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

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Carlsbad, CA

February 8, 2018

ARCADIS Design & Consultancy for natural and built assets

WATER ENVIRONMENT & REUSE FOUNDATION WE&RF

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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THE Water Research FOUNDATION

Acknowledgements

Research Team

- Brent Alspach, PI — Arcadis
- Greg Imamura — Arcadis
- Chris Hill — Arcadis
- Dr. Jerry Speitel — U. of Texas

Water Research Foundation

- Kristan VandenHeuvel, PM

Acknowledgements

Project Advisory Committee

- Wendy Chambers — Carlsbad Municipal Water District
- Dr. Robert Cheng — Coachella Valley Water District
- Dr. Christine Owen — Tampa Bay Water[1]
- Nikolay Voutchkov — Water Globe Consulting
- Justin Pickard — Water Systems Consulting[2]

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

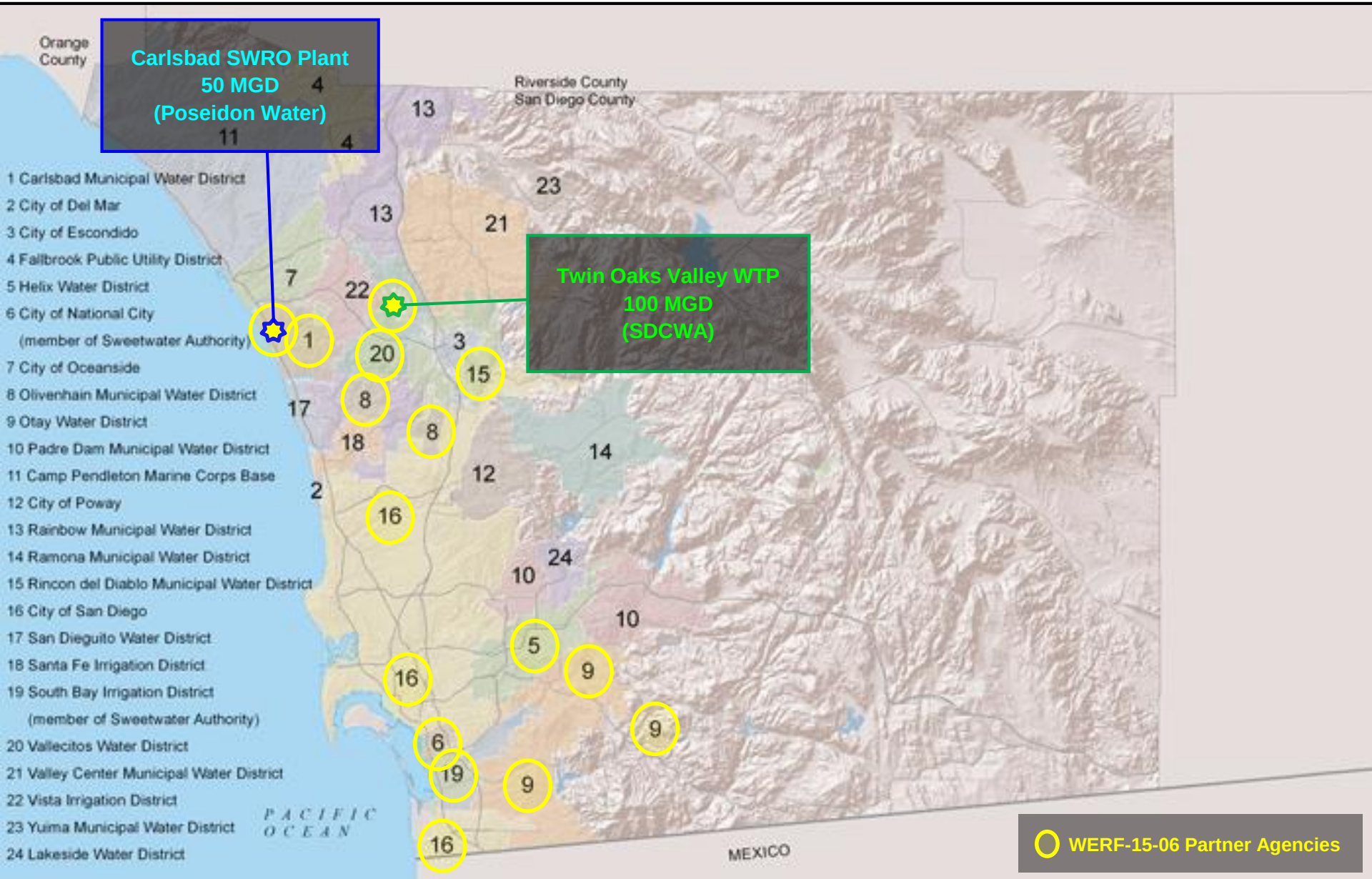
Rincon del Diablo Municipal Water District

San Diego County Water Authority

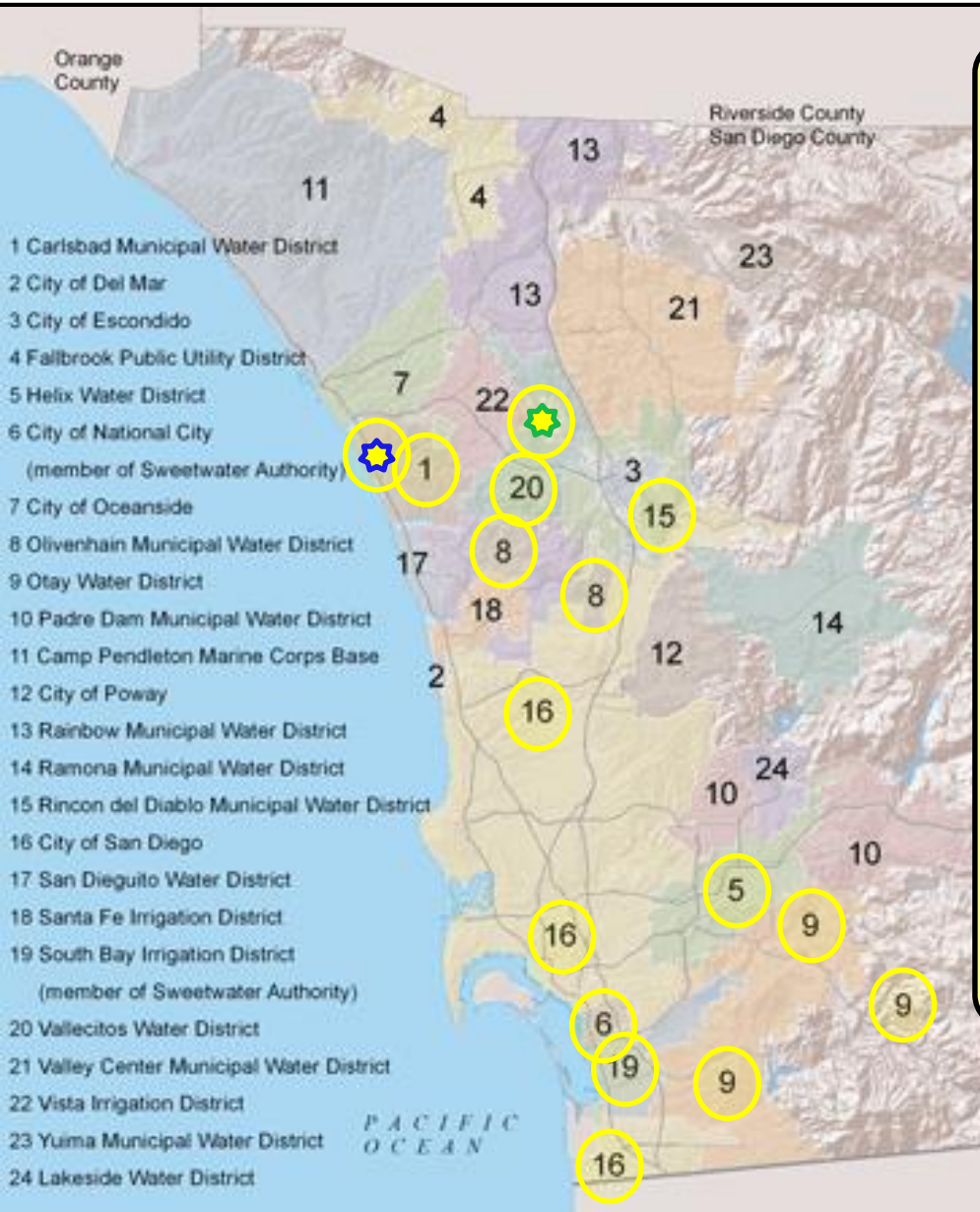
Sweetwater Authority

Vallecitos Water District

SDCWA Service Area



SDCWA Service Area



- 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.

WERF-15-06 Partner Agencies

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

LESS SALT. MORE WATER.

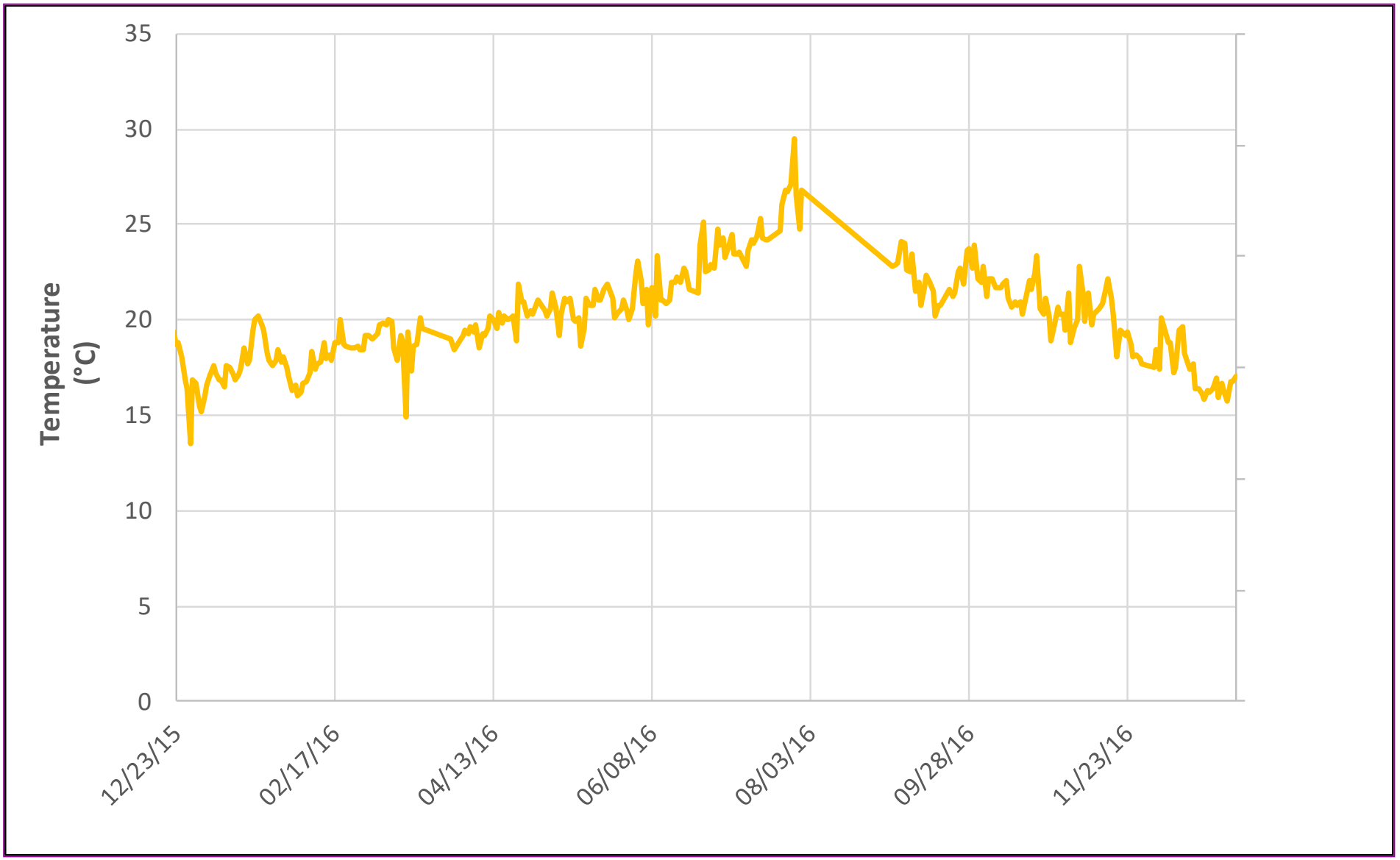
Concentrate & Salinity Management Session, Part 1

Multi-State Salinity Coalition

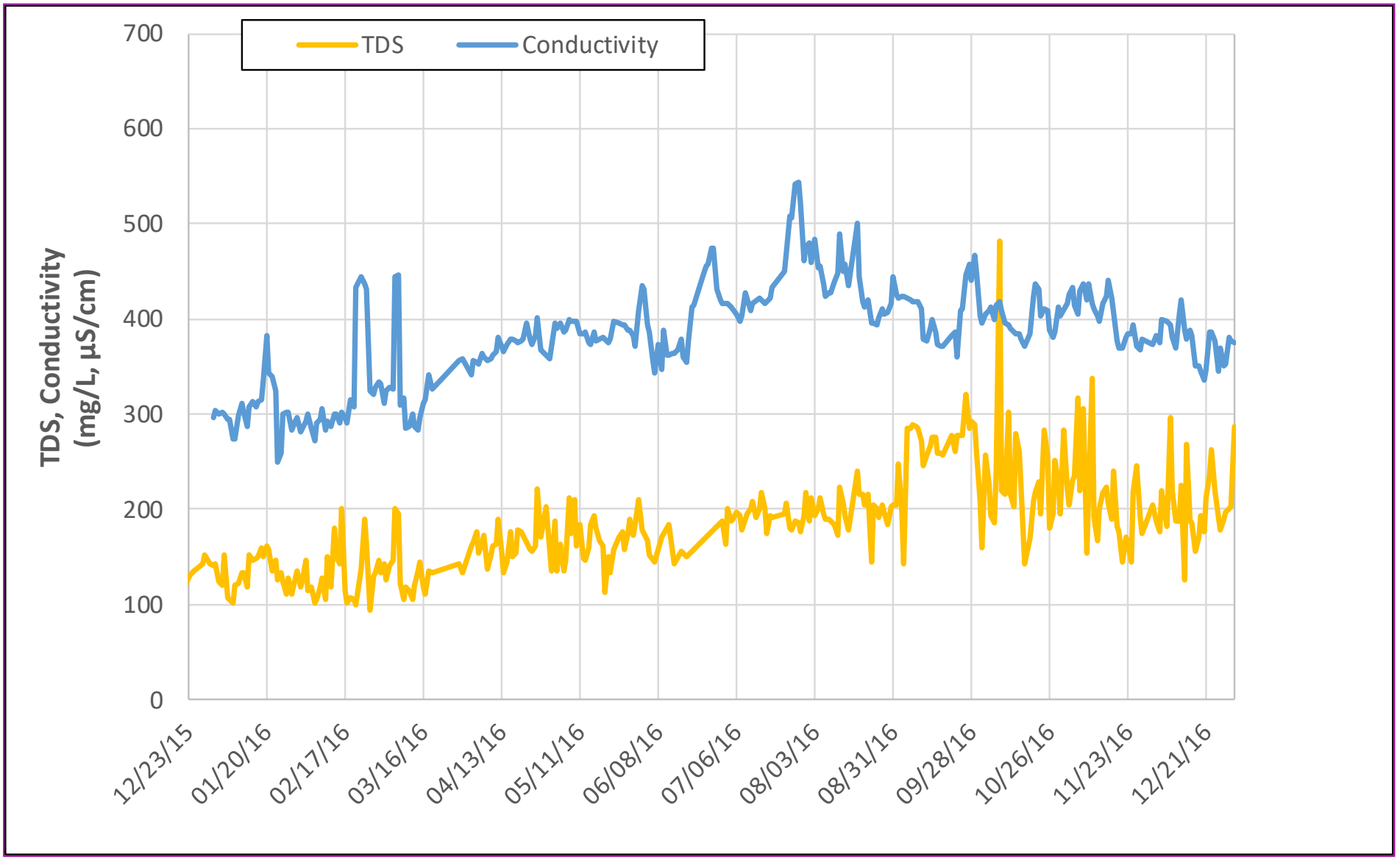
Preliminary Data

Carlsbad SWRO Plant

Temperature



TDS & Conductivity



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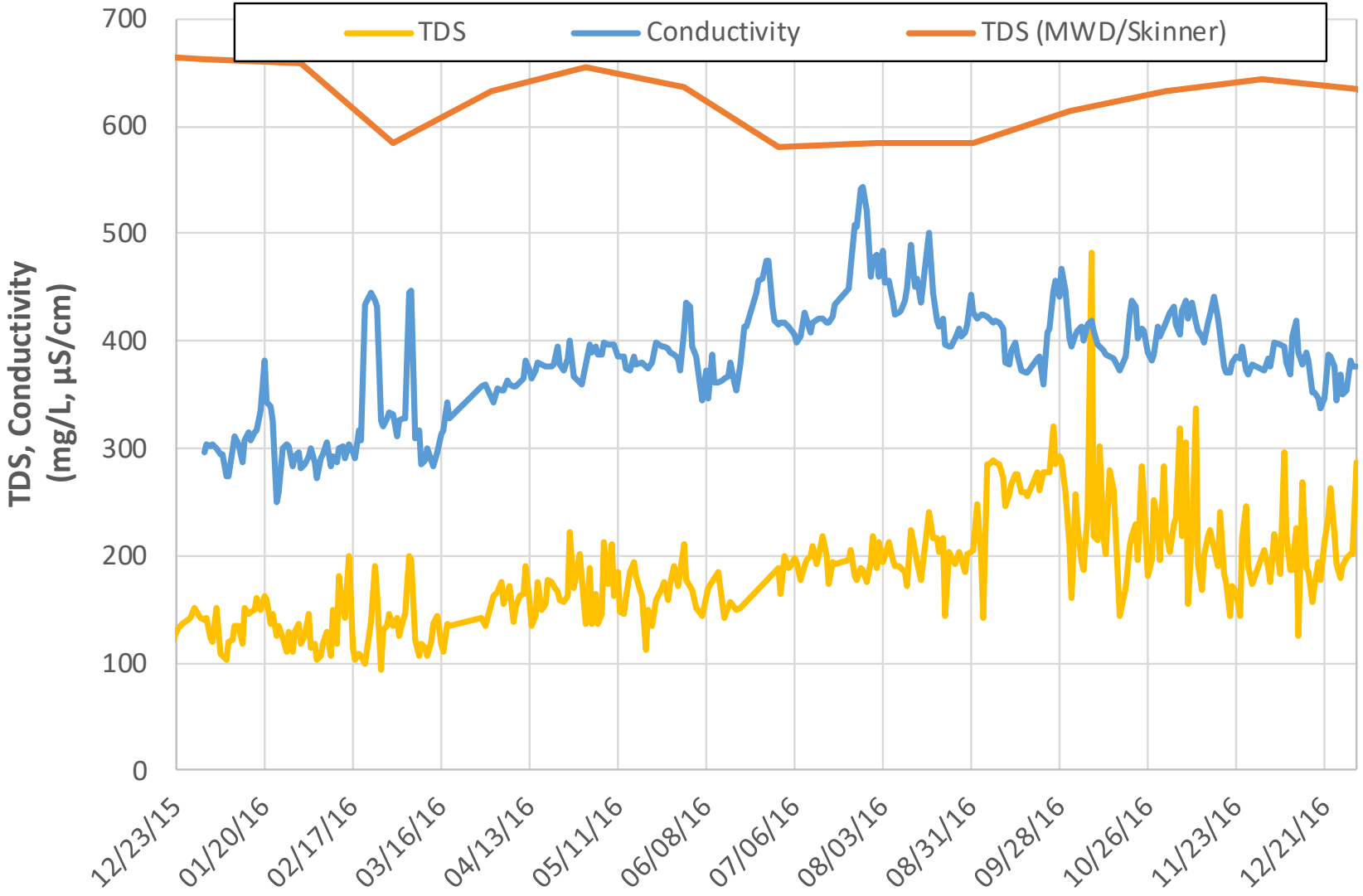
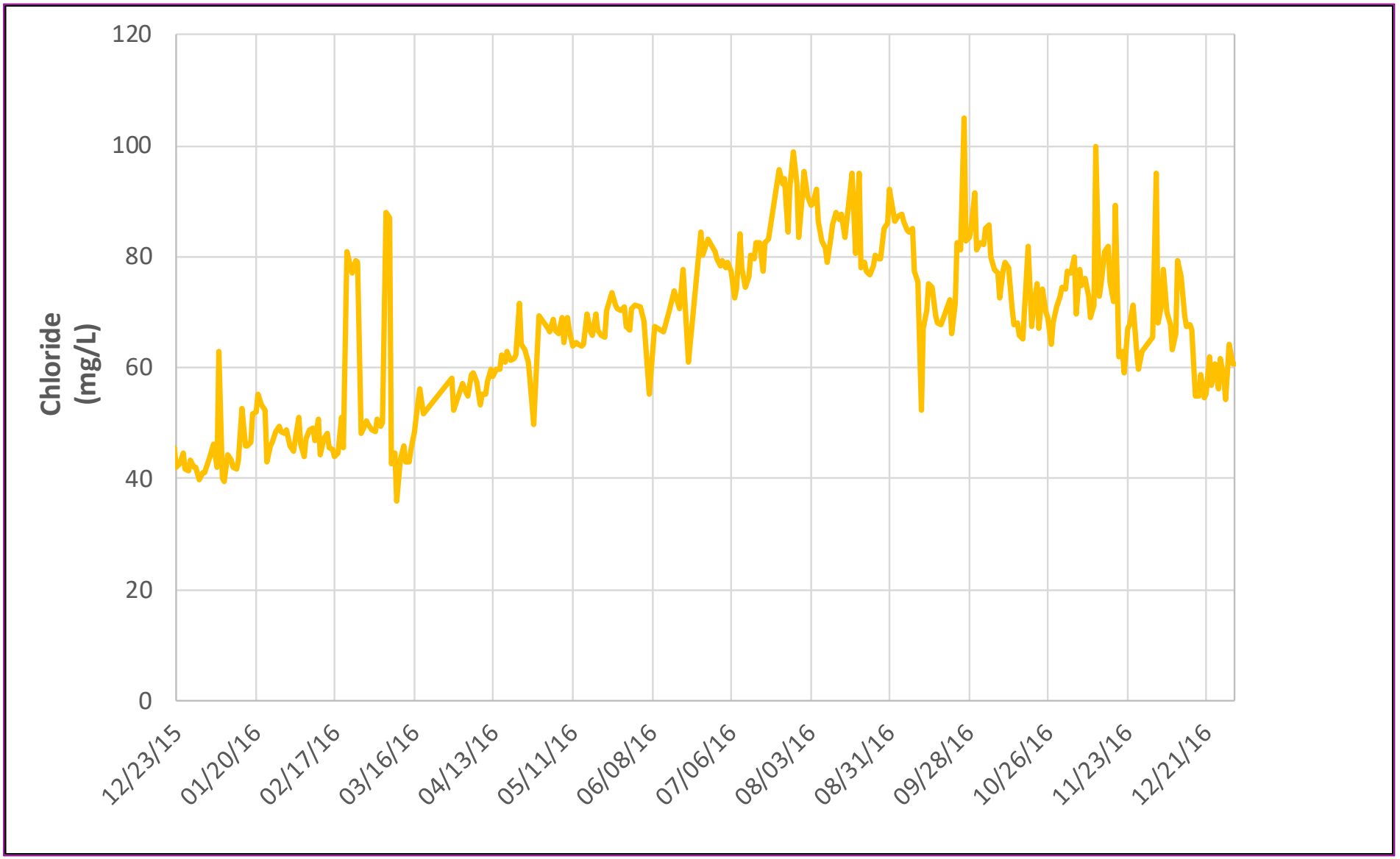
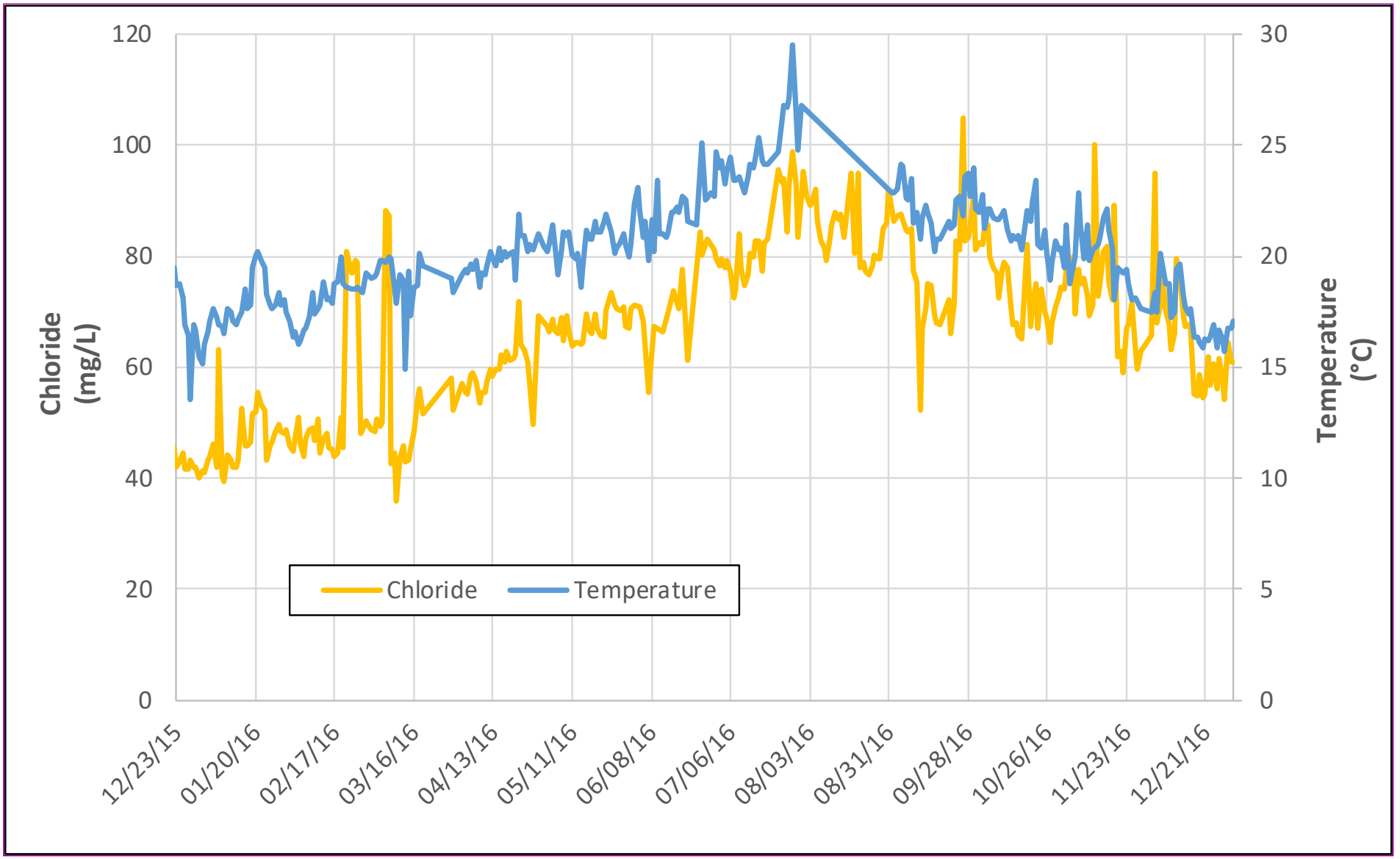


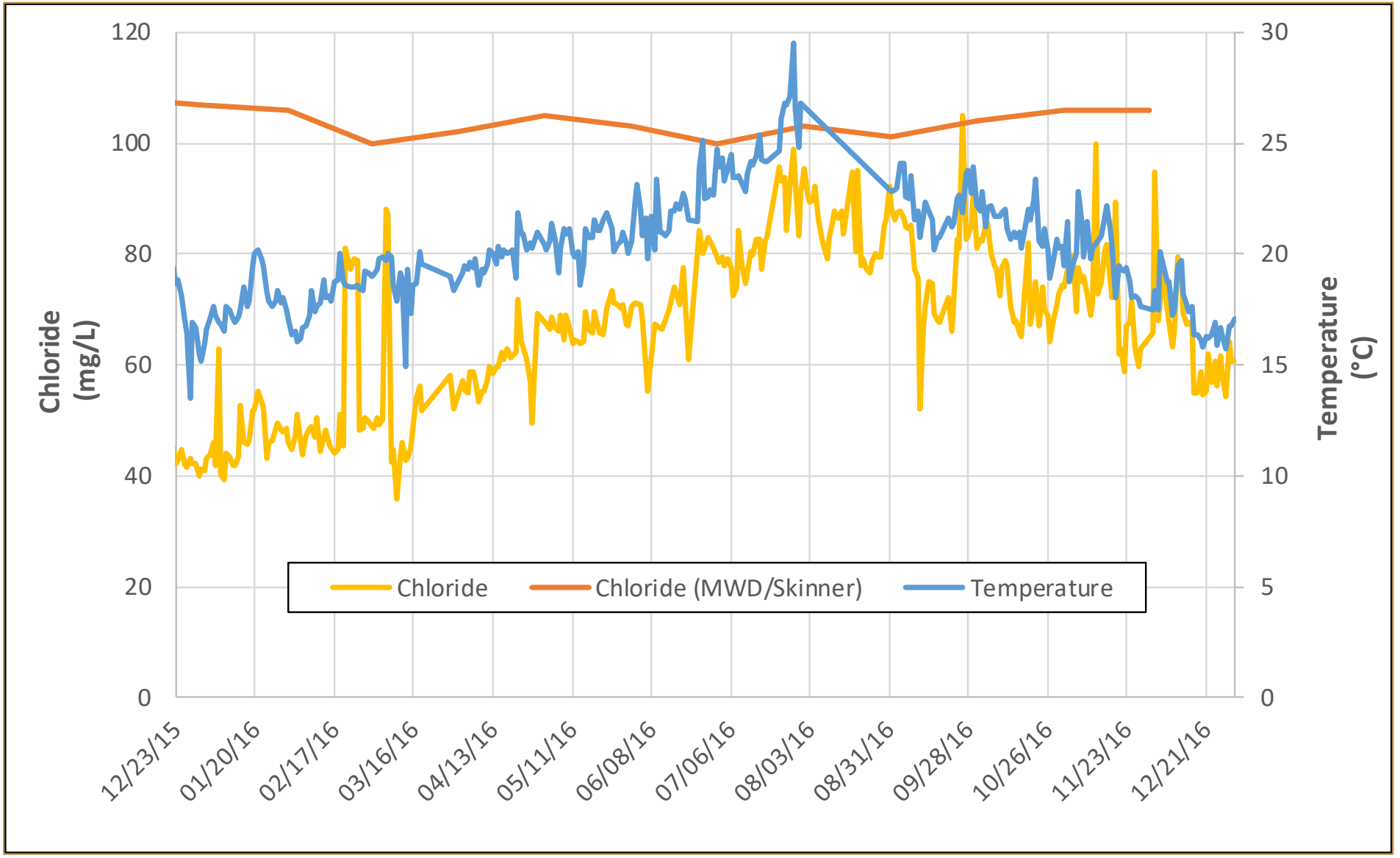
Chloride


Chloride (mg/L)
120
100
80
60
40
20
0
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

Chloride & Temperature



Chloride & Temperature: SWRO vs. MWD



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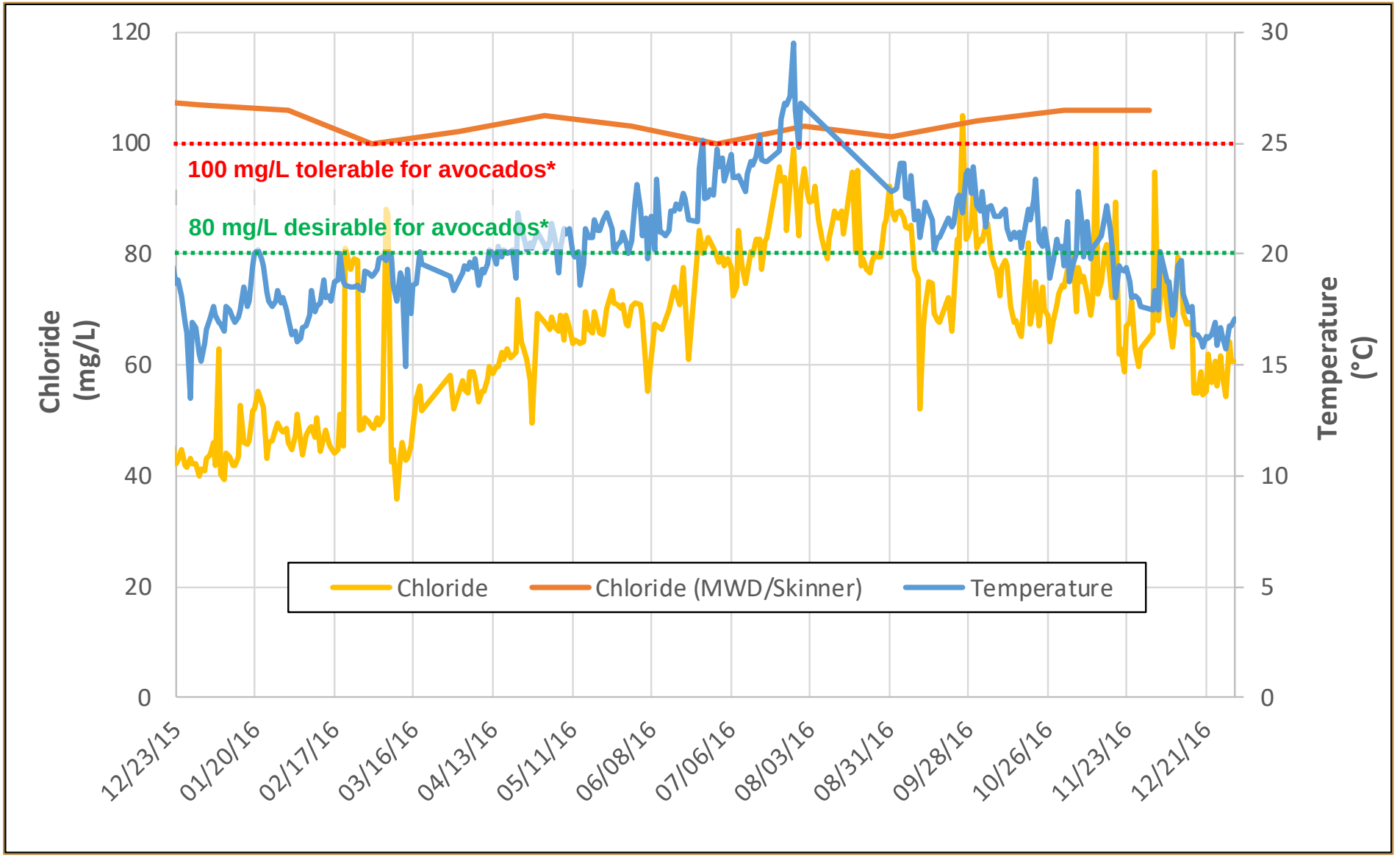
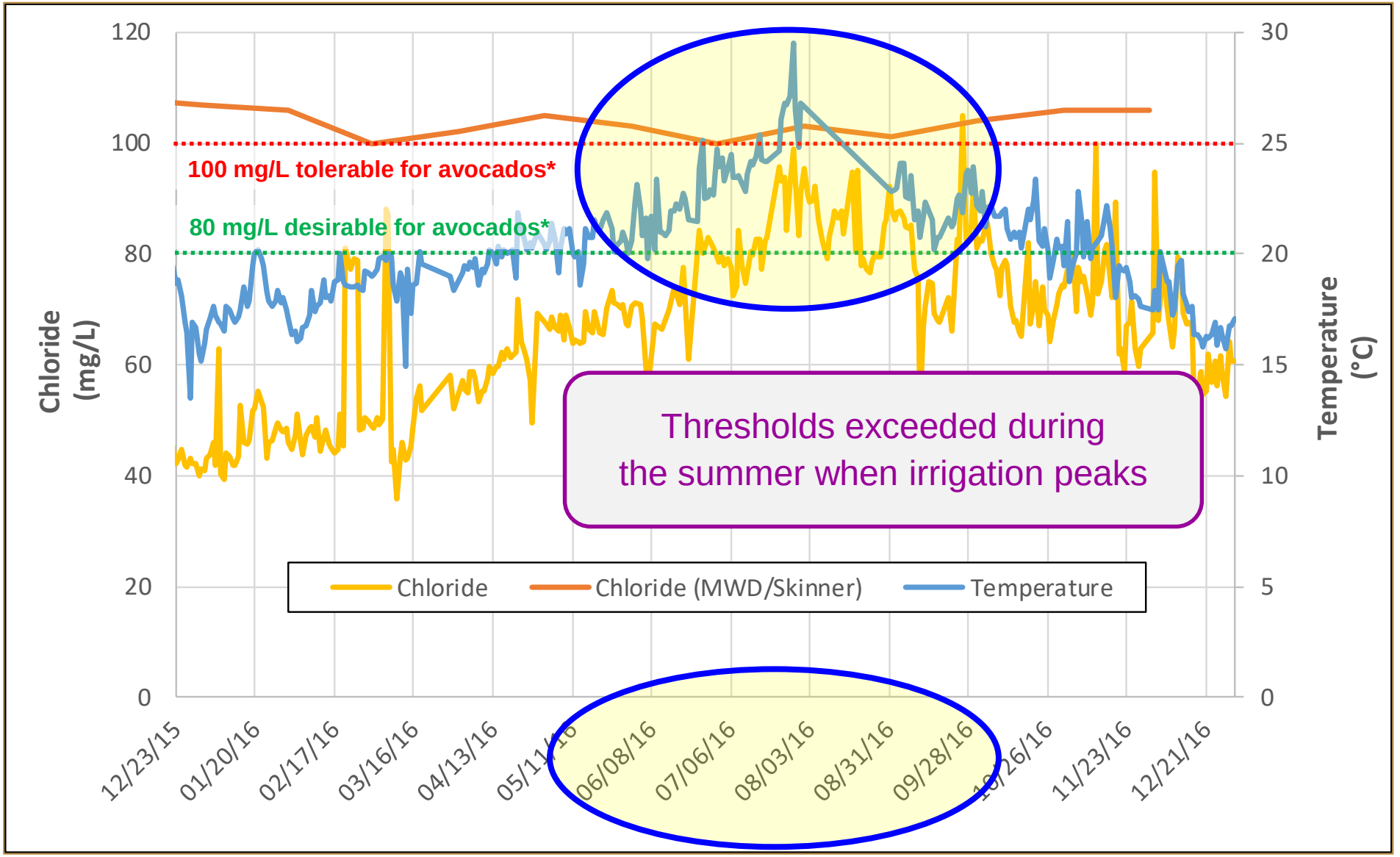


* Escondido Growers for Agricultural Preservation (EGAP)

Chloride & Temperature: SWRO vs. MWD



* Escondido Growers for Agricultural Preservation (EGAP)

Boron

About Boron

What You Need to Know

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

Reference Point		Boron Conc.	Notes
Seawater		~ 4.5 mg/L	
California Standard		1 mg/L	
SWRO Permeate		varies	Best case rejection: 80-90% (ideal)
Carlsbad WPA Limits	"Central Tendency"	0.75 mg/L	Acceptable in ≤ 50% of samples
	"Extreme"	1.0 mg/L	Acceptable in ≤ 5% of samples

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

Cash Crop	Value[1]	Rank[1]	% of Total[1]
Ornamental trees and shrubs	$425M	1	23%
Indoor flowering plants	$329M	2	18%
Avocados	$198M	4	11%
Lemons	$80M	6	4%

1 2013 Crop Statistics and Annual Report. County of San Diego Dept. of Agriculture, Weights, and Measures

Boron and Irrigated Plants

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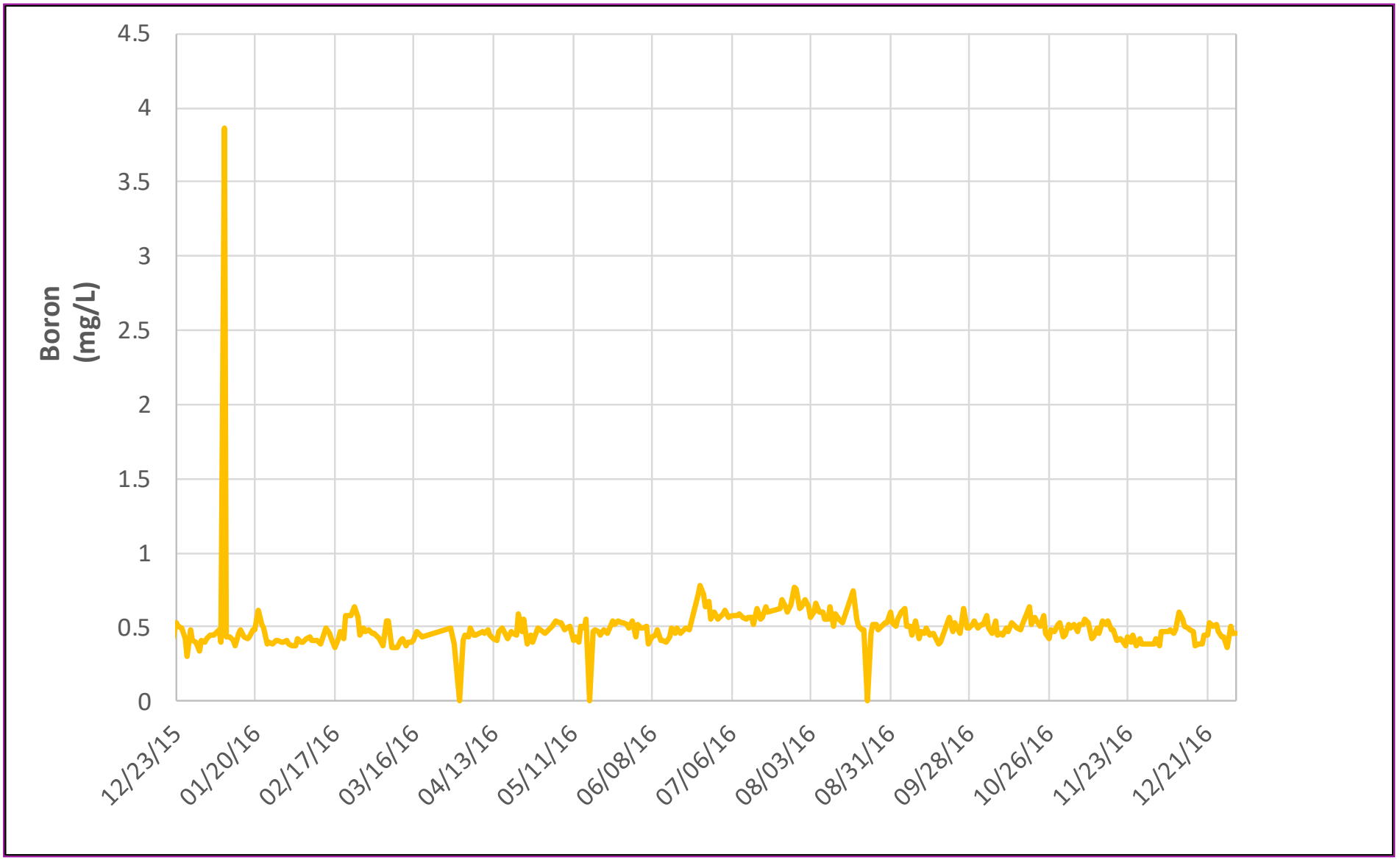
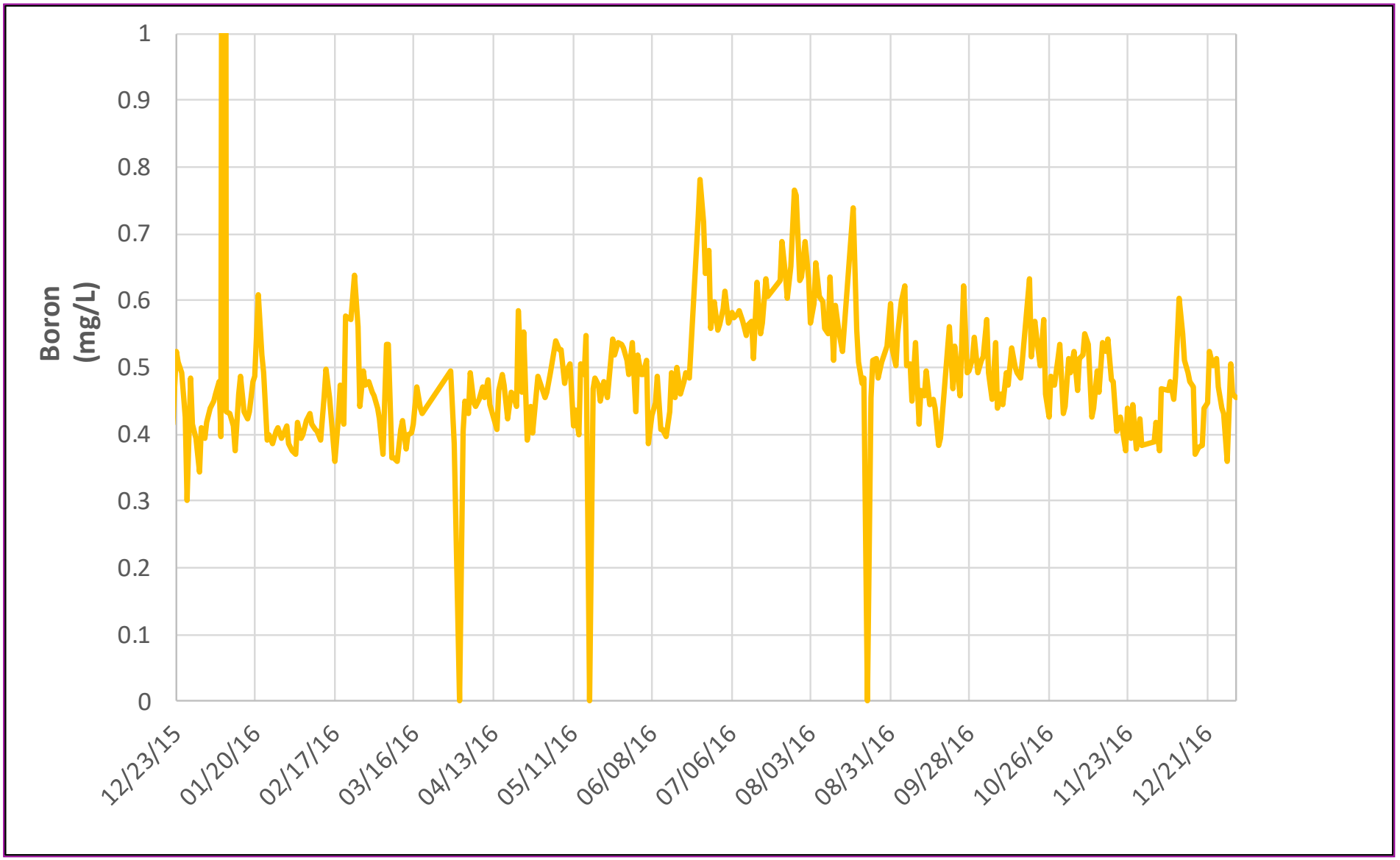
Boron is a potential concern for 56% of the region's cash crop.

1 2013 Crop Statistics and Annual Report. County of San Diego Dept. of Agriculture, Weights, and Measures

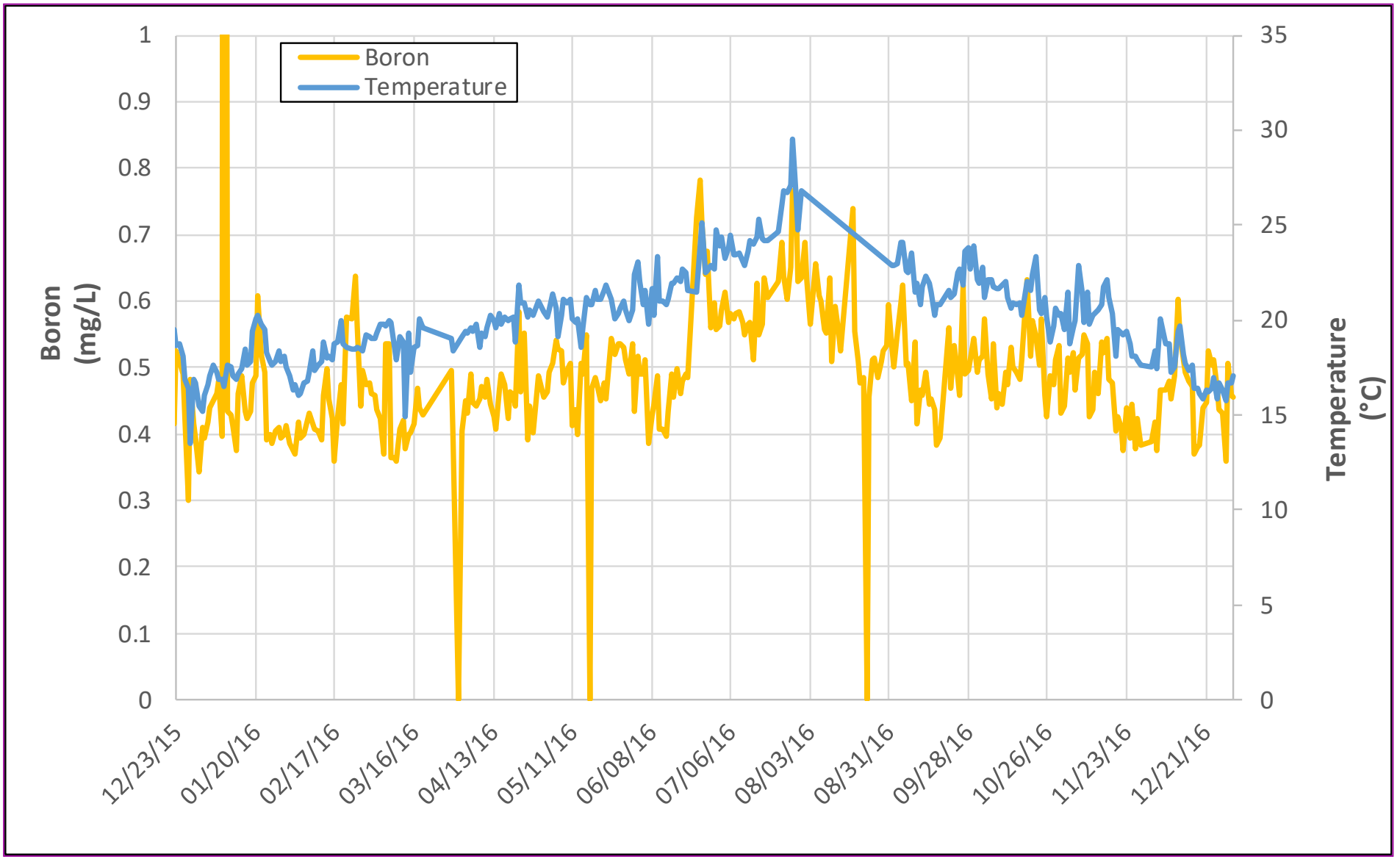
Boron


Boron (mg/L)
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
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

Boron


Boron (mg/L)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
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

Boron


Boron
Temperature
Boron (mg/L)
Temperature (°C)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
35
30
25
20
15
10
5
0
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

Sodium Adsorption Ratio (SAR)

Sodium Adsorption Ratio (SAR)

What You Need to Know

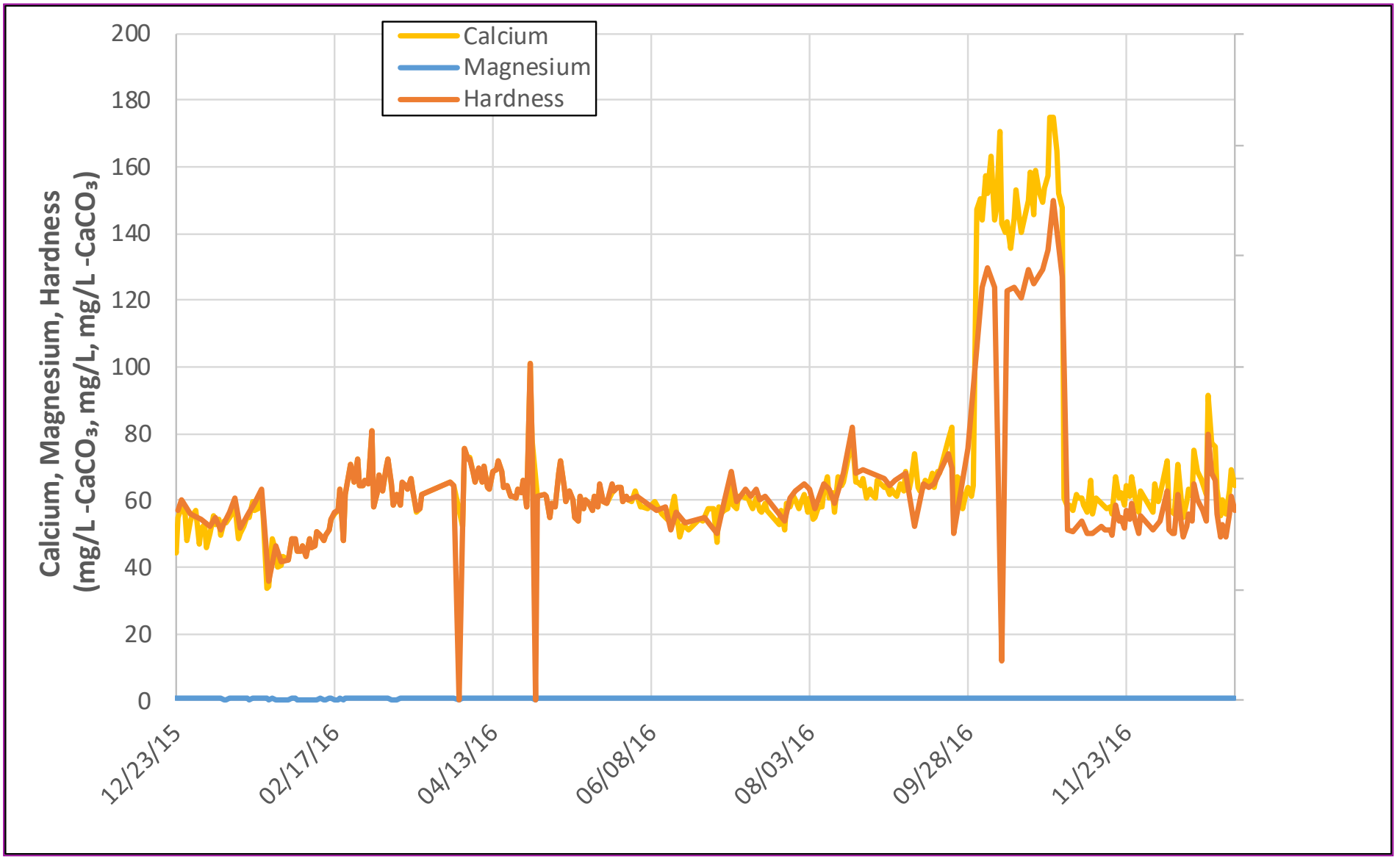
- Quantifies the suitability of irrigated water relative to sodium
- Lower values are desirable
- Many boron-sensitive plants are also susceptible to sodium effects

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

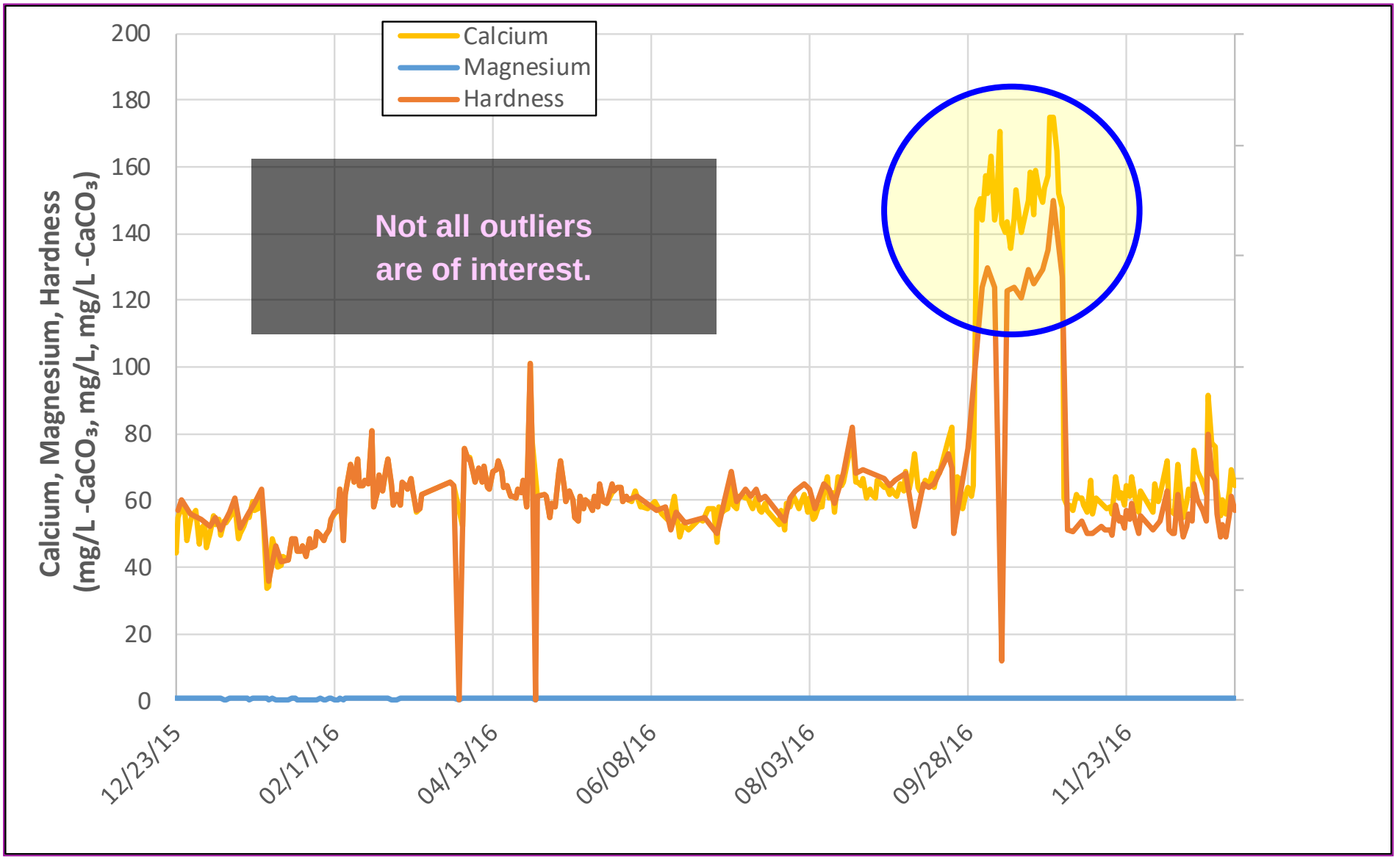
Carlsbad SWRO Requirements

- [Ca] > 40 mg/L in 10% of samples
- No specification for [Mg] or [Na]

Calcium, Magnesium, & Hardness



Calcium, Magnesium, & Hardness



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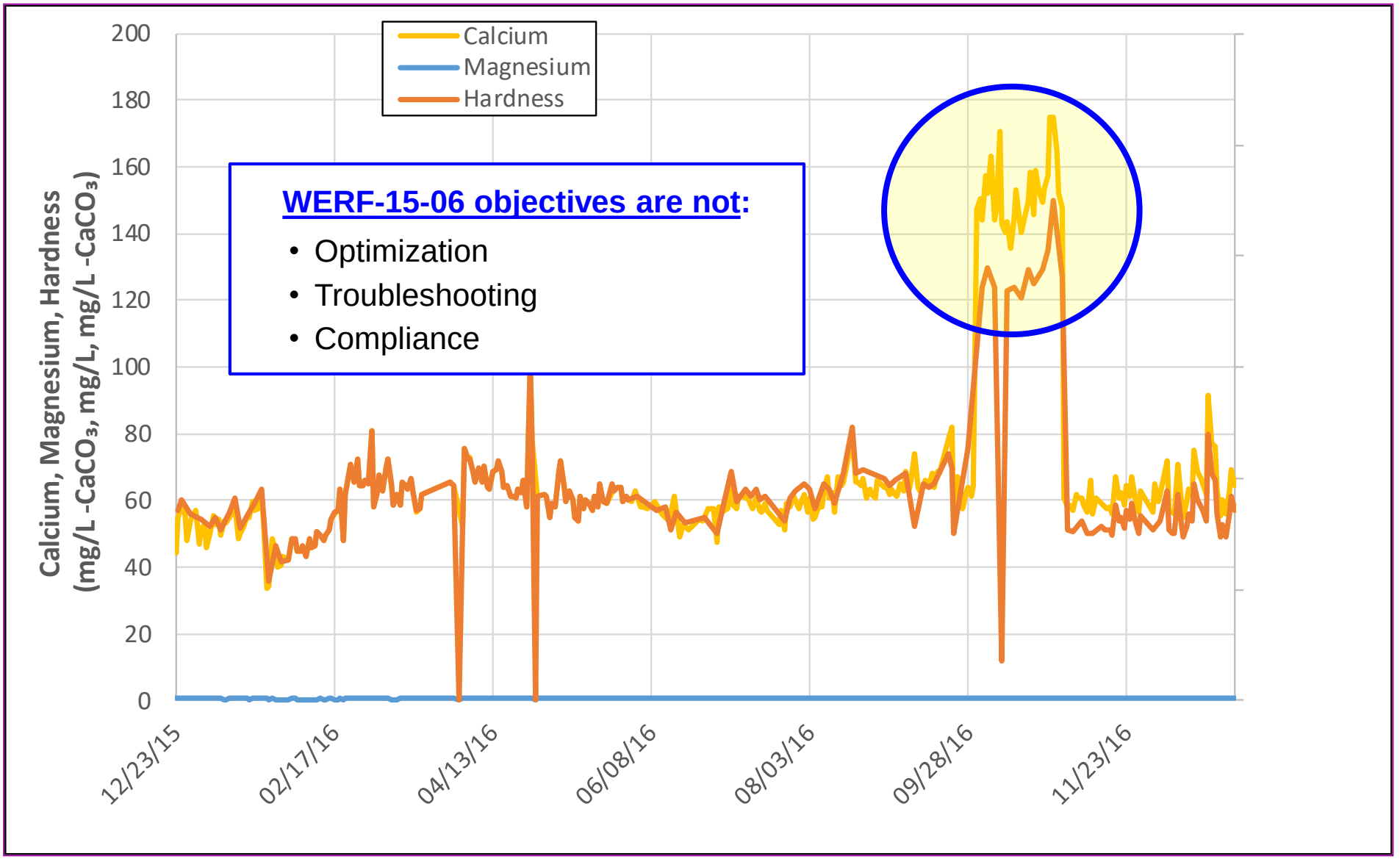
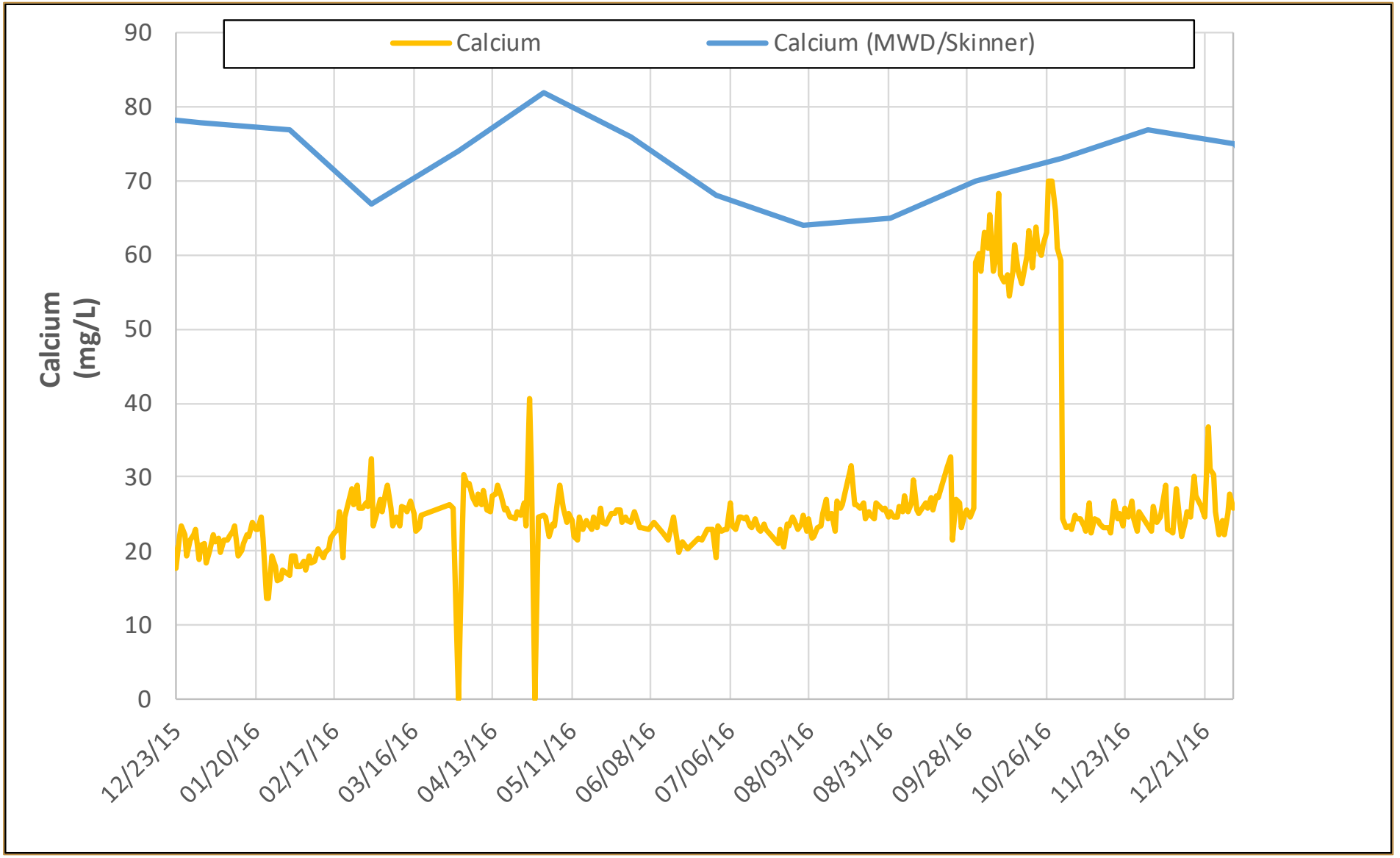
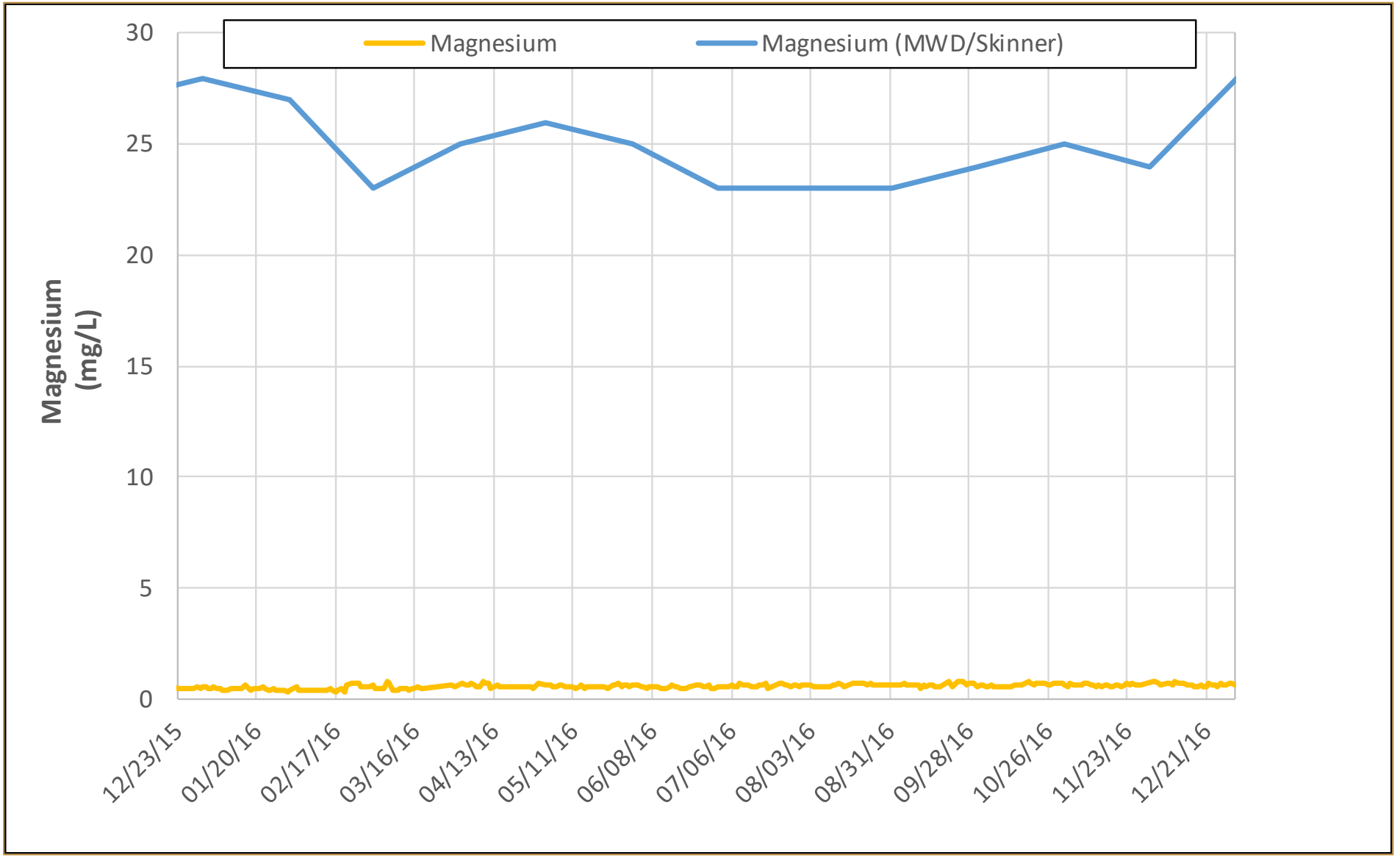


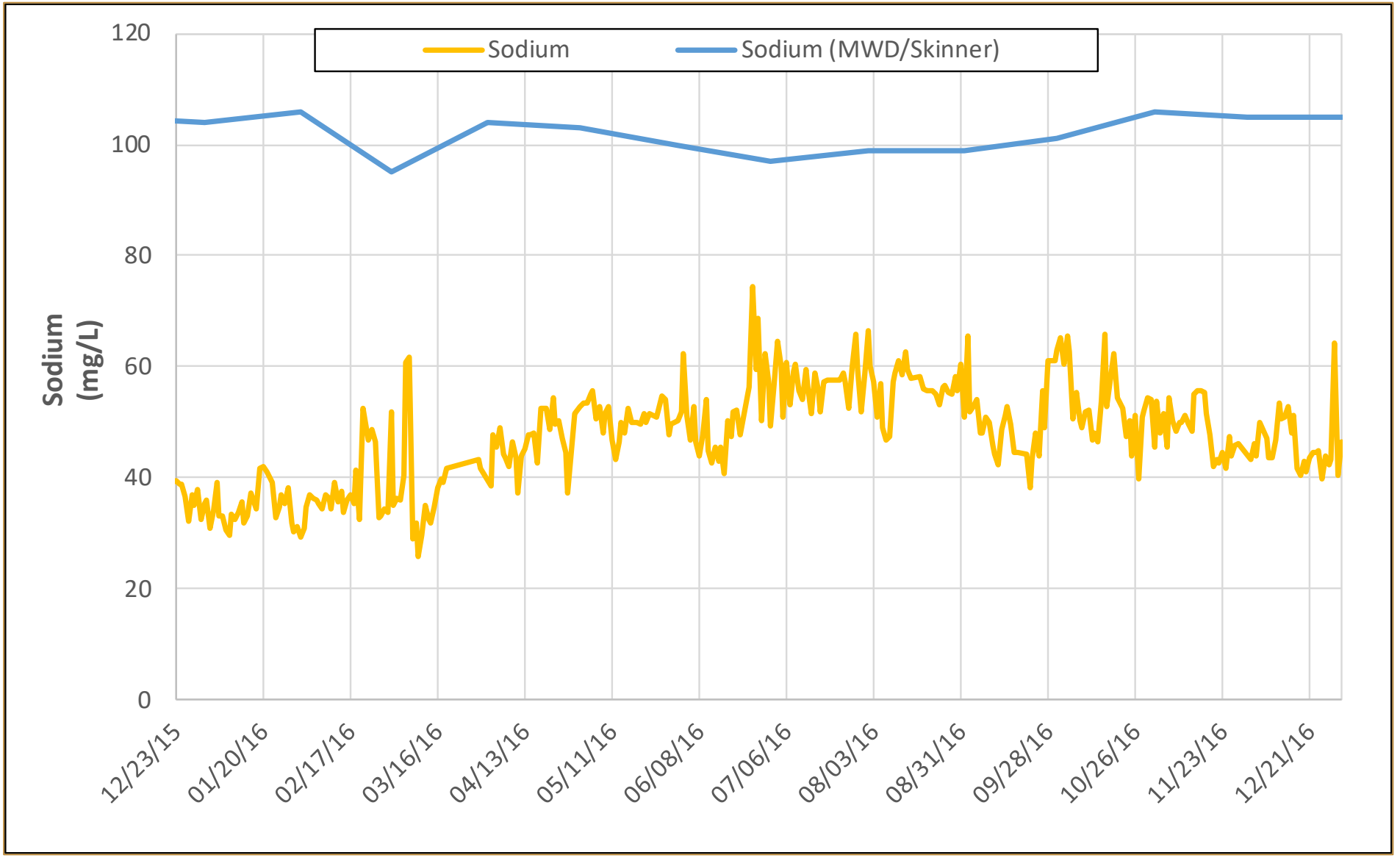
Calcium: SWRO vs. MWD



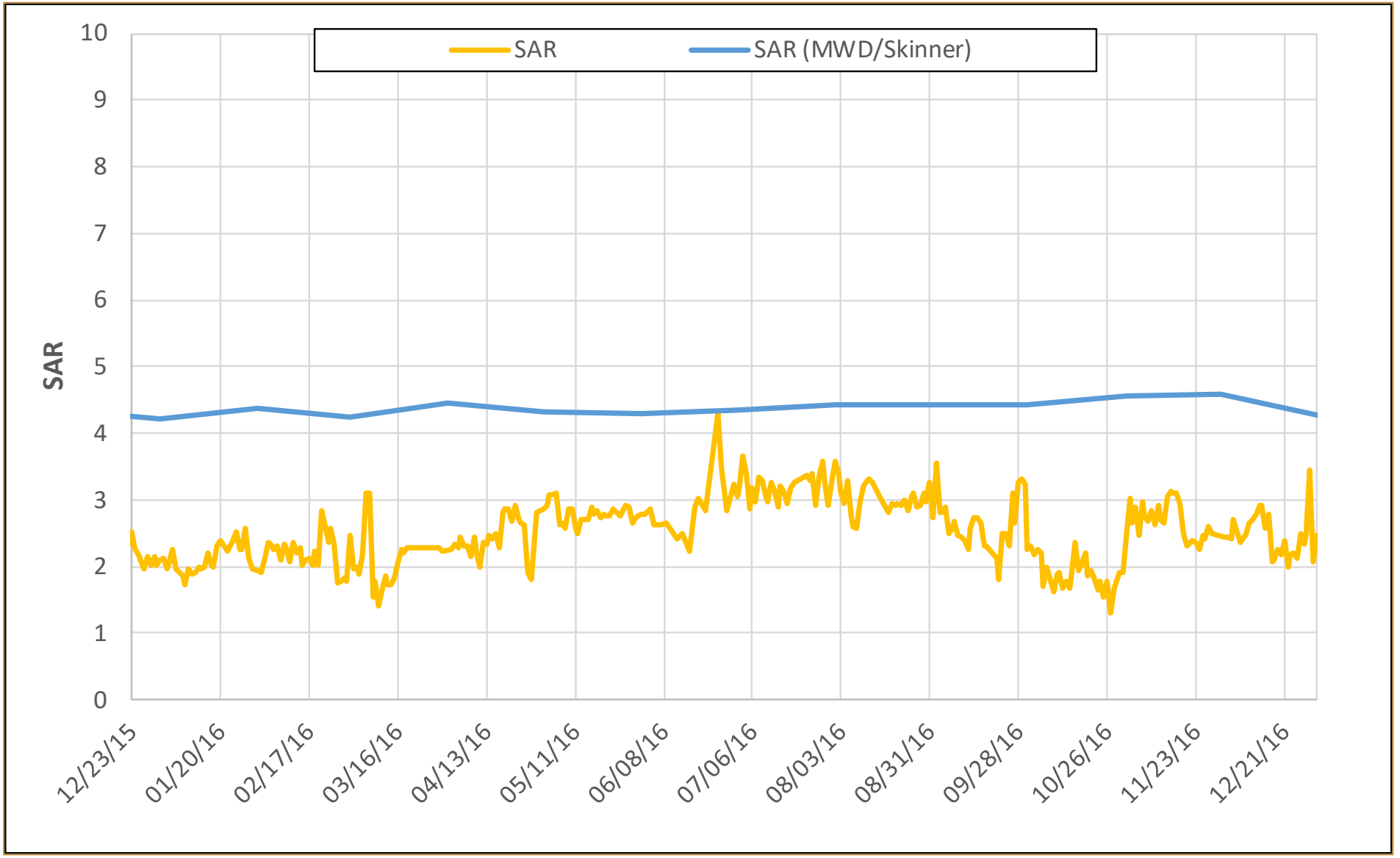
Magnesium: SWRO vs. MWD



Sodium: SWRO vs. MWD



SAR: SWRO vs. MWD



LESS SALT. MORE WATER.

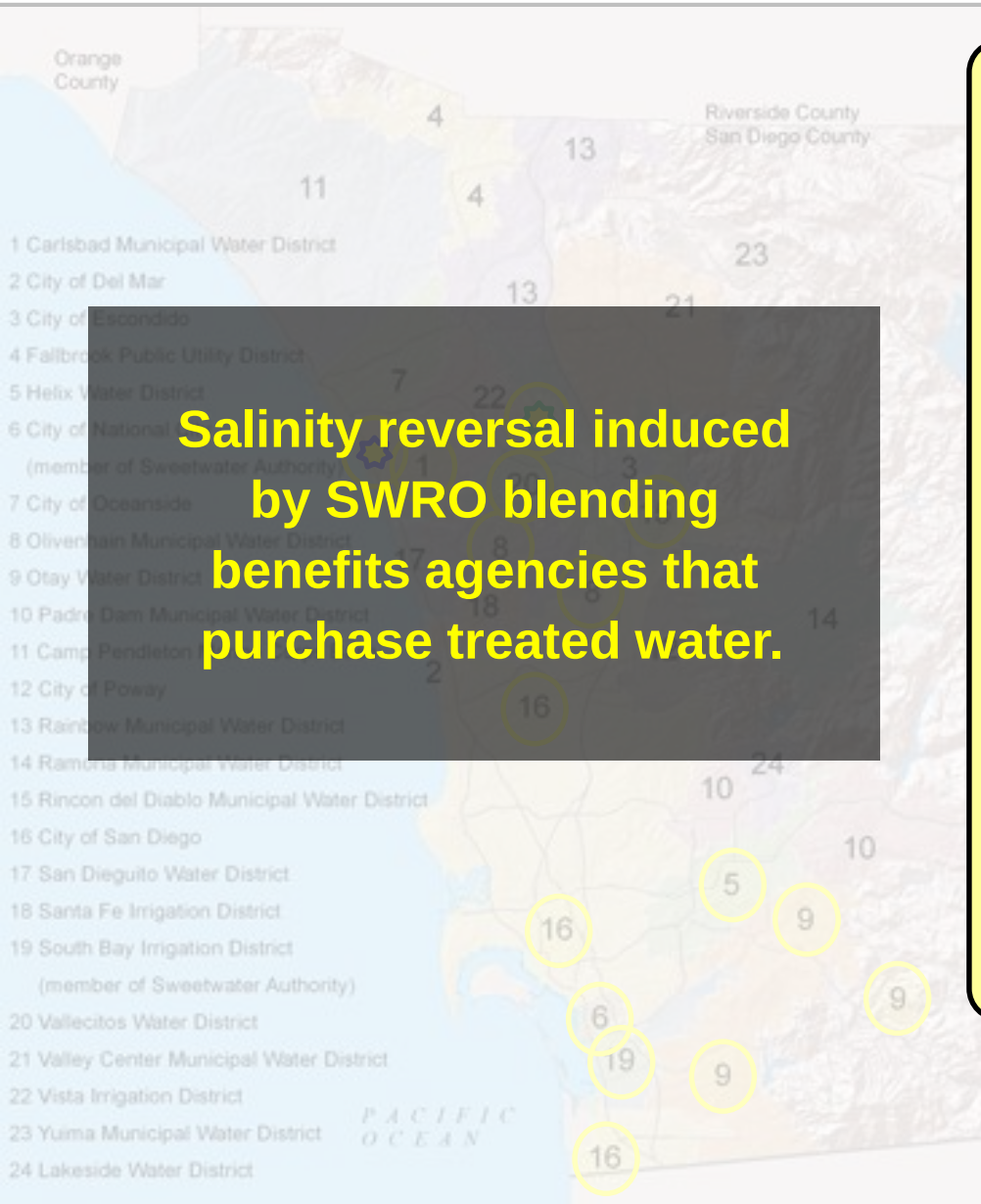
Concentrate & Salinity Management Session, Part 1

Multi-State Salinity Coalition

Concentrate & Salinity Reversal Session, Part 1

But not uniformly across the region

SDCWA Service Area



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

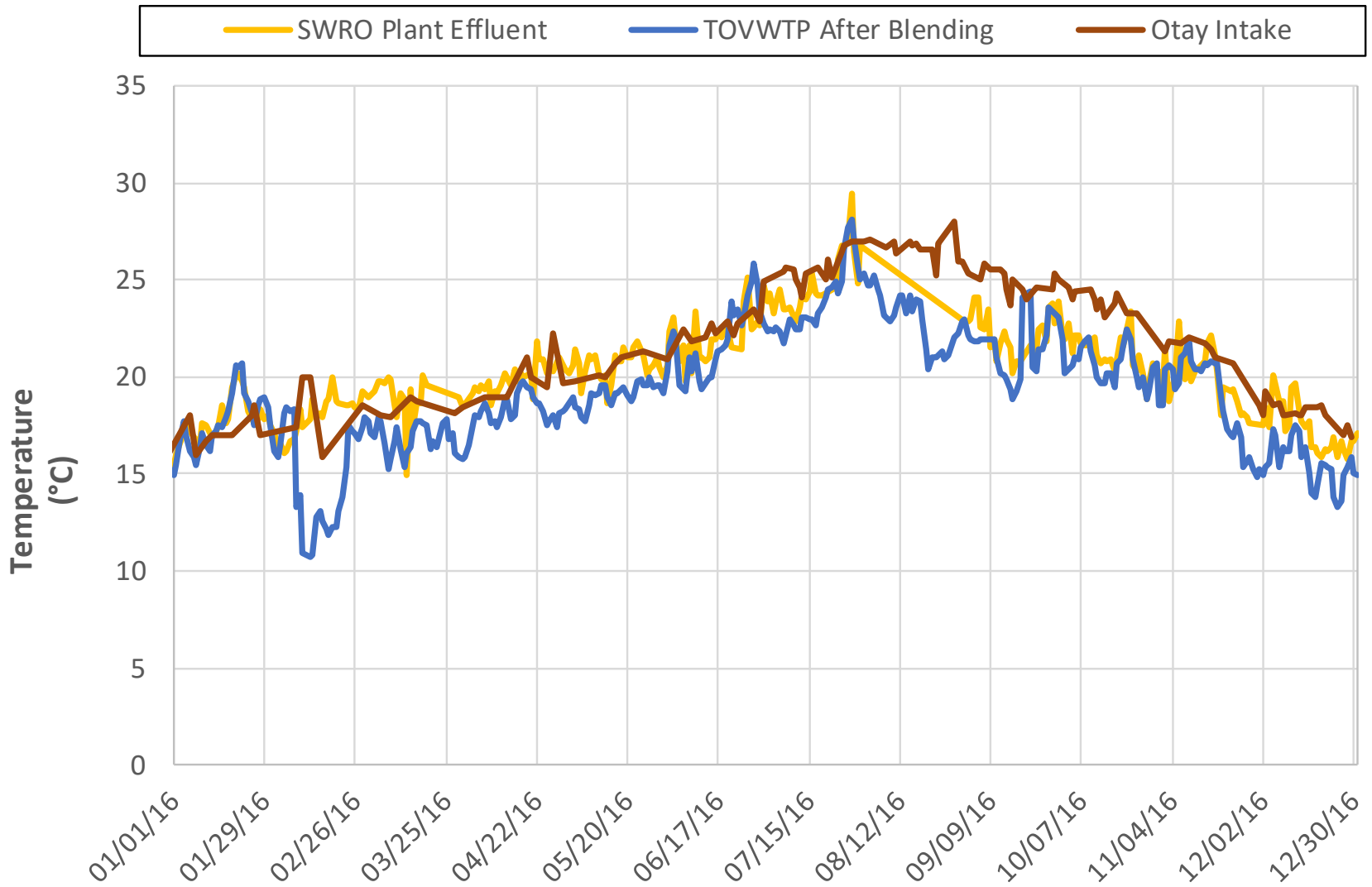
- Member Agencies that have their own surface water treatment plants typically purchase raw water exclusively.
- Member Agencies that **do not** have surface water treatment plants purchase treated water exclusively.

Agencies that purchase treated water will sometimes receive 100% SWRO water.

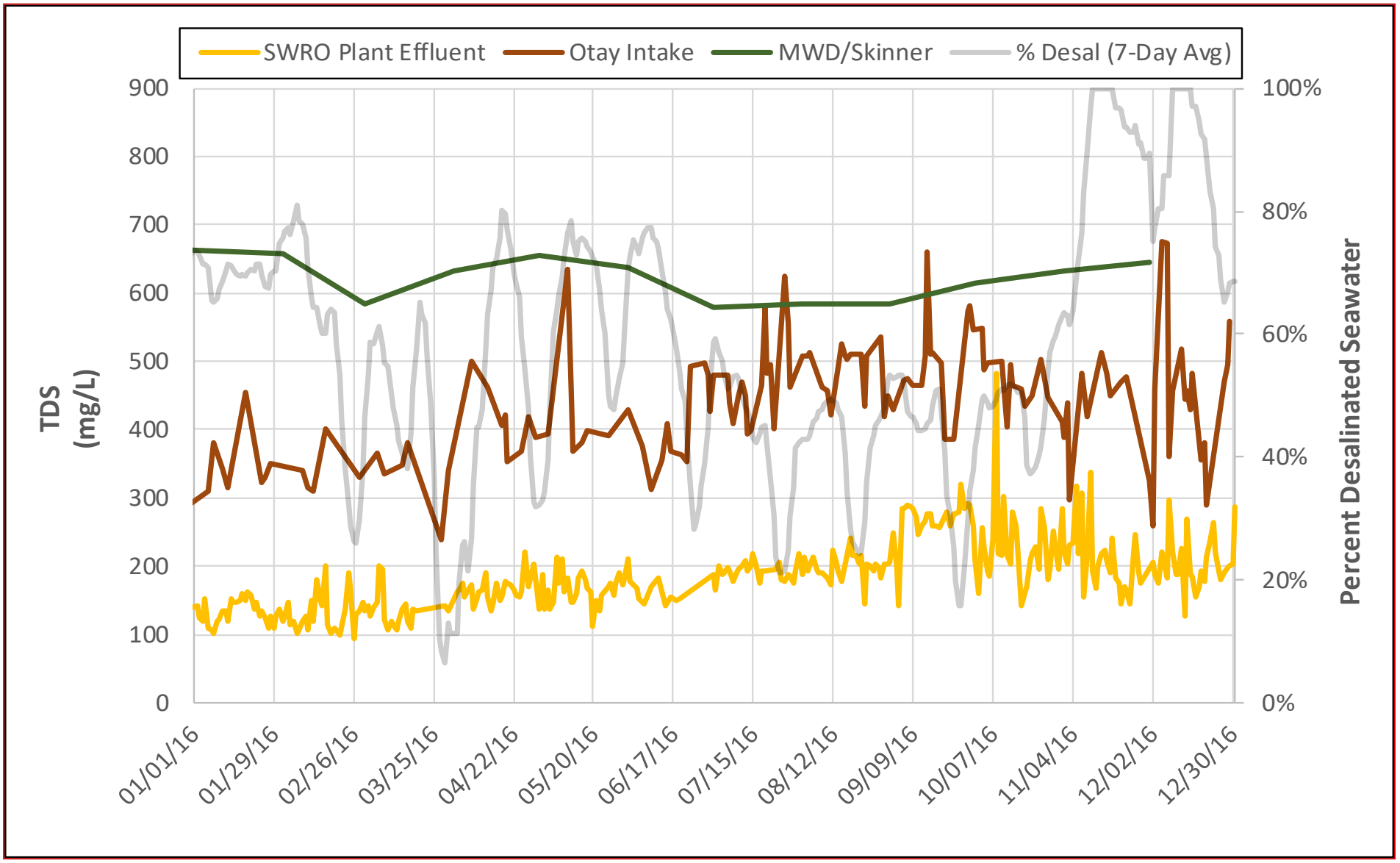
WERF-15-06 Partner Agencies

San Diego County Water Authority

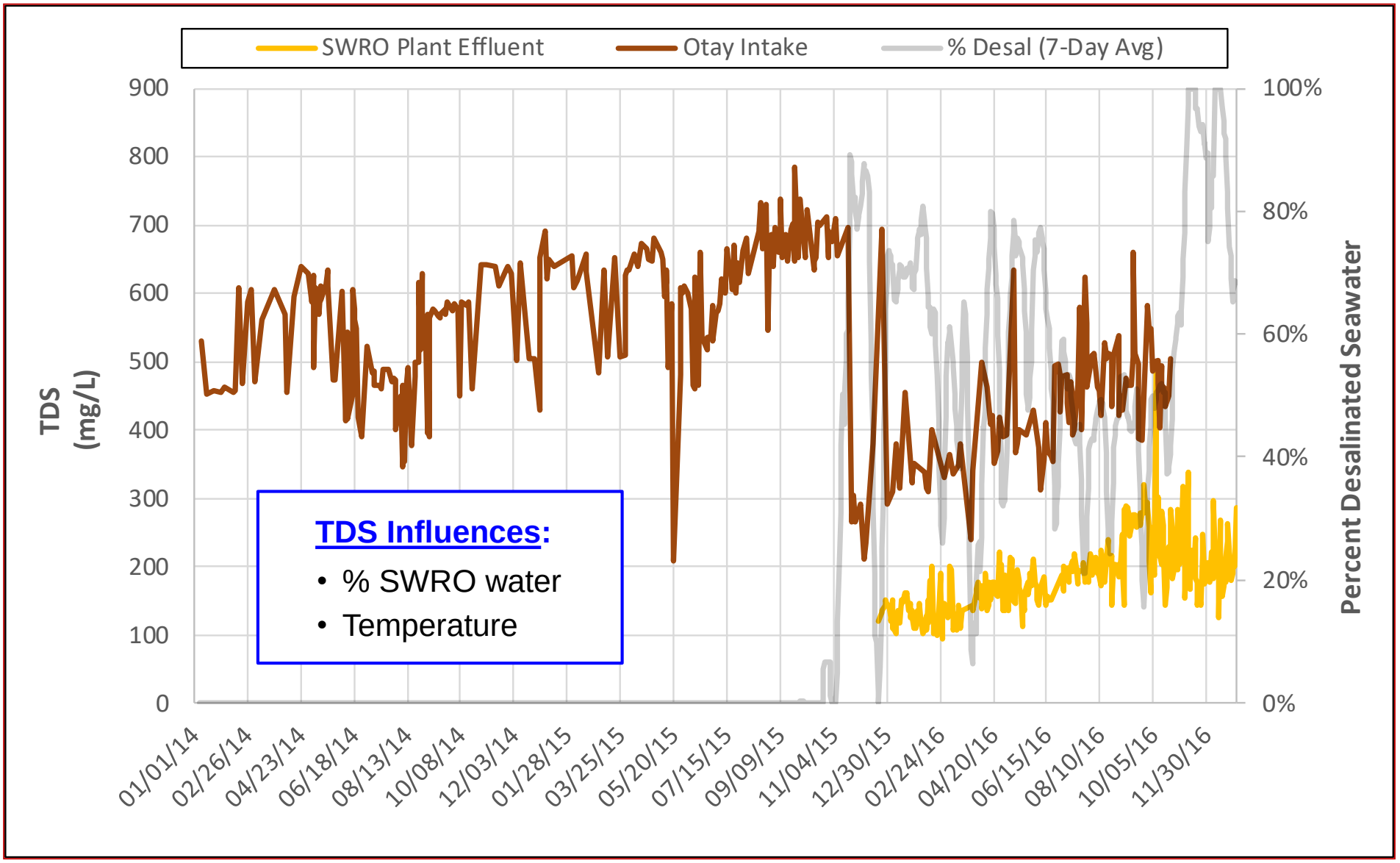
Temperature



TDS


SWRO Plant Effluent
Otay Intake
MWD/Skinner
% Desal (7-Day Avg)
TDS (mg/L)
Percent Desalinated Seawater
900
800
700
600
500
400
300
200
100
0
100%
80%
60%
40%
20%
0%
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

TDS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Otay Intake
% Desal (7-Day Avg)
TDS (mg/L)
Percent Desalinated Seawater
900
800
700
600
500
400
300
200
100
0
100%
80%
60%
40%
20%
0%
01/01/14
02/26/14
04/23/14
06/18/14
08/13/14
10/08/14
12/03/14
01/28/15
03/25/15
05/20/15
07/15/15
09/09/15
11/04/15
12/30/15
02/24/16
04/20/16
06/15/16
08/10/16
10/05/16
11/30/16
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)

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