% of samples</td>
</tr>
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Boron and Irrigated Plants

Local Impact

- San Diego area economy has a significant agriculture component.
- Many valuable crops are among the most boron-sensitive, with adverse effects from concentrations in the 1-2 mg/L range.

<table>
<thead>
<tr>
<th>Cash Crop</th>
<th>Value(^1)</th>
<th>Rank(^1)</th>
<th>% of Total(^1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ornamental trees and shrubs</td>
<td>$425M</td>
<td>1</td>
<td>23%</td>
</tr>
<tr>
<td>Indoor flowering plants</td>
<td>$329M</td>
<td>2</td>
<td>18%</td>
</tr>
<tr>
<td>Avocados</td>
<td>$198M</td>
<td>4</td>
<td>11%</td>
</tr>
<tr>
<td>Lemons</td>
<td>$80M</td>
<td>6</td>
<td>4%</td>
</tr>
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\(^1\) 2013 Crop Statistics and Annual Report. County of San Diego Dept. of Agriculture, Weights, and Measures
## Local Impact

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### Cash Crop

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Boron

Graph showing the concentration of Boron (mg/L) over time from 12/23/15 to 12/21/16.
Sodium Adsorption Ratio (SAR)
Sodium Adsorption Ratio (SAR)

What You Need to Know

• Quantifies the suitability of irrigated water relative to sodium
• Lower values are desirable
• Many boron-sensitive plants are also susceptible to sodium effects

\[
SAR = \frac{[Na^+] \sqrt{\frac{1}{2}([Ca^{+2}]+[Mg^{+2}])}}{\sqrt{[Ca^{+2}]+[Mg^{+2}]}}
\]

Carlsbad SWRO Requirements

• [Ca] > 40 mg/L in 10% of samples
• No specification for [Mg] or [Na]
Calcium, Magnesium, & Hardness

Calcium, Magnesium, Hardness (mg/L - CaCO₃, mg/L, mg/L - CaCO₃)
Calcium, Magnesium, & Hardness

Not all outliers are of interest.
Calcium, Magnesium, & Hardness

WERF-15-06 objectives are not:

- Optimization
- Troubleshooting
- Compliance
**Calcium: SWRO vs. MWD**

The graph illustrates the calcium levels over time for SWRO and MWD/Skinner processes. The orange line represents calcium levels in SWRO, while the blue line represents calcium levels in MWD/Skinner. The graph shows fluctuations in calcium levels from December 23, 2015, to December 21, 2016.
Magnesium: SWRO vs. MWD
Sodium: SWRO vs. MWD
SAR: SWRO vs. MWD
Concentrate & Salinity Management Session, Part 1
Concentrate & Salinity Reversal Session, Part 1

But not uniformly across the region
Member Agencies that have their own surface water treatment plants typically purchase raw water exclusively. Member Agencies that do not have surface water treatment plants purchase treated water exclusively. Agencies that purchase treated water will sometimes receive 100% SWRO water.

Salinity reversal induced by SWRO blending benefits agencies that purchase treated water.
Temperature

Temperature (°C)

- SWRO Plant Effluent
- TOVWTP After Blending
- Otay Intake

Temperature

01/01/16 01/29/16 02/26/16 03/25/16 04/22/16 05/20/16 06/17/16 07/15/16 08/12/16 09/09/16 10/07/16 11/04/16 12/02/16 12/30/16

0 5 10 15 20 25 30 35
TDS Influences:
- % SWRO water
- Temperature
Key Points

...from this brief presentation
Key Points

- Water temperature can affect the ability of a SWRO process to achieve finished water quality objectives.

- The components of salinity are also important:
  - Chloride
  - Boron
  - Calcium, magnesium, sodium (via SAR)

- The use of SWRO as a means of salinity management may not benefit an entire service area evenly.

- Salinity reversal can have unintended benefits (e.g., demand reduction)