



The Orange County Experience with Large Scale Water Reuse

Mehul Patel, P.E.

Executive Director of Operations

May 17, 2023



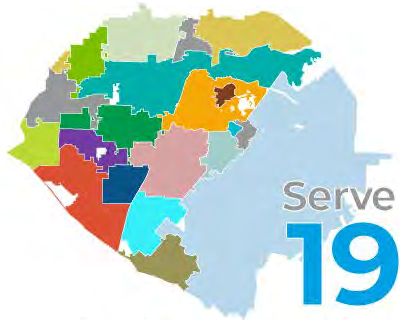
SINCE 1933

California Water Sources

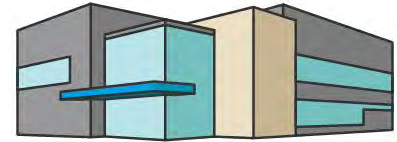
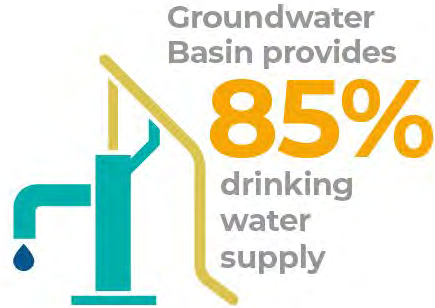
- Imported supplies
- Groundwater
- Stormwater
- Water transfers
- Desalination
- Water recycling



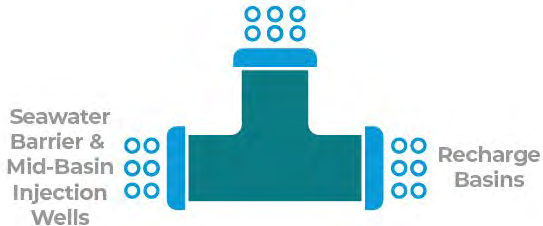
Orange County Water District



local water providers
and 2.5 million people

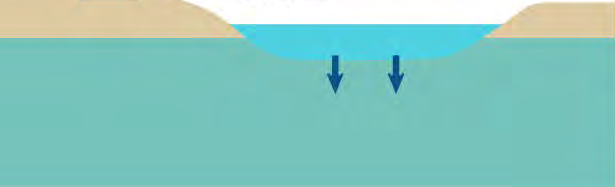


OVER **20,000 samples**
400,000 results

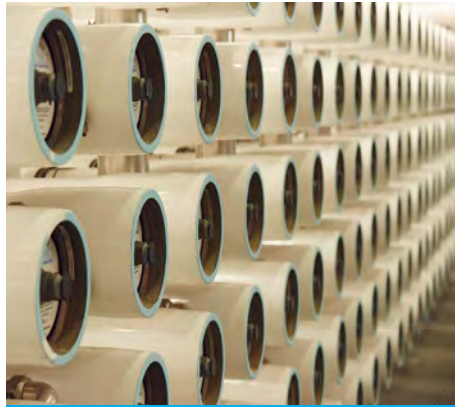


GWRS FINAL EXPANSION
130 MGD
serving **1 million** people

24 recharge basins
on **1,000+** acres
of land



Sustainable Groundwater Management



Water Reuse



Stormwater Capture

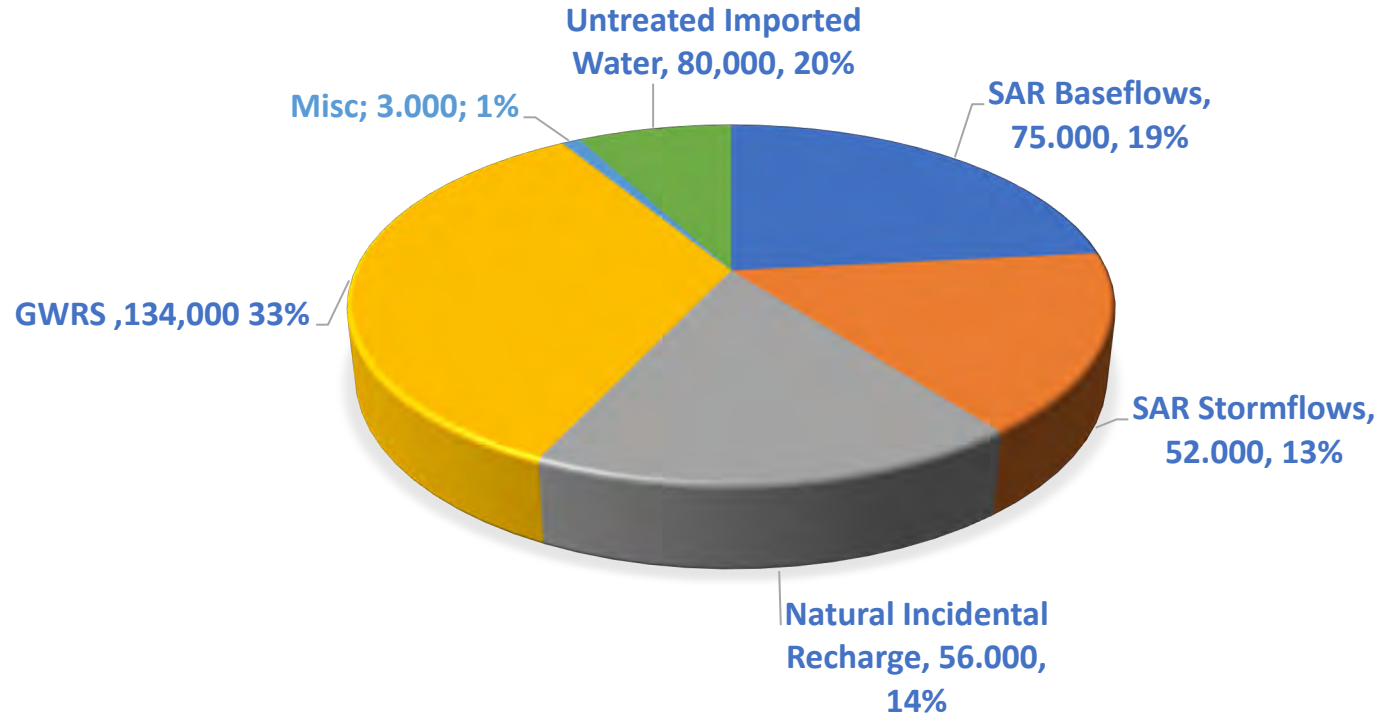


Santa Ana River

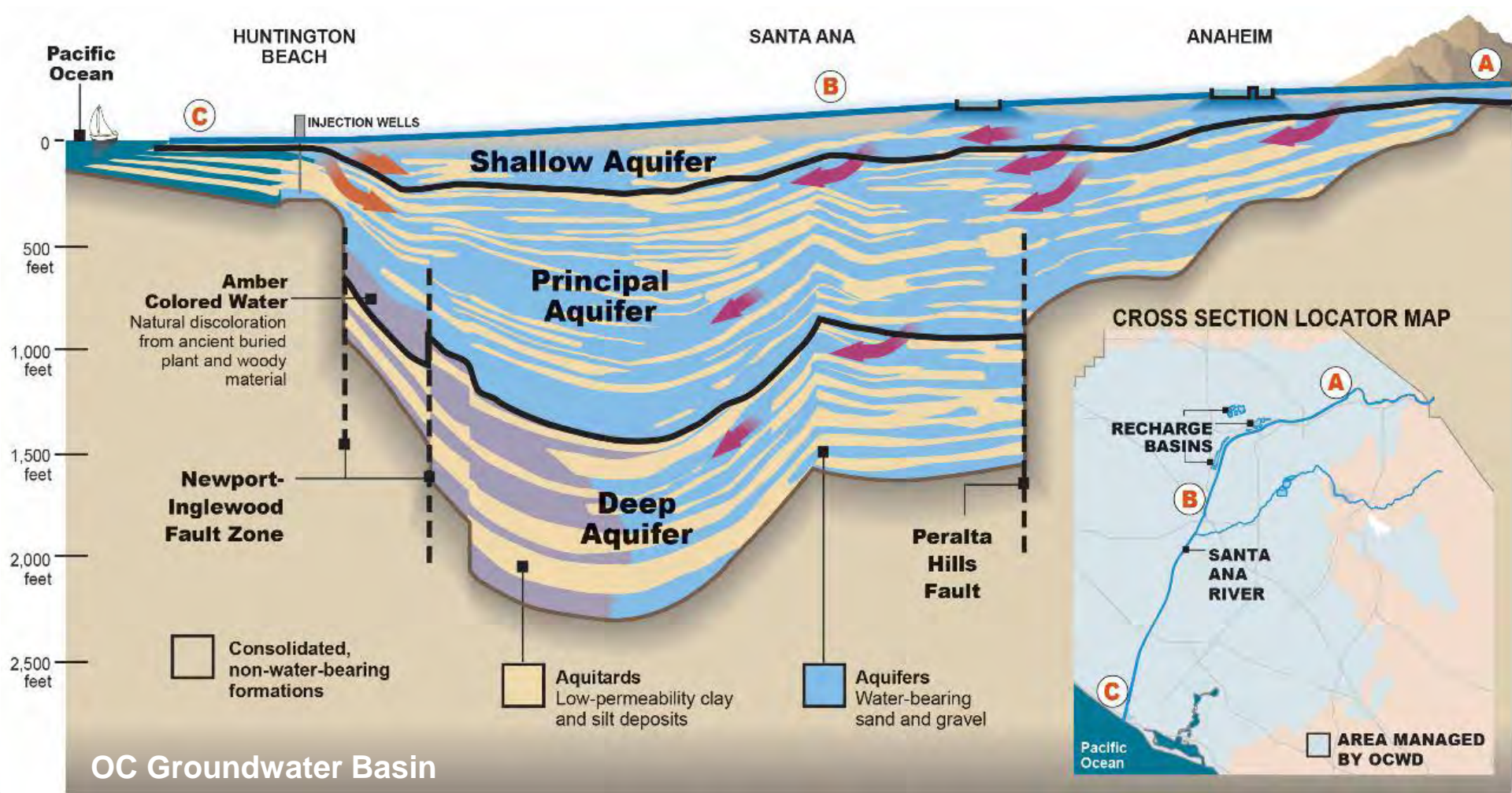


Basin Recharge

Diversified Water Supply Portfolio



OCWD Total Water Demands: 400,000 afy



Advancing Water Reuse Initiatives Over the Decades

1

1950s

- Growing population
- Increased water demands
- Decline in Orange County's water table
- Saltwater intrusion extended inland from the ocean

2

1960s

- Concept of Water Factory 21, the predecessor to GWRS, developed to address challenges
- Technical, engineering & operational experiments

3

1970s

- Launched advanced water treatment pilot project
- First ever application using RO on municipal wastewater
- Public outreach & education

4

1980s

- Continued operations of Water Factory 21
- Dedicated Research & Development (R&D) department
- Piloted various MF, UV, and RO membranes

5

1990s

- Concept & design of Integrated Membrane System
- Permit for direct injection of unblended purified wastewater into seawater intrusion barrier
- Guided formation of GWRS

6

2000s

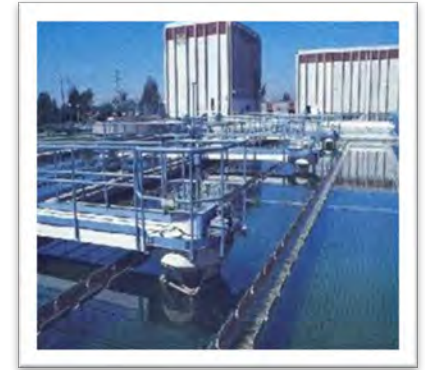
- Membrane treatment works on wastewater
- Full-scale pilot
- Advanced Water Quality Assurance Lab
- GWRS online in 2008; expanded in 2015; final expansion in 2023



History of Reuse at OCWD

Water Factory 21 - 1975 to 2004

- Lime, Recarbonation, Sand Filtration, GAC – 5 MGD, RO – 5 MGD, Deep wells – 5 MGD
- Research on RO and pretreatment options
- First plant in the world to use RO to purify wastewater to drinking water standards
- UV/H₂O₂ added in 2001 for NDMA, 1,4-dioxane



Green Acres - 1991 to present

- Tertiary treatment – 7.5 MGD (28,000 m³/d)

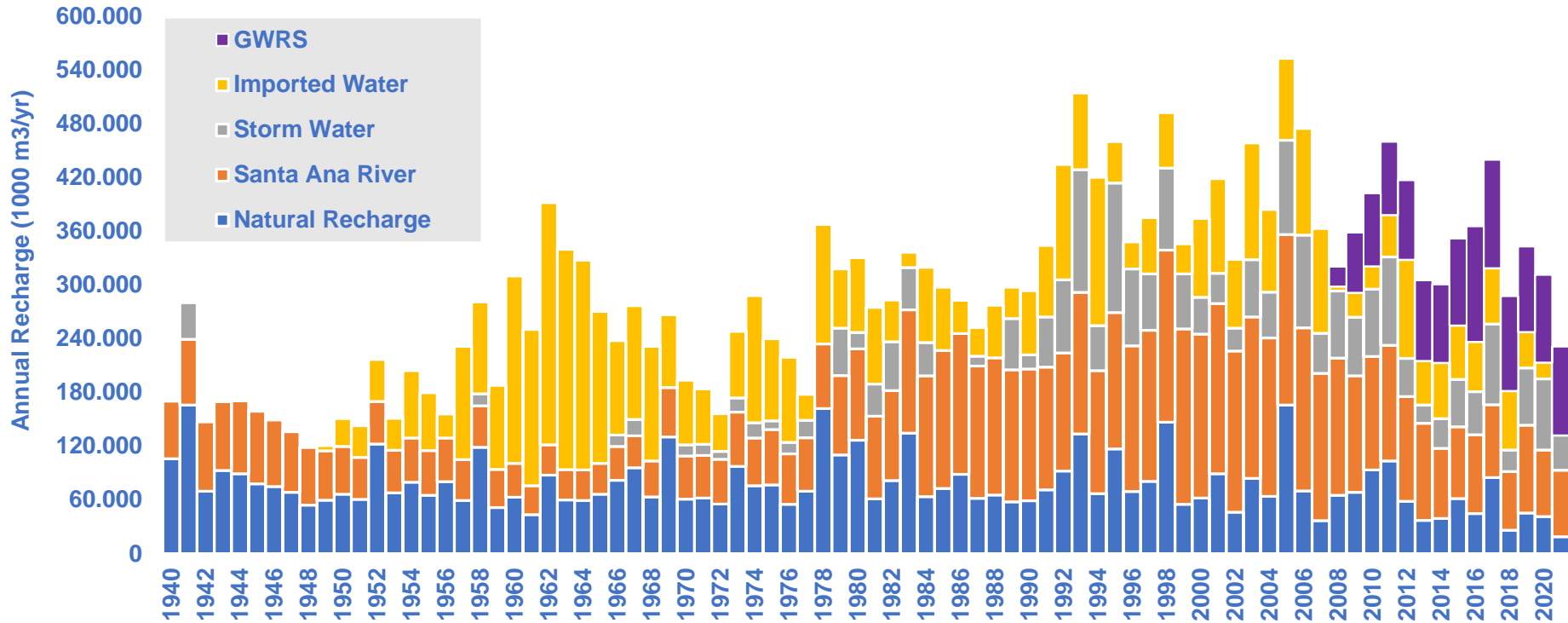
Interim Water Factory - 2003 to 2006

- MF/RO/UV – 5 MGD (19,000 m³/d)

GWRS – 2008 to present

- MF/RO/UV – 100 MGD since 2015 (378,000 m³/d)
- Final Expansion to 130 MGD in Jan. 2023 (492,000 m³/d)

Sources of Water to Orange County Groundwater Basin



Leaders in Water Reuse



- GWRS operational since January 2008 (70 MGD/265,000 m³/d), expanded May 2015 (100 MGD/378,000 m³/d), final expansion complete in early 2023 (130 MGD/492,000 m³/d)
- Purifies sewer water that would otherwise be discharged to the ocean
- Replenishes the Basin with 134,000 AFY of water, enough for nearly 1,000,000 people
- Largest potable reuse project in the world





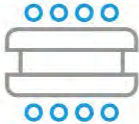
G | W | R | S



GROUNDWATER REPLENISHMENT SYSTEM

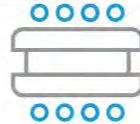
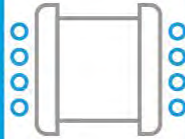
**Low Pressure
Membrane Filtration**

**OC San
Secondary
Effluent**



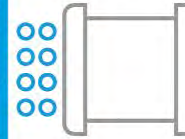
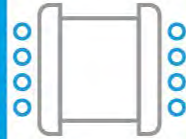
**Backwash
Sent to OC San**

Reverse Osmosis



**Concentrate Discharged
to OC San Outfall**

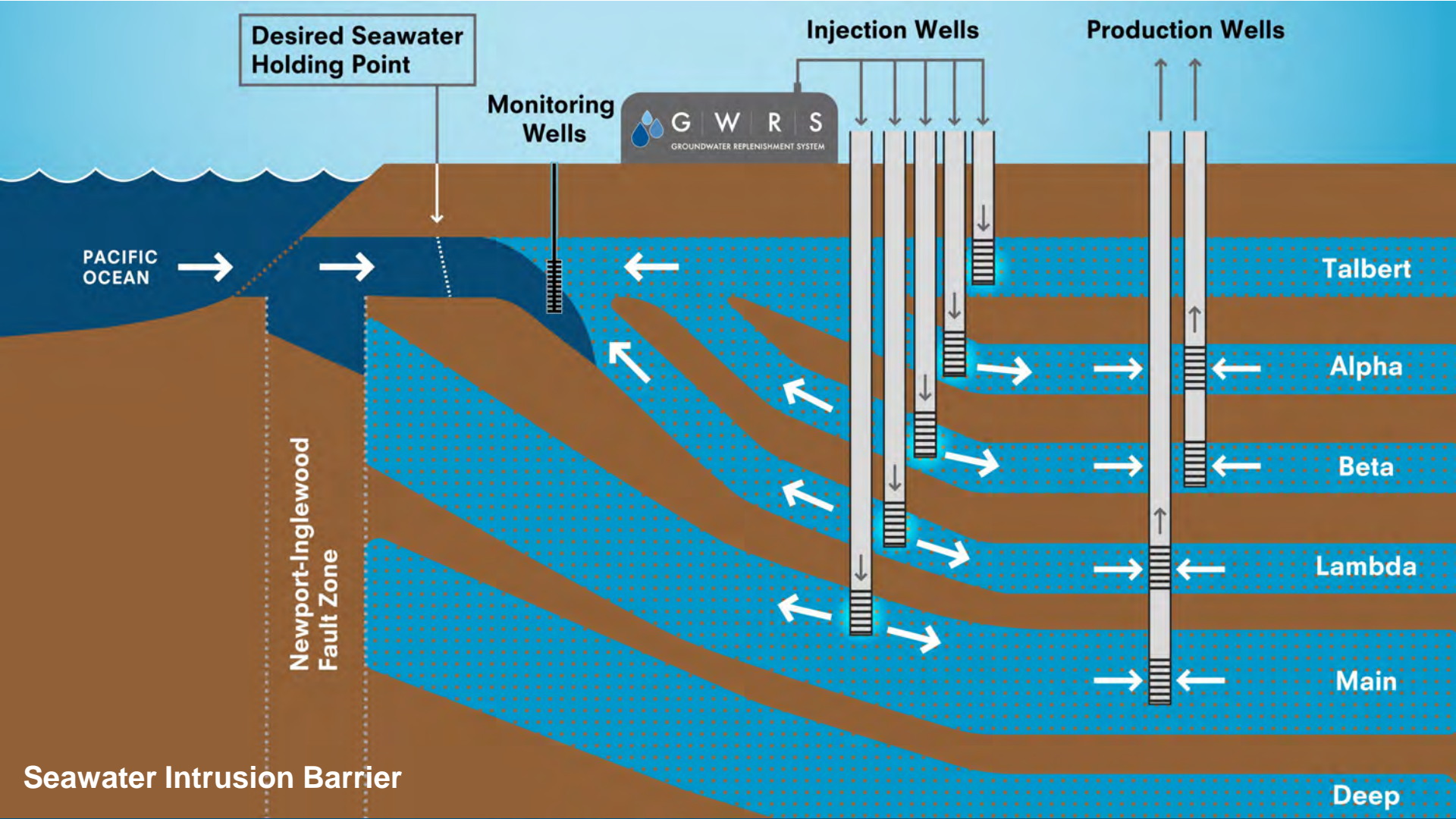
Ultraviolet Light + H₂O₂

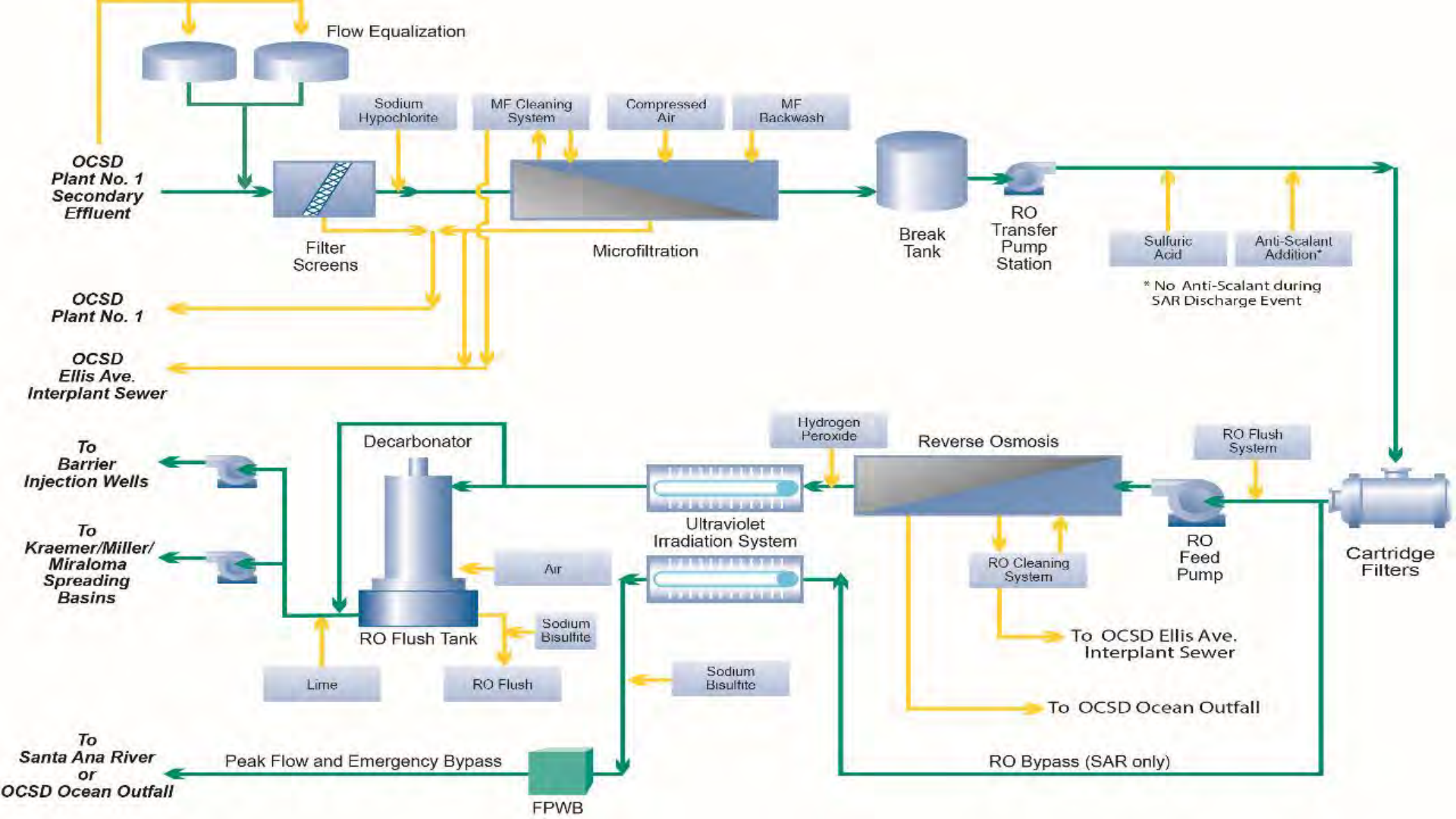


**Recharge
Basins**
○○○○

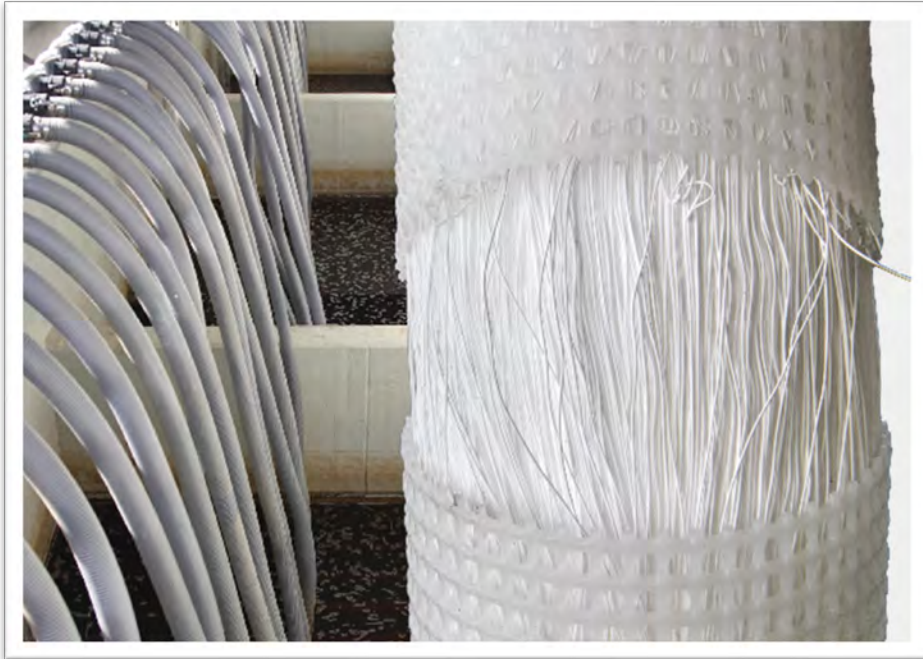


○○○○
**Seawater
Barrier &
Mid-Basin
Injection
Wells**





Microfiltration (MF) Process System



- 160 MGD (605,000 m³/d) Memcor CMF-S Microfiltration System
- In basin submersible system (48 individual below grade basins)
- 0.2 micron pore size polypropylene (32 basins)
- GWRSFE added PVDF membranes with 0.04 micron pore size (16 basins)
- Recovery rate: 90%
- Removes bacteria, protozoa, and suspended solids



8 basins
PP membrane

8 basins
PVDF membrane

8 basins
PVDF membrane

8 basins
PP membrane

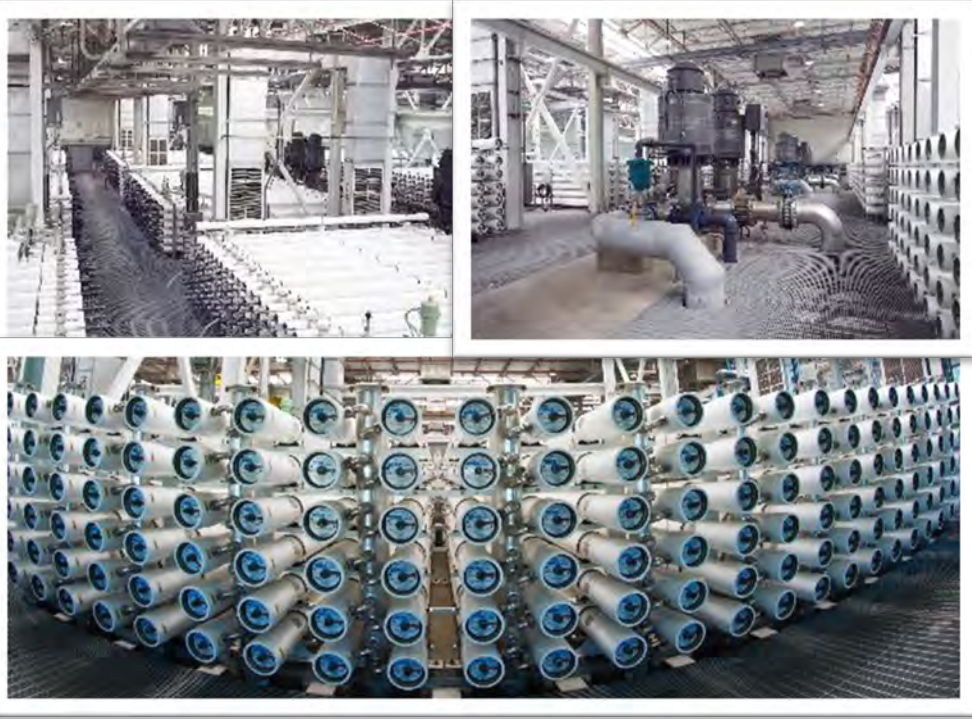
8 basins
PP membrane

8 basins
PP membrane



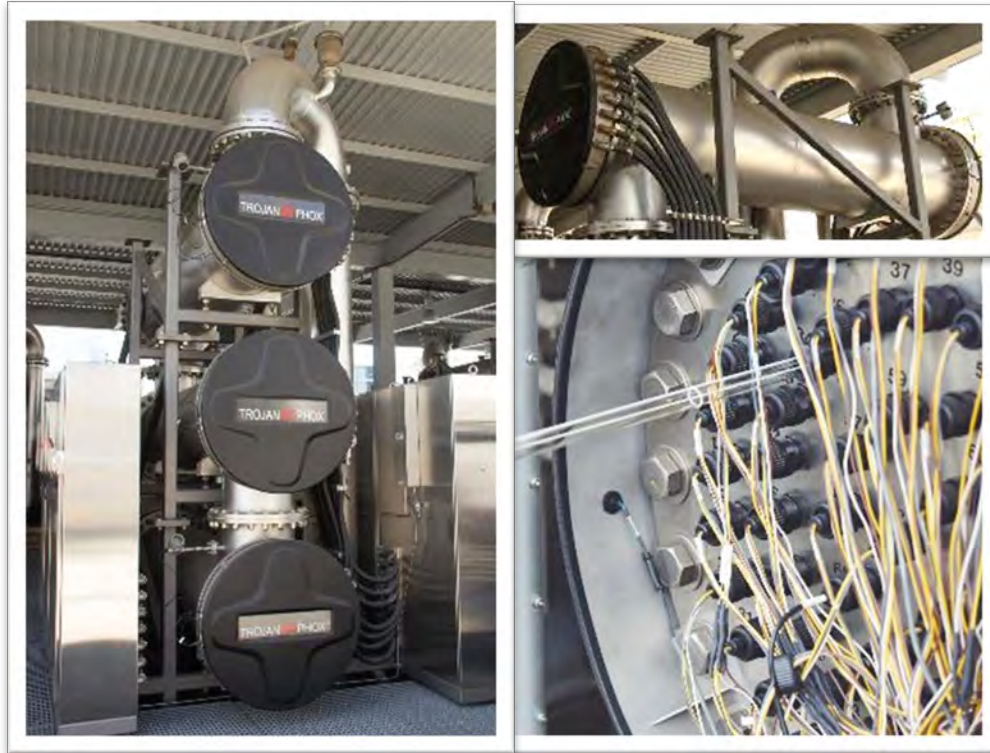


Reverse Osmosis (RO) Process



- 130 MGD (492,000 m³/d) RO System
- 3 stage: 78-48-24 array
- 27 individual, 5 mgd (19,000 m³/d) units
- Filmtec BW30XFRLE/XFRLE, Hydranautics ESPA2LD, LG BW400ES Membranes
- Recovery rate: 85%
- Removes dissolved minerals, viruses, and organic compounds (incl. pharmaceuticals)
- Permit limit of 0.5 mg/L TOC achieved by RO
- Pressure range: 150 – 220 psi (10-15 Bar)

Advanced Oxidation Process (AOP)



- 130 MGD (492,000 m³/d) Trojan UVPhox System
- Low pressure – high output lamp system
- Destroys trace organics
- Uses hydrogen peroxide to create an Advanced Oxidation Process
- After treatment, water is so pure that minerals (lime) are added back into the water

Post Treatment Process



- Partial decarbonation up to 45% of flow with remainder bypassing
- Hydrated lime added to combined decarbonated and bypass flows
- Process targets a final product water pH of 8.5, alkalinity of 50 mg/L as CaCO_3 , slightly negative LSI
- Final chemistry must avoid injection well fouling while also providing corrosion protection



Pathogen Removal Credits*

Process Monitored	Type of Analyzer/ Monitor Used and Limits to be Maintained	Pathogen Credit Received for Analyzer/Monitor Used
Microfiltration	<ul style="list-style-type: none"> • Turbidity < 0.2 • Pressure Decay Test (LRV>4) 	<ul style="list-style-type: none"> • 4+ log Giardia and Crypto
Reverse Osmosis	<ul style="list-style-type: none"> • TOC (2-log) • Electrical Conductivity (back up to TOC) • Turbidity < 0.2 	<ul style="list-style-type: none"> • 2+ Log Giardia and Crypto • 2+ Log Virus
UV/AOP	<ul style="list-style-type: none"> • UVT >95% • Ballast Power monitor (EED >0.23kWh/kgal) 	<ul style="list-style-type: none"> • 6 Log Giardia and Crypto • 6 Log Virus

* California regulations require 12-log virus, 10-log Giardia, 10-log Crypto removal (1-log virus removal credit for each month of underground travel time)

Benefits of GWRS

- Creates a new local water supply
- Reuses a wasted resource
- Increases water supply reliability
- Costs \$850 per acre-feet ($\$0.70/m^3$) or less than imported water sources
- Uses 1/2 the energy it takes to import water and 1/3 the energy to desalinate seawater
- Improves quality of water in the basin



Squeezing Out The Last Drop

- GWRS Final Expansion complete in 2023 Q1
- Requires brining in new supply from OC San Plant No. 2
- Recycle 100% of OC San's reclaimable flows
- 130 MGD (492,000 m³/d) capacity, enough to serve 1 million people
- Expanded treatment facilities, new conveyance facilities, pipeline rehabilitation
- Plant No. 2 source water provides new challenges (seawater intrusion, trickling filter)



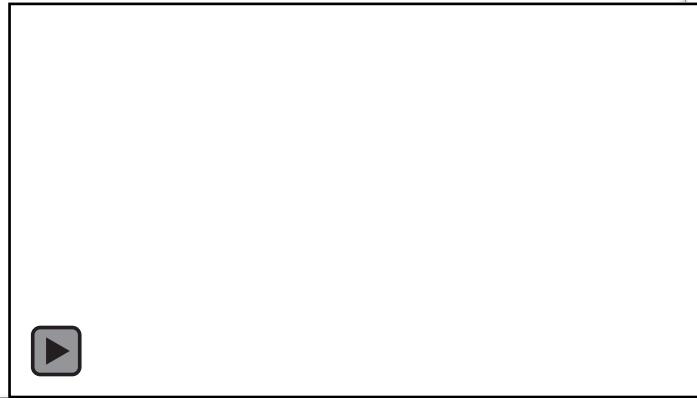
Unit Cost of Water Produced by GWRS

	Cost (\$)	\$/Acre Foot	\$/m³
Electricity	\$18,227,623	\$197	\$0.16
Chemicals	\$7,944,299	\$86	\$0.07
Labor	\$11,827,852	\$128	\$0.10
Plant Maintenance	\$3,860,555	\$42	\$0.03
R&R Fund Contribution	\$10,983,162	\$119	\$0.10
Debt Service	\$23,253,950	\$252	\$0.20
Demand Response	-\$716,695	-\$8	-\$0.01
	\$75,380,745	\$816	\$0.66

Production Volume (Acre Foot)	92,373	(113,895,909 m ³)
Power Consumption (kWh/AF)	1,468	(1.2 kWh/m ³)

Outreach & Education

- Early & often communications key to success
- Multi-year, proactive public & stakeholder outreach resulting in no active opposition
- Bottled water program
- Public tour program with nearly 50,000 visitors
- National & international media attention, recognition, awards
- Global model for water reuse projects



FEATURED IN



Securing a Reliable Supply for the Future

- We never took our foot off the pedal
- Do not fear change
- Public outreach must continue
- Ongoing and future research and innovation is needed
- Projects that embrace newer technologies that have been adequately researched & pilot tested will have a high probability of success
- Must have a diversified water supply portfolio



***405+ BILLION gallons produced...
and counting!***

QUESTIONS?

Mehul Patel, P.E.

Executive Director of Operations

Orange County Water District
18700 Ward Street, Fountain Valley, CA 92708
(714) 378-8209
mpatel@ocwd.com
www.OCWD.com

