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A-5-HNB-10-225 / 9-21-0488
(Poseidon Water, Huntington Beach)

MAY 12, 2022

CORRESPONDENCE
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(Poseidon Water, Huntington Beach)

CORRESPONDENCE:

Letters from

Organizations

Inflated Employment Claims Made by Brookfield-Poseidon are Public Cause for Concern

Thursday, April 7th, 2022

To: Donne Brownsey, Chair
California Coastal Commission
455 Market Street, Suite 300
San Francisco, CA 94105

cc: John Ainsworth, Executive Director
Kate Huckelbridge, Senior Deputy Director
Tom Luster, Senior Environmental Scientist

Regarding: Poseidon Resources, LLC; Seawater Desalination Project at Huntington Beach; Application for Coastal Development Permit; Appeal of Coastal Development Permit; 21730 Newland Street, Huntington Beach

Dear Chair Brownsey and Commissioners,

If approved, the Huntington Beach desalination plant, proposed by Brookfield-Poseidon, would be an energy-intensive hazard causing more harm to the communities of North Orange County ("North OC") than benefits.[1] Despite Brookfield-Poseidon's promises of economic prosperity, industrial polluters such as the entities behind the proposed desalination plant, are known to cause economic harm to commercial properties and residential areas.[2] And the permitting of such industrial activity on our coast has the potential to significantly diminish economic activity in the area that is unrelated to the desalination plant. It would also hinder the community's current and future residential population and the value of their properties.

Brookfield-Poseidon has made assertions that its project will create around 3,000 jobs for Huntington Beach residents, however, they admit that only 1% of that number will be permanent

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[1] *See* Oscar Rodriguez, *Rodriguez: The Environmental Racism Behind the Poseidon Desalination Proposal*, Voice of Orange County (2020) https://voiceofoc.org/2020/11/rodriguez-the-environmental-racism-behind-the-poseidon-desalination-proposal/ ("If the Brookfield-Poseidon desalination project is built, it would unnecessarily expose the community to another half-century of emissions from the Alamitos Energy Center, a gas power plant that has no place in a clean energy future, where everyone's health matters."); *See also* Gregory Pierce, *Analyzing Southern California Supply Investments from a Human Right to Water Perspective: The Proposed Poseidon Ocean Water Desalination Plant in Orange County*, UCLA Luskin Center for Innovation at 1-2 (2019) https://innovation.luskin.ucla.edu/wp-content/uploads/2019/04/Analyzing_Southern_CA_Supply_Investments_from_a_Human_Right_to_Water_Perspective.pdf (finding that the Water Purchase Agreement with Poseidon will make water severely less affordable for disadvantaged households in Orange County, and that the Human Right to Water cannot be plausibly realized from this project.); *See also* Brian Bienkowski, *Desalination plants are on the rise—so is their salty, chemical waste*, Environmental Health News (Jan. 15, 2019) https://www.ehn.org/desalination-plant-waste-oceans--2625733077.html ("When brine is sent back to the ocean it can harm aquatic life by sharply raising the salinity level of the water and can carry harmful chemicals that the brine picks up in the desalination process … high salinity and reduced dissolved oxygen levels can have profound impacts on benthic organisms, which can translate into ecological effects observable throughout the food chain.").

[2] Undesirable land uses like hazardous waste facilities have negative impacts on residential home values no matter the market. Laura O. Taylor, Daniel J. Phaneuf, Xiangping Liu, *Disentangling the Property Value Impacts of Environmental Contamination from Locally Undesirable Land Uses: Implications for Measuring Post-Cleanup Stigma,* J. of Urb. Econ. 85, 90 (2016).

occupations and even fewer would be locally sourced.[3] In fact, the site plans for the Huntington Beach facility contain 187 spaces for parking, a number far from Brookfield-Poseidon's original employment claims.[4] On their website, Brookfield-Poseidon claims the number of jobs is "over 2,000 though only 18 would be full time jobs.[5] We believe these inflated job estimates are an attempt to make their proposal seem more appealing and are used to justify the building of a toxic industrial desalination plant on the beautiful coast of Orange County, which is already tainted by the AES plant. The vast discrepancy in the numbers Brookfield-Poseidon communicated to the public and those actually planned by Brookfield-Poseidon show bad faith and should devalue any claims characterizing this project as a significant job creator. Instead, in reality, multi-use zoning and facilities that are close to the beach would likely yield more jobs, economic activity, and property value for local residents, all while protecting the environment.

Granting a permit to yet another polluting facility in North OC would limit tourism as well as residential and environmental activity. Desalination plants are known to have adverse environmental effects and possess the potential to diminish the environmental quality for humans and animals alike.[6] As a result, jobs, businesses, and residents could leave in search of a cleaner and healthier environment. Brookfield-Poseidon's erroneous job claims do not consider the jobs lost due to another toxic industrial facility being permitted to operate in North OC. However, this flight of jobs and capital need not happen if Brookfield-Poseidon's coastal development permit applications are denied, and other water conservation efforts and strategies are pursued instead.[7]

A denial of Brookfield-Poseidon's application for coastal development permits would give way to more sustainable and equitable strategies that offer better jobs, healthy economic activity, and

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[3] Proponents of the project often state this project would create over 3000 jobs for the community, however, Brookfield-Poseidon admits this estimate is solely based on construction work and contracting. According to the company's website, only 18 full-time jobs will be created along with an ambiguous "322 indirect jobs." And Brookfield-Poseidon's Carlsbad desalination plant only employs 35 workers. Whether the number is 18, 35, or 322, all are far short of the estimates proclaimed by the project's supporters. Furthermore, Brookfield-Poseidon has failed to provide any indication that the jobs will be locally sourced or that there is a local job hiring policy. *Huntington Beach Desalination Plant*, Poseidon Water https://www.poseidonwater.com/huntington-beach-desalination-plant.html; *The Many Benefits of Desalination*, Seawater Desalination Huntington Beach facility https://www.hbfreshwater.com/benefits.html; *See* Senator Barbara Boxer and Antonio Gonzalez, *Desalination plant in Southern California is important to water security,* Mercury News (Oct. 17, 2021) https://www.mercurynews.com/2017/10/13/opinion-desalination-plant-in-southern-california-is-important-to-water-security/ ("[T]he plant will support more than 3,000 jobs in desalination, engineering, and construction. Once operational, it will directly support 419 ongoing local jobs."); Carlsbad Chamber of Commerce https://carlsbad.org/Spotlight-OnPeter-MacLaggan-Poseidon-Resources-Corporation/.

[4] Poseidon Resources Application for Coastal Development Permit, Attachment 22, page 4.

[5] *See* Exhibit One (Screenshot of Brookfield-Poseidon's website).

[6] *See* Rodriguez*, supra* note 1.

[7] Water conservation efforts like reusing wastewater offers a safer and better option than desalination plants. *See* Erica Gies, *Slaking the World's Thirst with Seawater Dumps Toxic Brine in Oceans,* Scientific American (Feb. 7, 2019) https://www.scientificamerican.com/article/slaking-the-worlds-thirst-with-seawater-dumps-toxic-brine-in-oceans/ ("California, Arizona and … Singapore have been pioneers in … using treated wastewater for crop and landscape irrigation as well as drinking water. Conservation is another oft-overlooked approach to the problem of dwindling water supplies… some water supply systems lose more than half their water to leaks. Urban areas can also expand green spaces to capture more storm water, rather than trying to shunt it away as quickly as possible."); *see also* Rodriguez*, supra* note 1 ("When we get rain, much of it runs to the ocean. We can do a better job of capturing this water with rainwater harvesting and by encouraging more permeable surfaces so the water gets into the ground.").

healthy communities.[8] Well-funded water recycling and conservation efforts will produce tens of thousands of jobs while also providing better benefits for the residents of North OC.[9] The proposed site for the desalination plant is a brownfield surrounded by brownfields and development on the site and around it will further expose the community to more industrial waste and toxins. Instead, money should be directed to the brownfield project site for remediation and sustainable end uses rather than industrial end uses run on fossil fuels.[10] To be clear, we believe the area should be returned to the original ecology, namely, wetlands and preserved for future generations.[11] However, other end uses that promote sustainable and healthy activity would likely create more full time employment on the site than Brookfield-Poseidon's plant.[12]

This project is not a significant job creator, but a polluting facility that is likely a job and property tax killer, with a real potential to decrease the quality of life in North OC. Thus, the wildly divergent job claims asserted by Brookfield-Poseidon and the adverse human and environmental effects posed by the toxic plant should accrue towards a denial of Brookfield-Poseidon's permit application. We ask the Coastal Commission to require Brookfield-Poseidon to prove and clarify its job claims about the project and for the Commission to factor in Brookfield-Poseidon's bad faith use of inflated claims when deciding on the merits of this application.

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[8] Public resources intended for the Brookfield-Poseidon project can be diverted to more efficient sustainable and equitable water conservation strategies. For example, **the Carson Regional Recycled Water Project is expected to create over 47,000 jobs** with the number being evenly split between direct and indirect jobs.

[9] *See* Rodriguez, *supra* note 1 ("For every million-dollar investment, water conservation creates 16.6 jobs, water recycling creates 12.6 jobs while desalination would only create 8.7 jobs, and only 60 percent of those jobs would be local.").

[10] A brownfield is a property or area whose (re)development is complicated by the presence of pollutants, contaminants, and hazardous substances. However, if carefully planned and equitably executed its redevelopment can have substantial benefits on the surrounding community. Overview of EPA's Brownfields Program, EPA https://www.epa.gov/brownfields/overview-epas-brownfields-program ("Cleaning up and reinvesting in these properties increases local tax bases, facilitates job growth, utilizes existing infrastructure, takes development pressures off of undeveloped, open land, and both improves and protects the environment.").

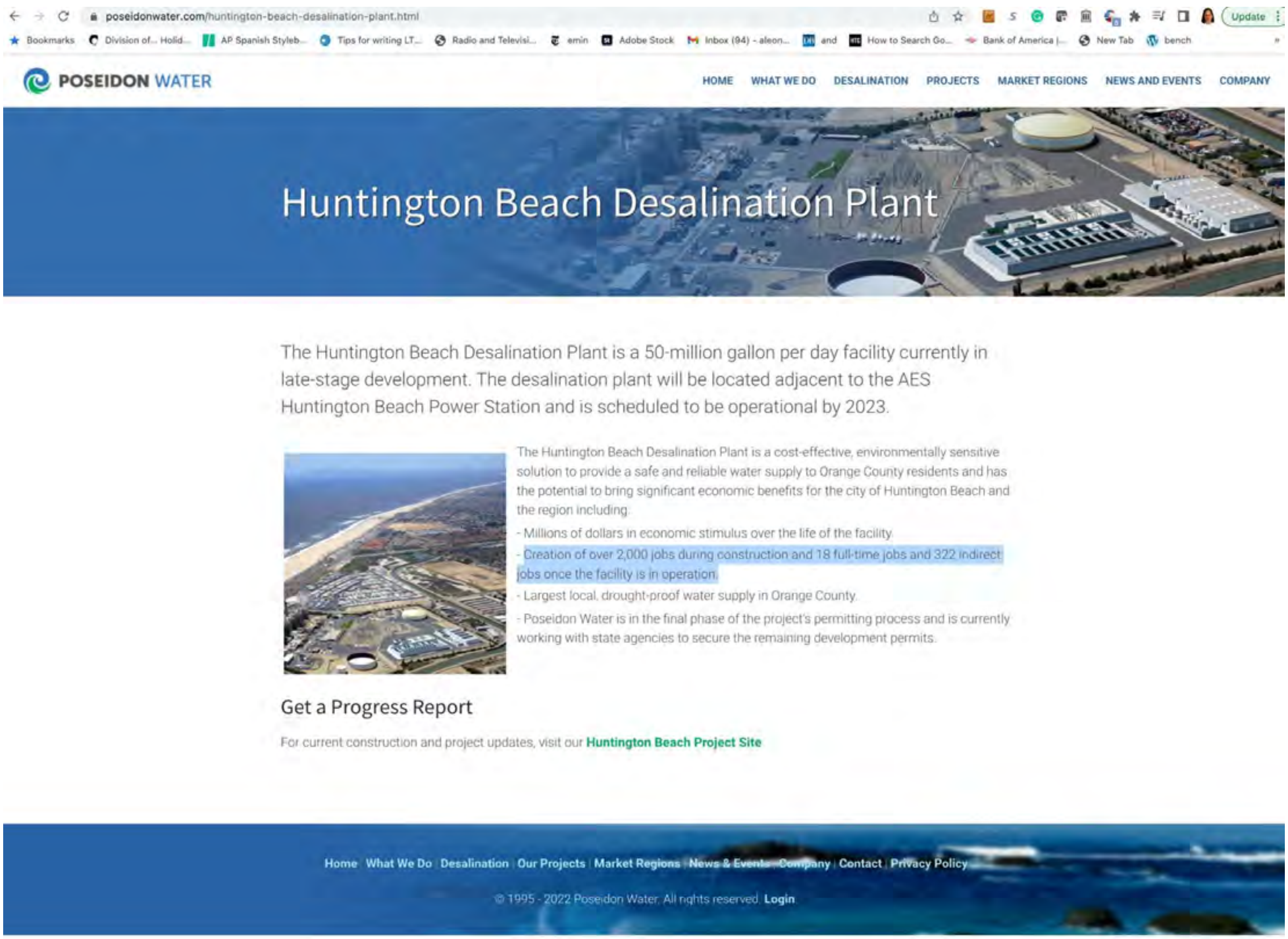
[11] Martin Wisckol, *Huntington Beach wetlands continue to expand, following decades of degradation*, The Orange County Register (October 16, 2020) https://www.ocregister.com/2020/10/16/huntington-beach-wetlands-continue-to-expand-following-decades-of-degradation/ ("The coastal wetlands of Orange and Los Angeles counties, once scorned for the obstacles they posed to the construction of roads and buildings, have been squeezed by development to less than 10% of their 19th-century size.").

[12] Wetland restoration produces numerous commercial, recreational, and aesthetic benefits for communities. Protecting and restoring wetlands can increase public safety and the quality of life in communities. *See, e.g., Basic Information about Wetland Restoration and Protection*, EPA https://www.epa.gov/wetlands/basic-information-about-wetland-restoration-and-protection#:~:text=These%20services%20generate%20state%20and,coastal%20areas%20from%20storm%20surges
("Wetlands also control erosion, limit flooding, moderate groundwater levels and base flow, assimilate nutrients, protect drinking water sources, and buffer coastal areas from storm surges."); *See*
Michelle Banks, *Wetland restorations offer environmental, economic benefits*,
https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/home/?cid=stelprdb1117054 ("[P]lants and biological processes in the wetlands break down pollutants like fertilizers … filtered water then flows into nearby streams or sinks into underground aquifers, which become sources of municipal drinking water … towns are able to reduce water treatment system costs … as an added benefit, wetlands slow down and soak up water that runs off the land, reducing flood impacts and eliminating the need to build expensive flood control structures").

Sincerely,

Andrea León-Grossmann | Climate Action Director of Azul
Frankie Orona | Executive Director, Society of Native Nations
Lydia Poncé | Director, Idle No More So Cal
Charming Evelyn | Chair - Water Committee, Vice Chair Environmental Justice Committee - Sierra Club Angeles Chapter, Co-Chair Conservation Committee - Water, Sierra Club CA
Oscar Rodriguez | Co-founder of OakView ComUnidad
Alejandro Sobrera | Hub Coordinator of Sunrise OC
Patricia J. Flores Yrarrázaval | Project Director, Orange County Environmental Justice (OCEJ)
Espe Vielma | Executive Director of the Environmental Justice Coalition for Water
Conner Everts | Desal Response Group, Southern California Watershed Alliance
Dave Hamilton | President, Residents for Responsible Desalination
Mandy Sackett | California Policy Coordinator, Surfrider Foundation

Attachment 1



poseidonwater.com/huntington-beach-desalination-plant.html

POSEIDON WATER

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Huntington Beach Desalination Plant

The Huntington Beach Desalination Plant is a 50-million gallon per day facility currently in late-stage development. The desalination plant will be located adjacent to the AES Huntington Beach Power Station and is scheduled to be operational by 2023.

The Huntington Beach Desalination Plant is a cost-effective, environmentally sensitive solution to provide a safe and reliable water supply to Orange County residents and has the potential to bring significant economic benefits for the city of Huntington Beach and the region including:

- Millions of dollars in economic stimulus over the life of the facility.
- Creation of over 2,000 jobs during construction and 18 full-time jobs and 322 indirect jobs once the facility is in operation.
- Largest local, drought-proof water supply in Orange County.
- Poseidon Water is in the final phase of the project's permitting process and is currently working with state agencies to secure the remaining development permits.

Get a Progress Report

For current construction and project updates, visit our **Huntington Beach Project Site**

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MEMORANDUM

To:	Ray Hiemstra and Mandy Sackett
From:	David Revell, PhD
Date:	1/28/2022
Subject:	Sea level rise concerns for the proposed Poseidon desal project
Project No.:	C3010

PURPOSE

The purpose of this comment letter is to summarize the more detailed sea level rise and coastal hazard analyses that have been previously submitted. Even with the updated 2020 Moffat and Nichol Sea Level Rise and Adaptation report, several factors are not adequately addressed that raise substantial concerns about the proposed location for this project. This letter highlights outstanding concerns about the proposed Poseidon Huntington Beach Desalination Plant project and is based on a previously submitted Revell Coastal/Integral comment letter submitted in April 2021 and attached to the end of this summary letter.

KEY CONCERNS

1. **Maladaptation**. The Poseidon project proposes to locate critical water supply infrastructure in a vulnerable location while relying on the existing distribution pipeline network that has not been adequately analyzed for exposure to sea level rise and coastal hazards. The definition of ***maladaptation*** is actions that may lead to increased risk of adverse climate-related outcomes, including via increased GHG emissions, increased vulnerability to climate change, or diminished welfare, now or in the future[1]. This project encourages existing and future redevelopment to remain and occur in vulnerable low lying areas.

2. **Beach Nourishment, Closed Barrier Beach and Flood Control Channel.** The proposed Poseidon project must rely on various artificial flood defenses to avoid hazards at the facility. These defenses include the existing maintained beaches

[1] IPCC AR15 2018

resulting from upcoast Army Corps operations, Orange County Flood Control District maintenance of the existing flood control channel, and outlet beach management of the Talbert Channel into the future. Poseidon has no authority to implement or execute these expensive management actions or public works projects – which involve extensive permitting processes and careful management of impacts on Endangered Species Act listed species. Nor are they contributing financially to the long term maintenance and management costs of these resources. The flood control channel outlet maintenance permit, for example, expires in 2023.

3. **Island Effect.** While the proposed project as revised and described in the Moffat & Nichol report says the site elevation will be graded to 14-16 feet, access to the site and the feasibility of existing distribution infrastructure is not considered. While this grading increase will improve site resilience to sea level rise to some of the coastal hazards, this increased grading further contributes to "an island effect" in which the facility will become more and more inaccessible as sea level rises, with routine flooding as early as 2030 during higher tides (See Table 1).

4. **Distribution Network.** The existing pipeline distribution network has not been fully evaluated for its increasing exposure to sea level rise and coastal hazards, nor has an operations and maintenance program been put forth for consideration as to the long term efficacy of this critical infrastructure which proposes to provide important water supply to the communities in Orange County.

5. **Extreme Sea Level Rise.** Recent State guidance states that critical infrastructure such as water supply should consider the H++ scenario of 9.9 feet by 2100 – and that desalination facilities are generally considered critical infrastructure where they are integrated with other water systems, provide needed or emergency water, or have the potential to cause environmental or social impacts if damaged by future hazards. The City of Huntington Beach defines important infrastructure and this definition includes "water facilities." This proposed project does not adequately evaluate the H++ scenario despite State Guidance. Given that the Poseidon reported project life is 50 years that pushes its performance to beyond 2070 where sea levels could potentially increase by over 5 feet.

THE ISLAND EFFECT

Using results of previous analyses and the revised proposed project description, Table 1 below highlights the key elevations of sea level that are likely to cause flooding and reduced access to the proposed facility. For this analysis, Integral extracted elevation statistics (Minimum, Maximum and Average elevations in NAVD88) of the access road along Edison Avenue and Newland Street. Table 1 reports only the flood elevation potential along Newland Street between Edison Avenue and Pacific Coast Highway (PCH), other segments of Newland are even lower so access over the Newland Bridge would be compromised before the main PCH access.

The facility may become an inaccessible island before 2030 due to routine flooding of the surrounding area. Simple analyses show that the facility's isolation will become routine during high tide events of 5.3 MHHW and greater with one foot of SLR. This portion of California's coast experiences high tides of 5.3 MHHW over 200 times per year, thus the proposed facility could become inaccessible during high tides a majority of the year as early as 2030 when those tides occur along with one foot of sea level rise. Groundwater daylight flooding occurs in many adjacent areas under present day conditions. Daylighting will likely be more prevalent in the rainy season when groundwater levels are at their highest and additional tidal elevations occur due to king tides (see 2018 Revell Report and April 27, 2021 Comment Letter).

Table 1. Summary of Impacts to Proposed Facility Access from various coastal hazards

	H++				Updated State Guidance		H++				Updated State Guidance	
	Edison Drive (Minimum Elev 5.3 feet, Average Elev 6.6 feet)						Newland Street South to Pacific Coast Highway (Minimum Elev 3.4 feet, Average Elev 7.6 feet)					
Years	Existing	2050	2070	2100	Existing	2050	Existing	2050	2070	2100	Existing	2050
Base Level of Rise (Mean Sea Level)	0	2.6	5	9.9	0	3.5	0	2.6	5	9.9	0	3.5
Base Level of Rise (Mean High Water)	4.5	7.1	9.5	10.4	4.5	8	4.5	7.1	9.5	10.4	4.5	8
King Tide (+7.0 NAVD)	7	9.6	12	16.9	7	10.5	7	9.6	12	16.9	7	10.5
Coastal Erosion												
Coastal Wave Flooding												
Groundwater Daylighting	5.3	7.9	10.3	14.3	5.3	8.8	5.3	7.9	10.3	14.3	5.3	8.8
Fluvial Flooding 500-yr												
Coastal Confluence Flooding 100-yr #1	9.6	11.2	12.2	15.1	9.6	12.1	9.6	11.2	12.2	15.1	9.6	12.1
Coastal Confluence Flooding 100-yr #2	9.5	11.7	13.6	16.7	9.5	12.6	9.5	11.7	13.6	16.7	9.5	12.6
Barrier Beach Flooding	13	15.6	18	22.9	13	16.5	13	15.6	18	22.9	13	16.5
Tsunami	13.6	16.2	19.6	23.5	13.6	17.1	13.6	16.2	19.6	23.5	13.6	17.1

***Green**: No documented increase in risk of specific hazard impacts at the site.*
***Yellow**: Site access likely to be affected.*
***Orange**: Flooding of at least half of the access road*
***Red**: Greater than 2 feet of flooding on the road*
***Dark Red**: Flooding of the entire road*
***Numbers**: Where available report the flood elevations for each hazard type, not all hazards have an elevation available*

Of key concern here is that even under existing present day conditions there is reasonable potential that portions of Edison Drive could be flooded during certain king tides. By 2050, all of Edison Avenue is likely to be flooded during daily high tides with water depths of over 2 feet. This greatly reduces the ability to maintain this critical facility or even access the facility which is particularly of concern in the case of an emergency either from a storm event or another oil spill.

CONCLUSION

This maladaptive project creates a disincentive for the surrounding communities to explore more hazard avoidance adaptation strategies and the island effect will result in catastrophic failure of this proposed critical infrastructure. Many of the flood defenses necessary to keep the proposed facility are beyond the authority of Poseidon to manage or implement. As a result of these remaining concerns, it is our professional opinion that this is not the appropriate location for Poseidon's proposed desalination project.

EOCWD
EAST ORANGE COUNTY
WATER DISTRICT

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March 29, 2022

The Hon. Donna Brownsey
Chair
California Coastal Commission
455 Market Street, Suite 300
San Francisco, CA 94105

Dear Chair Brownsey:

East Orange County Water District (EOCWD) is both a retail and wholesale public water district serving the communities of East Orange, North Tustin and the unincorporated area in Central Orange County. EOCWD was founded in 1961 under the principles of local community service and fiscal discipline, which it maintains to this day. We pride ourselves on providing high-quality, reliable water at a fair price.

We recognize and appreciate the role that the California Coastal Commission has in regulating projects that impact our coast and coastal resources.

Few projects have gone through as intense a review as the Huntington Beach Seawater Desalination plant. The project meets all of the state's new regulations set forth under the Ocean Plan and has earned the right to have its Coastal Development Permit approved.

The Huntington Beach Desalination Project was the first desalination plant to be approved under the State Water Board's new Ocean Plan regulations. As the drought worsens, Orange County must be given the opportunity to consider new water supplies like desalination. You provided San Diego County that opportunity by approving their permit and that desalination plant has been operating successfully for more than five years.

Please vote to approve the Coastal Development Permit for the Huntington Beach Seawater Desalination Plant.

Sincerely,

Douglass S. Davert
President
East Orange County Water District

Cc: Vice Chair Dr. Caryl Hart
Commissioner Danya Bochco
Commissioner Effie Turnbull-Sanders
Commissioner Sara Aminzadeh
Commissioner Steve Padilla

Commissioner Mike Wilson
Commissioner Catherine Rice
Commissioner Linda Escalante
Commissioner Megan Harman
Commissioner Roberto Uranga
Commissioner Carole Groom
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February 11, 2022

Via Electronic Mail *Tom.Luster@coastal.ca.gov*
HuntingtonBeachDesalComments@coastal.ca.gov

Mr. Tom Luster
Senior Environmental Scientist
California Coastal Commission
455 Market Street, Suite 300
San Francisco, CA 94105

Re: Poseidon Resources, LLC; Seawater Desalination Project at Huntington Beach; Application for Coastal Development Permit; Appeal of Coastal Development Permit; 21730 Newland Street, Huntington Beach

Dear Mr. Luster and Honorable Commissioners:

We submit these comments to you on behalf of California Coastal Protection Network, California Coastkeeper Alliance, the Orange County Coastkeeper and the Surfrider Foundation concerning the Commission's review of the coastal development permits ("CDPs") sought by Poseidon Resources, Inc. for the Seawater Desalination Project at Huntington Beach ("Project").

If approved and constructed, the massive Poseidon Project will become the second-largest marine predator along California's 1,100-mile coastline.[1] The Project's open-water intakes will kill 108 million[2] fish larvae, eggs, and invertebrates each year, with dramatic impacts to miles of coastline that include Marine Protected Areas (MPAs). Its brine will pollute the habitat of surviving wildlife by increasing salinity and other chemical pollutants. The energy-intensive desalination process will result in greenhouse

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[1] The current largest marine predator, the Diablo Canyon Power Plant in San Luis Obispo County, will be taken offline in 2025. (https://www.slocounty.ca.gov/Departments/Planning-Building/Department-News-Announcements/Diablo-Canyon-Nuclear-Power-Plant-Decommissioning.aspx.)

[2] This number was presented in the Power Point presentations given during at the Santa Ana Regional Water Quality Control Board proceedings.

gases that exacerbate sea-level rise and coastal hazards while adding the electrical load equivalent of 38,732 homes to the grid.[3] The Poseidon Project is also unnecessary, considering North Orange County's demonstrated water demand, and unnecessarily expensive when compared to other methods of ensuring sustainable water supplies, such as conservation, recycling, or stormwater capture. Designed only as a "community facility" instead of International Building Code Risk Category IV[4] "critical infrastructure," the Project cannot even ensure its availability as an emergency water supply. On behalf of thousands of California resident members who treasure California's coastal resources, we urge you to reject this harmful Project, once and for all.

The Project was first considered by the Commission in 2006 and again in November 2010 pursuant to appeals of the CDP issued by the City of Huntington Beach. In response, the Commission adopted findings of Substantial Issue concerning the Project's compliance with Huntington Beach Local Coastal Program ("LCP") policies related to protection of marine life, water quality, protection of environmentally sensitive habitat areas ("ESHA"), energy use, public services, protection against seismic events and liquefaction, and whether the Project met LCP mitigation requirements. Yet, 15 years since the first appeal was filed and the Commission found substantial issues, Poseidon has failed to remedy the problems.

In November of 2013, Commission Staff prepared a detailed staff report.[5] The Report determined that, as initially proposed, the Poseidon Project violated numerous provisions of the Coastal Act and the LCP. In addition to the magnitude of impacts to marine wildlife, the Staff Report found that the high salinity of effluent discharge would harm coastal waters and marine life populations. Further, the Staff Report found the Project site is subject to a multitude of significant coastal and geological hazards, including floods, tsunami, surface fault rupture, ground movement, and liquefaction. Accordingly, Staff recommended approval of the Project only if strictly conditioned not to harm marine life through intakes or effluent; if reconfigured with a 100-foot buffer from wetlands and other mitigation to prevent noise effects on endangered, threatened and sensitive species; and if redesigned to address and withstand known and anticipated

[3] Powers Engineering, Assessment of Energy Intensity and Greenhouse Emissions of Proposed Poseidon Huntington Beach Desalination Plant – 2022 Update Report, January 19, 2022 p. 13, https://documents.coastal.ca.gov/assets/upcoming-projects/environmental-coalition/2022_Powers%20Engineering%20Review%20of%20Poseidon%20HB%20GHG%20reduction%20strategy.pdf.
[4] See, International Building Code Table 1604.5, Risk Category of Buildings and Other Structures, https://www.fandr.com/wp-content/uploads/2020/07/Speaking-in-Code-August-2020.pdf.
[5] Attachment 1, Coastal Commission Staff Report, Appeal No. A-5-HNB-10-225, November 2013.

coastal and geological hazards. Poseidon withdrew its application for a retained jurisdiction CDP and requested another postponement of the appeals.

On June 29, 2021, Commission Staff sent Poseidon a list of questions and areas of remaining concern and asked Poseidon to address them before deeming the application complete. Staff posed additional questions and concerns to Poseidon on August 4, 2021, and again on October 7, 2021. At that time Staff identified a "way forward," despite Poseidon's repeated failure to provide information necessary to evaluate the Project's consistency with the Coastal Act and the Huntington Beach LCP and the site's open wetlands violation.

While Poseidon publicly claims that its project has been held up by unnecessary bureaucratic red tape, it is Poseidon's own refusal to comply with the law that is at fault. Unfortunately, our review of the CDP application for the Huntington Beach Desalination Plant reveals that Poseidon has failed to adequately modify its Project in response to concerns the Commission raised eight years ago. Nor has Poseidon removed concerns raised as recently as 2021. The Project is still too large for the demonstrated water demand, and the Applicant has failed to incorporate feasible alternatives and mitigation measures to reduce the Project's enormous environmental footprint. If approved, the current iteration of the Poseidon Project would violate the California Coastal Act and be inconsistent with the Huntington Beach Certified LCP. Further, of importance to both public safety and consistency with the Coastal Act and the LCP, Poseidon does not propose to construct the desalination facility to Risk Category IV "critical infrastructure" standards, even though the Project is intended to supply water in the event of an emergency, which renders it critical infrastructure under the Ocean Protection Council's 2018 *State of California Sea- Level Rise Guidance*, and thereby subject to heightened Sea Level Rise projections.

We urge the Commission to deny the Project's CDPs.

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I. The Coastal Commission Can and Must Use its Authority to Analyze Less Damaging Alternatives and to Impose the Maximum Feasible Mitigation Available.

Coastal Act section 30233 only allows dredging and filling in coastal waters "*where there is no feasible* ***less environmentally damaging alternative.***" This requirement to consider alternatives to the proposed project is also mandated under CEQA, as discussed in Section II below.

a. The Commission Retains Authority to Consider Alternatives to Regional Board Decisions.

Before discussing alternatives to the project, it is critical to understand that the Commission is not bound by the Santa Ana Regional Water Quality Control Board's prior issuance of the Water Code § 13142.5(b) determination (13142.5 Determination). Regardless of the Regional Board's primary responsibility over water quality, the Commission retains authority to require an alternative to the project under Coastal Act section 30233 to ensure the full enforcement of marine life protections articulated in Coastal Act section 30230. Further, any alternatives required could bring the project into compliance with section 30231

Chapter 5, section 30412 states:

> (a) In addition to Section 13142.5 of the Water Code, this section shall apply to the commission and the State Water Resources Control Board and the California regional water quality control boards.
>
> (b) The State Water Resources Control Board and the California regional water quality control boards are the state agencies with primary responsibility for the coordination and control of ***water quality***. The State Water Resources Control Board has primary responsibility for the administration of ***water rights*** pursuant to applicable law. The commission shall assure that proposed development and local coastal programs shall not frustrate this section. The commission shall not, except as provided in subdivision (c), modify, adopt conditions, or take any action ***in conflict*** with any determination by the State Water Resources Control Board or any California regional water quality

> control board in ***matters relating to water quality or the administration of water rights.***
>
> ***Except as provided in this section, nothing herein shall be interpreted in any way either as prohibiting or limiting the commission, local government, or port governing body from exercising the regulatory controls over development pursuant to this division in a manner necessary to carry out this division.***

(emphasis added). This delegation of authority to the Regional Board is limited to decisions concerning water quality and water rights but does not include decisions regarding marine life protection. Therefore, the Regional Board's "Section 13142.5(b) Determination" is outside the scope of Coastal Act section 30412.

First, subsection 30412 (a) provides that this section is inclusive of Water Code section 13142.5. But, aside from subsection (b), Water Code section 13142.5 regulates water quality. Coastal Act Section 30412(b) clearly articulates that the Coastal Commission shall not take any action "in conflict" with any determination by the Regional Board in "matters relating to water quality or the administration of water rights." But the Regional Board's "Section 13142.5(b) Determination" does not necessarily regulate water quality because it applies only to the seawater intake.

Water Code Section 13142.5(b) states:

> For each new or expanded coastal powerplant or other industrial installation using seawater for cooling, heating, or industrial processing, the best available site, design, technology, and mitigation measures feasible shall be used to minimize the intake and mortality of all forms of marine life.

Coastal Act Section 30412 should not be read to eliminate the Commission's authority to Protect coastal resources by requiring alternatives. The Commission has authority to require modifications to what the Regional Board found was the best site for the facility, the best design (size), the best technology (subsurface intakes), or even consider and incorporate the best mitigation.

Additionally, the policy objectives in Coastal Act Section 30230 differ from the objective of Water Code Section 13142.5(b). The Water Code merely seeks to ensure "[minimization of] the intake and mortality of all forms of marine life." In contrast, Coastal Act 30230 mandates: "Marine resources shall be **maintained, enhanced**, and, where feasible, **restored**." We disagree that the Regional Board adequately enforced

Water Code section 13142.5(b). Regardless of the Regional Board decision, however, alternatives for meeting regional water reliability are available that do more than just minimize intake and mortality – the alternatives discussed below are proven and feasible ways to enhance and restore marine resources.

Finally, regarding the best technology to minimize intake and mortality, the Regional Board concluded Poseidon had provided an "identified need" for 50 million gallons of water per day (mgd). The record clearly shows that alternatives are available to ensure a reliable supply for predicted demand. Again, Coastal Act Section 30412 does not prohibit reconsideration of the "need" for 50 mgd, nor findings by the Commission that alternatives not only ensure a reliable supply to meet demands into the foreseeable future, but that those alternatives are mandated under Section 30233.

Below we document several alternatives that would "feasibly restore marine life populations" in compliance with Section 30230 rather than continue the destruction of marine life through surface screened intakes. These alternatives would also make significant improvements to ocean water quality in furtherance of Coastal Act Section 30231.

b. The Coastal Act Requires the Commission to Consider Less Damaging Alternatives to the Project.

The Coastal Act requires heightened protections where projects include dredge and fill in coastal waters, as proposed here.

Coastal Act Section 30233, subdivision (a) prohibits filling or dredging when less damaging alternatives exist. Specifically, the section provides, the filling or dredging of open coastal waters, wetlands, estuaries, and lakes shall be permitted in accordance with other applicable provisions of this division, **"where there is no feasible less environmentally damaging alternative**, and where feasible mitigation measures have been provided to minimize adverse environmental effects." As a preliminary matter, the Commission must utilize any feasible, less environmentally damaging alternatives to the Poseidon Project.

Section 30260 provides for the accommodation of certain developments "where new or expanded coastal-dependent industrial facilities cannot feasibly be accommodated consistent with other policies of this division." However, this section is limited to specific types of development, none of which apply to the Project. Moreover, in order to permit the Project under this section, the Commission must make and support findings that: "(1) alternative locations are infeasible or more environmentally damaging; (2) to do otherwise would adversely affect the public welfare; and (3) adverse environmental effects are mitigated to the maximum extent feasible." Both sections require the Commission to incorporate all feasible mitigation if it determines alternatives are infeasible.

The Coastal Act defines "feasible" as "capable of being accomplished in a successful manner within a reasonable period of time, taking into account economic, environmental, social, and technological factors." (Coastal Act Section 30108.) Findings about feasibility must be supported. The Commission cannot simply take Poseidon at its word that a proposed alternative or mitigation measure is infeasible, without independent evidentiary support.

Finally, the Commission must keep any "public welfare" determination made under section 30260 separate from its determination about whether a particular alternative or mitigation is feasible. Even if the Commission finds the Project important to public welfare, this does not mean Poseidon is not fully capable of bearing or passing on to its consumers the full cost of appropriate alternatives or mitigation. Passing the public welfare test cannot enable mitigation avoidance.

The Project requires a dredge and fill permit to modify the existing AES intake and discharge structures, and to construct the artificial reef required to "minimize intake and mortality" as part of the Regional Board's 13142.5(b) determination, as well as to grade on-site historical wetlands. Yet, all of the Project's planned dredge and fill, and the resulting environmental impacts, could be avoided or dramatically minimized with feasible alternatives. These alternatives include conservation, acquiring water from the Metropolitan Water District's proposed wastewater recycling plant in Carson, and through construction and operation of a smaller desalination facility, tailored to supply the amount of water actually needed to satisfy demand, where slant wells may be feasible. Thus, the Commission has not only the authority but the responsibility to analyze and require feasible, less environmentally damaging alternatives. Sections 30233 and 30260 of the Act require rejection of the Poseidon Project, as proposed.

i. The Region's Water Needs Could Be Satisfied Through Conservation or Through Construction of a Smaller Facility.

Poseidon's application seeks CDPs for a 50 mgd facility, but Poseidon has never demonstrated a local need for 50 mgd of desalinated water. Since around 2000, when Poseidon first proposed the project, water demand in Orange County has remained relatively flat. The Orange County Water District has successfully completed a wastewater recycling facility – the Groundwater Replenishment System (GWRS). GWRS currently supplies a local drought-proof supply of approximately 100 million mgd – twice the volume Poseidon proposes. Further, the GWRS is on track to expand production by an additional approximate 30 mgd. The predicted shortfall for which Poseidon proposed a 50 mgd facility has not materialized.

Looking forward, the Metropolitan Water District of Orange County's 2018 Water Reliability Study demonstrated that "the need for additional water supplies for the OC Basin is fairly small," and occurs once in 20 years.[6] The Study concluded that a 10 percent water cutback would fill the supply gap. The Study further compared eight water reliability supply alternatives for filling a ten percent supply gap, including the Poseidon Project. The Study found that alternatives better met the District's needs. Further, the 2020 Metropolitan Water District of Orange County Urban Water Management Plan (UWMP), drafted prior to and only published after the Regional Board's conditional approval of the Project, further concluded that the region had sufficient water supplies and discussed plans to continue increasing supplies through conservation and recycling.[7] While seawater desalination is considered, the Plan notably does not state a need for the Poseidon Project to conclude there will be water supply reliability for the foreseeable future.

This is relevant to the Commission's review because Poseidon has never provided a good faith analysis of conservation, of recycled wastewater, or of a smaller desalination facility designed to meet the region's actual shortfall between water supply and water demand. Water conservation would require no construction, dredge, or fill in the coastal zone, and would fully eliminate impacts to ESHA, coastal wetlands, frontline communities, recreation, and marine life. It would require no armoring or fill that would later become an island. Conservation and wastewater recycling would also be significantly less impactful from a greenhouse gas standpoint.[8] Finally, these alternatives would have direct benefits to ocean water quality from outdoor water conservation programs that reduce polluted runoff, as well as wastewater recycling benefits of significantly limiting wastewater treatment plant effluent discharge to the ocean – all benefits required under Coastal Act Section 30231.

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[6] https://www.mwdoc.com/wp-content/uploads/2019/01/OC-Water-Reliability-Study-2018-Briefing-December-12-Revision.pdf.

[7] MWDOC 2020 Urban Water Management Plan, https://documents.coastal.ca.gov/assets/upcoming-projects/environmental-coalition/MWDOC-2020-UWMP_2021.06.02.pdf

[8] Powers Engineering, Assessment of Energy Intensity and Greenhouse Emissions of Proposed Poseidon Huntington Beach Desalination Plant – 2022 Update Report, January 19, 2022 pp. 9-10, https://documents.coastal.ca.gov/assets/upcoming-projects/environmental-coalition/2022_Powers%20Engineering%20Review%20of%20Poseidon%20HB%20GHG%20reduction%20strategy.pdf.

Compared to the Project, a smaller desalination facility would reduce construction impacts, such as dredge and fill, and associated impacts to wetlands, ESHA, and beach access. Importantly, the proposed surface intake with wedgewire screens would only reduce entrainment by one percent or less than a similar volume from continued use of the now-outlawed cooling water intake.[9] A facility producing less than 50 mgd would need to process far less water through its intakes, thereby reducing the facility's impact on marine life through entrainment and impingement. A smaller facility could potentially avoid entrainment and impingement altogether by feasibly incorporating slant wells or other subsurface intake technology. Less desalination would also mean less brine: a smaller facility would discharge less hypersaline brine into coastal waters, thereby reducing water quality, marine life, and recreational impacts. Operation of a smaller facility would also limit the electricity demand of the desalination facility, thereby reducing its greenhouse impacts and contribution to future sea-level rise that endangers coastal resources. Importantly, subsurface intakes would significantly reduce energy demand because the natural filtration eliminates the need for costly and energy intensive in-plant pre-filtration.

ii. The Carson Project Is a Feasible Alternative that Would Reduce Project Impacts.

The Metropolitan Water District (MWD) is currently planning a Potable Reuse project on the site of the Los Angeles County Wastewater Treatment Plant (WWTP) in Carson ("Carson Project"). The Carson project would provide approximately 150 mgd, or approximately 160,000 acre feet per year (afy) for regional distribution.[10] The most recent 2020 MWD "White Paper" shows approximately 60 mgd could be "feasibly" delivered to Orange County for groundwater basin recharge – more water than the 50 mgd Poseidon Project would produce.[11] The Carson project would meet OCWD's claimed need for a drought-proof supply of potable water.

Importantly for Coastal Act section 30233 compliance, the Carson Project could feasibly deliver recharge water for the Orange County Basin while eliminating dredge and fill around the proposed Poseidon Project's intake and discharge structures. Because it would eliminate intake and mortality of marine life, it would eliminate dredge and fill at the site of the proposed artificial reef mitigation project. The Carson Project would

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[9] Santa Ana Regional Water Quality Control Board Staff Report, July 30, 2020, p. 11, https://documents.coastal.ca.gov/assets/upcoming-projects/environmental-coalition/Regional%20Board%20Poseidon_Staff_Report_July_30,2020.pdf.

[10] See, https://www.eenews.net/articles/could-la-water-recycling-be-a-miracle-for-parched-west/.

[11] See, Attachment 4, Regional Recycled Water Program: Institutional and Financial Considerations, White Paper 2, October 13, 2020, p. 12.

further improve ocean habitat through reduced ocean discharges from the Carson WWTP. For these reasons, the Carson Project is a feasible alternative that is consistent with Coastal Act sections 30230 and 30231.

Coastal Act Section 30231 provides, "The biological productivity and the quality of coastal waters, streams, wetlands, estuaries, and lakes appropriate to maintain optimum populations of marine organisms and for the protection of human health ***shall be maintained and, where feasible, restored*** through, among other means, ***minimizing adverse effects of waste water discharges and entrainment***, controlling runoff, preventing depletion of ground water supplies and substantial interference with surface waterflow, encouraging waste water reclamation, maintaining natural vegetation buffer areas that protect riparian habitats, and minimizing alteration of natural streams." (emphasis added.) In contrast to the proposed desalination facility, the Carson Project will feasibly "restore" water quality for both marine life and human health by "minimizing adverse effects of wastewater discharges and entrainment." Likewise, in contrast to the proposed project, the "Carson Project" complies with the Coastal Act Section 30230 mandate that "Marine resources shall be maintained, enhanced, and where feasible, restored. Special protection shall be given to areas and species of special biological or economic significance. Uses of the marine environment shall be carried out in a manner that will sustain the biological productivity of coastal waters and that will maintain healthy populations of all species of marine organisms adequate for long-term commercial, recreational, scientific, and educational purposes." The Commission should note that the existing cooling water intake will be discontinued in 2023, which would help "restore" marine life populations – if not for the proposed plan to re-purpose the structures for Poseidon's continued use.

The Commission must review the Carson Project as a less-damaging alternative water supply to the Project. Only after the Commission has determined that there are no "less environmentally damaging alternatives," may it move to the next step of the inquiry, conditioning the Project on minimizing the impacts of dredge and fill through mitigation. Less damaging and feasible alternatives to the Project exist, and we urge the Commission to deny the CDPs for this harmful Project.

iii. A Smaller Desalination Facility is Feasible.

Achieving reliable water supplies into the foreseeable future does not require the Poseidon proposed 50 mgd project. Further, although we disagree with the analyses and conclusions in the Regional Board's "13142.5(b) Determination" regarding "identified need" and the feasibility of slant well intake technology, the heightened standards for marine life protection in Coastal Act section 30230 mandate a different analysis and conclusion by the Commission. A smaller desalination facility sited and designed to use subsurface wells for withdrawing source water is feasible and must be required under the Coastal Act policies.

The Regional Board staff analyses concluded that slant wells were "technically infeasible."[12] This was based on the ISTAP Phase 2 report.[13] But these conclusions were based on information supplied by the Orange County Water District (OCWD), Poseidon's partner in the proposed "public-private-partnership" (PPP) proposal. OCWD claimed that withdrawal of more than 1,000 afy of freshwater into the slant wells was unacceptable.[14] Closer scrutiny shows that OCWD's objection to freshwater withdrawal into slant wells was primarily based on the cost of replacing that water.[15] OCWD's conclusion regarding freshwater withdrawal was: "Not only would this interfere with the operation and benefits of OCWD's Talbert Seawater Barrier, the volume of extracted groundwater would need to be accounted for in OCWD's annual water budget, meaning it would need to be balanced by some combination of increased replenishment water or reduced pumping – which would be a substantial financial impact to OCWD and its ratepayers."[16] While the record shows that OCWD was primarily concerned about the "cost" of freshwater withdrawal, neither the ISTAP nor the Regional Board conducted the analysis necessary to support a conclusion of economic feasibility.

Importantly, a report provided by HydroFocus, the hydrogeologist experts who conducted the CalAm-Monterey slant well analyses, found that the reports prepared by Geosyntec for Poseidon needed to be calibrated with physical data for reliability.[17] Further, the HydroFocus 2 report showed that if OCWD modified the volume of water injected into the Talbert Gap seawater intrusion barrier, and added slant wells for seawater desalination source water, the volume of freshwater withdrawn could be significantly reduced.[18] On behalf of Poseidon, Geosyntec responded that the HydroFocus modeling showed the freshwater withdrawal would still exceed the 1000 afy economic threshold asserted by OCWD. Again, importantly, neither ISTAP nor the Regional Board conducted an economic feasibility analysis. It should be noted that subsurface intakes can significantly reduce energy demand because they source water filtration that is needed from expensive and energy intensive in-plant pre-filtration

[12] Attachment 5, Santa Ana Regional Water Quality Control Board, Poseidon Staff Report, July 30, 2020, p. 4.
[13] Ibid.
[14] Attachment 6, Letter from OCWD to Regional Board, May 18, 2018.
[15] Attachment 6, p. 2.
[16] Ibid.
[17] See Attachment 7, HydroFocus Report, March 10, 2020.
[18] Ibid.

systems – and this benefit translates to both construction and operation costs associated with screened surface intakes.

Further, the Geosyntec response to the 2020 HydroFocus Report[19] concluded that a 25 mgd seawater intake through slant wells would withdraw 1120 afy of freshwater – a small marginal increase above the OCWD self-determined 1000 afy threshold. A 25 mgd seawater intake volume could produce approximately 12 mgd of potable water, only approximately 120 afy over OCWD's arbitrary1000 afy threshold.

Given that the 2020 MWDOC UWMP concludes water demand in the foreseeable future can be reliably met without the 50 mgd proposed facility, a 12 mgd facility is a feasible alternative.

Finally, OCWD is conducting a study to plan construction of a new seawater intrusion barrier in the Sunset Gap just north of the proposed Poseidon facility. The situation in Sunset Gap is similar to the seawater intrusion barrier in the Talbert Gap studied by HydroFocus: seawater intrusion is threatening nearby freshwater production wells. The wells constructed for this barrier could provide a reliable, drought-proof water sources.

The OCWD study includes a combination of injection wells inland of the planned barrier as well as extraction wells seaward of the planned barrier – similar to the HydroFocus 2 simulations.[20] OCWD plans to extract 3 mgd seaward of the proposed barrier in combination with injection 13 mgd of fresh water inland of the barrier.[21] Mr. Herndon from OCWD noted that the extracted water could be desalted if the salinity was low enough to make it economically feasible. He also noted that an alternative plan could be to rely solely on extraction wells in lieu of any inland injection wells -- but he did not indicate what volume would be extracted. Clearly, the water extracted from the proposed wells would be equal to or less saline than water extracted from the screened surface intake Poseidon proposes, and consequently more economically feasible.

This new study, not considered by the Regional Board "13142.5(b) Determination," is substantiating evidence that the HydroFocus 2 report should be given substantial weight in determining the economic feasibility of alternative sized facilities utilizing subsurface intakes. Further, this study introduces a potential new site for a

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[19] Attachment 8, Appendix GGGGGG, Geosyntec Response to HydroFocus Report, Attachment Table 1.
[20] See: Seawater Intrusion Control in Orange County - Do We Need Another Barrier? (12/14/21) at https://www.ocwd.com/news-events/events/water-webinars/
[21] Id at Slide 27

desalination facility that may provide a more economical solution because it would provide source water for desalination as a by-product of seawater intrusion protection.

Finally, in regard to the “economic feasibility” analysis that has yet to be conducted, the Commission must consider the context of a proposed desalination facility with construction costs at approximately $1.3 billion. It is difficult to imagine the additional cost of 1,000 acre feet of water per year would render the project “economically infeasible.”

For example, OCWD quoted a replacement cost of $445 per acre foot. An annual cost would be $445,000 per year). The annual revenue from Project water sales would be, at a conservative minimum, $102 million ($2,000 ac/ft X 56,000 ac/ft/yr = $102,000,000 per year). Therefore, the marginal cost for replacing the freshwater withdrawn at $445,000 / $102,000,000 would be less than half of one percent of Poseidon’s annual revenue. Poseidon would need to show that a minor cost escalation of less than one percent would “render the project unviable.”

Coastal Act Section 30233 mandates alternatives to the proposed project. A smaller desalination facility utilizing subsurface intakes is clearly a feasible alternative.

c. The Commission Has The Duty and Authority to Impose the Maximum Feasible Mitigation Available to Protect Coastal Resources.

The Coastal Commission retains jurisdiction and is obligated to impose the “maximum feasible mitigation available” on the Project to ensure its consistency to protect coastal resources, wildlife, and public safety, consistent with the Coastal Act and the Huntington Beach certified LCP. (Section 30260.) As proposed, the Project fails to incorporate all feasible mitigation measures to minimize its well-documented adverse effects, in violation of Coastal Act section 30233 and section 30260.

The Commission’s feasibility standard is a high bar, and it cannot be overcome simply because a proposed mitigation measure or technology is not cheap or easy. On the contrary, innovation can and should be expected of projects that will impose great environmental cost. An alternative or mitigation is not infeasible unless there is “evidence that the additional costs or lost profitability are sufficiently severe as to render it impractical to proceed with the project.” (*Citizens of Goleta Valley, supra,* 197 Cal.App.3d 1167, 1181; *Uphold Our Heritage v. Town of Woodside* (2007) 147 Cal.App.4th 587, 599.) The Coastal Act defines “feasible” in the same way as the California Environmental Quality Act (CEQA), “capable of being accomplished in a successful manner within a reasonable period of time, taking into account economic, environmental, social, and technological factors." (*Compare* Coastal Act Section 30108 *with* Pub. Resources Code § 21061.1.) Thus, CEQA case law is instructive on this issue. "[I]f the project can be economically successful with mitigation, then CEQA requires that mitigation…" (*Uphold our Heritage, supra,* 147 Cal.App. 4th at 600.) In short, the Commission should not "authorize an agency to proceed with a project that will have significant, unmitigated effects on the environment…unless the measures necessary to mitigate those effects are *truly* infeasible." (*City of Marina v. Board of Trustees of the California State University* (2006) 39 Cal.4th 341, 368, emphasis added.) Under this standard, each potential mitigation measure is analyzed individually.

Outside the CEQA context, courts have applied more stringent definitions of feasibility. Regarding a water safety regulation claimed infeasible by industry, the Court of Appeal held, "A standard is not infeasible simply because it is financially burdensome or even because it threatens the survival of some companies within an industry [citation]. A standard is economically feasible if the costs it imposes do not 'threaten massive dislocation to or imperil the existence of, the industry." (*California Manufacturers & Technology Assn. v. State Water Resources Control Bd.* (2021) 64 Cal.App.5th 266, 282-283.)

Poseidon has not demonstrated the infeasibility of Project alternatives and mitigation measures, including, but not limited to, the Carson Project, a smaller project, alternative intake locations, and slant wells. While Poseidon makes these claims, these claims do not supply substantial evidence necessary to support Commission findings. The Commission should obtain or conduct an independent economic feasibility analysis and not simply take Poseidon at its word.

During Regional Board proceedings, two alternative intake locations were identified that would reduce marine life mortality.[22] However, Poseidon claimed that the time it would take to relocate intakes to new locations, and the time it would take to receive permits for the changes, would cut into its profits. The very idea that a Project could be made infeasible solely because permitting agencies follow California law is absurd. Even if this absurd notion were accepted, case law is clear that reduced profits do not render a project infeasible. (*City of Marina, supra,* 39 Cal. 4th at 368, emphasis added.)

[22] Santa Ana Regional Water Quality Control Board, Attachment G – Narrowing Sites, November 21, 2019, p. G1-44 and p. G1-57, https://documents.coastal.ca.gov/assets/upcoming-projects/environmental-coalition/Attachment%20G.1%20Narrowing%20of%20Sites%20Parts%201%20to%203.pdf.

The Project also fails to include slant wells, which have been deemed feasible for other proposed desalination plants. When other similar projects implement particular mitigation measures, it is evidence that those measures are feasible. (*Western States Petroleum Association v. Southern California Air Quality Management District* (2006) 136 Cal.App.4th 1012, 1020 [no evidence showing that refineries could not make the same air pollution control changes one refinery made or that the cost of such changes would be prohibitive].) Poseidon has claimed slant wells to be infeasible, but the record shows that the determination of infeasibility rests on primarily economic concerns, and there are no economic feasibility analyses included. It also relies on the independent scientific technical advisory panel (ISTAP) for this conclusion[23], but, notably, ***the ISTAP failed to analyze the economic feasibility of slant wells, and the process was never completed***. Commission staff had recommended that Poseidon fund a third phase, but this phase never occurred. "Infeasible" means that the Project cannot be completed, not that it might be marginally less profitable and not that an applicant has not bothered to study a mitigation measure for a project. Unlike the Poseidon Project, the proponents of both the Cal-Am and Doheny desalination proposals studied the feasibility of slant wells and calibrated the computer modeling with test wells – a critical step missing in this CDP application.[24]

The CalAm and Doheny tests demonstrate that slant wells are feasible, in particular for a desalination facility that is actually designed to meet the area's water demand.[25] Despite Poseidon's claim that OCWD needs 50 mgd, the 2020 Urban Water Management Plan for the Municipal Water District of Orange County recently determined that rare demand shortfalls can be more feasibly met with alternatives to the Project.[26] A smaller facility designed to produce only what OCWD needs could feasibly supply seawater through slant well intakes, thereby avoiding the massive entrapment and entrainment impacts of open water intakes, as well as the maintenance concerns posed by wedgewire screens.

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[23] Phase 2 Report: Feasibility of Subsurface Intake Designs for the Proposed Poseidon Water Desalination Facility at Huntington Beach, California, ISTAP, August 2015, https://documents.coastal.ca.gov/assets/press-releases/huntington-beach-desal/CCC-Poseidon_ISTAP_Draft_Phase_2_Report_for_Public_Review_8-14-15.pdf

[24] Staff Report for Cal-Am Desalination Project, September 2020, p. 114 fn. 116, https://documents.coastal.ca.gov/reports/2020/9/Th3a&4a/Th3a&4a%20Staff%20Report.pdf.

[25] Staff Report for Cal-Am Desalination Project, September 2020, p. 114 fn. 116, https://documents.coastal.ca.gov/reports/2020/9/Th3a&4a/Th3a&4a%20Staff%20Report.pdf.

[26] The Municipal Water District of Orange County (MWDOC) 2020 UMWP and 2018 Reliability Study demonstrate the projected need for water can be met with alternatives. The Regional Board relied on the 2015 Urban Water Management Plan in determining the region's water "need" for 56,000 afy.

As proposed, the mitigation incorporated into the Project is insufficient. For example, the State Water Resources Control Board acknowledges that the wedgewire screens would reduce entrainment of marine organisms by a ***single percent***, or less.[27] This abysmal performance assumes that the wedgewire screens do not experience the same unexpected maintenance issues experienced at the Carlsbad Desalination Plant.

Other Project mitigation itself will harm wildlife. The Project will incorporate linear brine diffusers on the outfall, which themselves cause marine life mortality through shear.[28] In the turbulent mixing zone of a diffuser, entrained eggs, larvae and juvenile adults suffer both ***impact mortality*** from direct contact with the high velocity core of a diffuser jet and ***turbulent shear mortality*** along the edges of the turbulent mixing zone. Marine eggs, larvae, soft shelled veligers, and juvenile adults are particularly vulnerable to becoming distorted or ripped apart, particularly when the size of the affected organisms is comparable to the Kolmogorov turbulent mixing lengths.[29] Outfall systems can be designed to try to reduce shearing impacts on larger organisms, but the size-specific nature of shear mortality may limit these mortality reductions to larger juvenile and adult organisms. While it was previously thought that the use of linear diffusers on outfalls would reduce marine life mortality of a desalination plant by reducing entrainment caused by plant intakes, more study is needed. Linear diffusers increase the size of the turbulent mixing zone, where shear mortality occurs, shear mortality rates in and along the edge of the turbulent mixing zone are very high, and mitigation of impacts to eggs larvae, and juvenile organisms may not be possible. [30]

Proposed Project mitigation is also speculative. Wetland mitigation sites at Bolsa Chica will likely go underwater during the life of the Project. A recent study evaluating the sustainability of the Bolsa Chica Lowlands Restoration Project concluded, "In the long term (2060 to 2100), placement or redistribution of sediment appears to be the only remediation measure available to provide coastal salt marsh habitat under projected

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[27] Santa Ana Regional Water Quality Control Board Staff Report, July 30, 2020, p. 11, https://documents.coastal.ca.gov/assets/upcoming-projects/environmental-coalition/Regional%20Board%20Poseidon_Staff_Report_July_30,2020.pdf.
[28] Even documents produced in support of desalination facilities describe shear mortality. See, e.g., Dilution Issues Related to Use of High Velocity Diffusers in Ocean Desalination Plants: Remedial Approach Applied to the West Basin Municipal Water District Master Plan for Sea Water Desalination Plants in Santa Monica Bay, pp. 9-15, available at https://www.westbasin.org/wp-content/uploads/2020/07/Brine-Diffuser-Study.pdf.
[29] Id., pp. 9-15.
[30] Id., p. 36 ["It is not possible to both minimize jet velocity and shearing rate, while simultaneously making the Komogorov turbulent mixing lengths small relative to ***all*** resident water column species and life phases.]

increases in sea levels."[31] The wetlands are unable to migrate inland because they are surrounded by urban development.[32] Figure 4-4 of the attached report shows substantial inundation of Bolsa Chica in 2060 and near-total inundation in 2100 under even minimum anticipated levels of sea level rise.

Moreover, if the Commission is inclined to approve the Project, it must be conditioned on being designed and constructed to Risk Category IV Critical Infrastructure standards. As proposed, the Project will be subject to sea-level rise, coastal flooding, and tsunami, all while being built along an active and dangerous fault line. Unless constructed to withstand geologic, coastal, and seismic hazards *while continuing to operate safely at full capacity*, the Project would run counter to several Coastal Act and LCP policies.

Poseidon has not disclosed the basis for any of its infeasibility claims, and its conclusions about slant wells are based on a ***lack*** of study. Thus, neither the public nor the decisionmakers can confirm whether any of the proffered alternatives or mitigation measures are truly economically infeasible. The few datasets that are cited regarding alternative locations and intakes are woefully out-of-date and, in some instances, have been superseded by studies demonstrating feasibility. Consequently, the Commission currently lacks substantial evidence supporting any infeasibility findings it makes on Poseidon's behalf. The Commission must also remember that, even if it is able to find that a particular mitigation measure is infeasible, it does not mean that all mitigation is infeasible. It just means that other mitigation must be incorporated for that impact. Poseidon should not be allowed to claim that "maximum feasible mitigation" means "no mitigation." Nor should Poseidon be allowed to claim under section 30260 that, because water supports the public welfare, the Project is exempt from mitigation. This is especially true, here, where mitigation costs can be passed on to end users, and where the Project is seeking public funding.[33] Given the gravity of the consequences of these determinations, the Coastal Commission cannot be expected to rely on Poseidon's unsupported assertions. An independent and thorough feasibility analysis must be conducted.

Finally, we note that Poseidon has known about the environmental groups' concerns and mitigation proposals for well over a decade by this point. Management failure on the part of a project proponent to properly anticipate and budget for these costs

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[31] Attachment 3, Bolsa Chica Lowland Restoration Project, Sustainable Alternatives Study Analysis, December 2021, p. ES-7.
[32] Id. p. 46.
[33] https://voiceofoc.org/2021/12/will-poseidons-hb-desal-plant-take-state-money-away-from-low-income-housing/

in its financial calculations and product delivery contracts is not a reason to assert that mitigation is economically infeasible. Mitigation for project impacts is as easily anticipated as any other cost of doing business on a major project, and management decisions solely in the interests of Poseidon's business plan should not provide a basis to pass the Project's enormous environmental costs on to the public or to future generations.

Regardless of the Regional Board's findings on this issue, the Commission must require conformance with the Coastal Act, require all feasible mitigation of environmental impacts, and select less-damaging alternatives.

II. The Commission Has the Authority and the Duty to Analyze the Environmental Impacts of the Project, and Recent Project Changes, Under CEQA.

The Coastal Commission derives its authority under CEQA to review the CDPs from at least two sources. First, the Coastal Commission's program for reviewing and granting CDPs is a certified regulatory program that serves as a "functional equivalent" of CEQA. (Pub. Resources Code § 21080.5 (c); 14 CCR § 15251(c).) The Commission's administrative regulations require CDP application approvals to be supported by a finding that the application, as modified by any conditions of approval, is consistent with any applicable requirements of CEQA. (Section 13096.)

Second, the Commission is a responsible agency for the Project under CEQA, although the City of Huntington Beach and the State Lands Commission have served as the lead agencies for environmental impact report (EIR) preparation. (14 CCR § 15381.) Because the Commission must take discretionary action regarding the Poseidon Project's CDPs, it must comply with CEQA. While CEQA permits a responsible agency to rely on a lead agency's CEQA document, the Commission complies with CEQA "by considering the EIR or negative declaration prepared by the Lead Agency and by reaching its own conclusions on whether and how to approve the project involved." (14 CCR § 15096(a).) The Commission retains responsibility for mitigating or avoiding the direct or indirect environmental impacts of the portions of the project that approves. (14 CCR § 15096(g)(1).)

CEQA's primary purpose is to ensure that the environmental consequences of an action are disclosed to the public and to agency decisionmakers before that action is taken. Put another way:

> The CEQA process is intended to be a careful examination, fully open to the public, of the environmental consequences of a given project, covering the entire

> project, from start to finish. This examination is intended to provide the fullest information reasonably available upon which the decision makers and the public they serve can rely in determining whether or not to start the project at all, not merely to decide whether to finish it. The EIR is intended to furnish both the road map and the environmental price tag for a project, so that the decision maker and the public both know, before the journey begins, just where the journey will lead, and how much they-and the environment-will have to give up in order to take that journey."

(*Natural Resources Defense Council v. City of Los Angeles* (2002) 103 Cal.App.4th 268, 271.) CEQA further contains a substantive mandate that a project's adverse environmental impacts must be avoided or reduced to the extent feasible through the incorporation of project alternatives or mitigation measures. (Pub. Resources Code § 21002.) For this reason, it is imperative that alternatives and mitigation measures not be foreclosed prior to project approval. (*Save Tara v. City of West Hollywood* (2008) 45 Cal.4th 116, 138.) Environmental review must occur prior to project approval.

a. CEQA Requires Environmental Review of Project Changes, Including the Marine Life Mitigation Plan and the Artificial Reef.

Although we dispute the adequacy of the Poseidon Project's CEQA review, we acknowledge that environmental impacts for ***portions*** of the Project have been certified. However, no environmental review has been conducted for the Marine Life Mitigation Plan portion of the Project, which will include the construction of an artificial reef near Palos Verdes, which we have reason to believe is in relatively close proximity to DDT contamination,[34] among other impactful activities. Sinking debris into the ocean will undoubtedly have environmental impacts, and these impacts must be disclosed, analyzed, and fully mitigated before the Commission may approve portions of the Project reliant on the Marine Life Mitigation Plan. The reef will require transporting large quantities of quarried rock from Catalina Island, which will generate greenhouse gas and air pollution-attributable impacts from both quarrying and barge transport. There will also be cumulative impacts from the dredge and fill for the intake and discharge locations, combined with the exact same kind of activity at the artificial reef site. Environmental

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[34] See, e.g., https://www.latimes.com/projects/la-coast-ddt-dumping-ground/, https://www.theguardian.com/environment/2021/apr/29/californias-legacy-of-ddt-waste-underwater-dump-site-uncovers-a-toxic-history, amd https://www.smithsonianmag.com/smart-news/deep-sea-robots-kick-start-ddt-ocean-floor-clean-south-californian-coast-180977237/ (extent of dumping much larger than initially understood).

review has not been conducted for changes to the discharge structures imposed by the Santa Ana Regional Water Quality Control Board, either. That review was a narrowly focused Addendum that did not consider the direct or cumulative impacts from the artificial reef construction that they mandated as part of the "13142.5(b) Determination."

It appears that some future review of the Marine Life Mitigation Plan may be contemplated, later, by the State Lands Commission, after Poseidon applies for the lease needed to construct the reef, but "CEQA's informational purpose 'is not satisfied by simply stating information will be provided in the future.'" (*Vineyard Area Citizens v. City of Rancho Cordova* (2007) 40 Cal.4th 412, 440-41.) The information must be disclosed and evaluated, now, before approvals provide momentum that forecloses feasible alternatives or mitigation measures that may have fewer environmental risks. Approval of the Project without a thorough, ***prior***, analysis of project components such as the artificial reef violates CEQA.

CEQA requires environmental review to evaluate the "whole of a project" and not simply its constituent parts when determining whether it will have a significant environmental effect. (CEQA Guidelines § 15003(h).) Separating the Marine Life Mitigation Plan and the changes to the Project discharge structures from the rest of the Project results in impermissible segmentation.

CEQA also requires that environmental documents evaluate mitigation measures – both the adverse environmental impacts caused ***by*** mitigation and the efficacy ***of*** that mitigation. (14 CCR § 15126.4; *San Joaquin Raptor Rescue Center v. County of Merced* (2007) 149 Cal.App.4th 645.) Here, neither has occurred, leaving the Commission in a precarious position. The Commission has not received any information about the reef's potential environmental consequences, so it cannot make a decision about whether to approve the reef or how to condition it so that it complies with the Coastal Act. The same goes for other portions of the Marine Life Mitigation Plan. The Commission also lacks information of the efficacy of the Marine Life Mitigation Plan as mitigation for the Poseidon Project's harm to marine organisms. Similarly, the Commission does not have before it environmental review of the changes to the discharge structures. Given the enormous potential of discharge shear to cause mortality of marine organisms, this information is critical. The Commission cannot determine whether the Project will actually offset its environmental harms or whether more mitigation is needed. Nor can it support its findings on these issues, as required.

While CEQA permits reliance on prior EIRs, this reliance does not extend to changes to a Project that occur between EIR certification and the grant of a new discretionary approval, when those changes and their impacts were not analyzed in the certified EIR. (Pub. Resources Code § 21166.) Subsequent or supplemental environmental review must occur when changes to a Project necessitate revisions to the EIR for it to retain relevance and accuracy. (14 CCR §§ 15162, 15163.) In particular, CEQA requires preparation of subsequent environmental review when:

(1) Substantial changes are proposed in the project which will require major revisions of the previous EIR or negative declaration due to the involvement of new significant environmental effects or a substantial increase in the severity of previously identified significant effects;

(2) Substantial changes occur with respect to the circumstances under which the project is undertaken which will require major revisions of the previous EIR or negative declaration due to the involvement of new significant environmental effects or a substantial increase in the severity of previously identified significant effects; or

(3) New information of substantial importance, which was not known and could not have been known with the exercise of reasonable diligence at the time the previous EIR was certified as complete or the negative declaration was adopted, shows any of the following:

(A) The project will have one or more significant effects not discussed in the previous EIR or negative declaration;

(B) Significant effects previously examined will be substantially more severe than shown in the previous EIR;

(C) Mitigation measures or alternatives previously found not to be feasible would in fact be feasible and would substantially reduce one or more significant effects of the project, but the project proponents decline to adopt the mitigation measure or alternative; or

(D) Mitigation measures or alternatives which are considerably different from those analyzed in the previous EIR would substantially reduce one or more significant effects on the environment, but the project proponents decline to adopt the mitigation measure or alternative.

(14 CCR § 15162 (a).)

Substantial changes have been incorporated into the Project, the circumstances under which the Project is being evaluated have changed, and new information of substantial importance has been developed since the Project's last relevant environmental review. In particular, the Project now proposes mass grading on a toxic site to remove existing berms to build the foundation 14 to 16 feet higher – above the level where coastal flooding is expected in the near-term. This change has significant environmental implications related to air quality and construction, hazards and toxics, air quality, water quality, and environmental justice. As Commission staff found in 2013:

> Based on limited sampling at the site, there are known and expected soil and groundwater contaminants that Poseidon will need to remediate. Although sampling has not yet been conducted beneath the storage tanks, which cover a substantial area of the project footprint, Poseidon proposes to implement a Remedial Action Plan (RAP) that includes excavation and removal of up to about 18,000 cubic yards of soil (a worst-case estimate) containing petroleum and possibly other contaminants.[35]

The site is toxic, and doubling the expected quantity of grading will have environmental impacts that have not yet been studied. This alone requires supplemental environmental analysis. As soil sampling has not yet occurred, the extent of contamination is unknown, and the measures needed to remediate the expected contamination have not yet been identified. Remediation may require removal and disposal of contaminated soil, coupled with import of soil needed to raise the Project's base elevation. The Project leans on deferred analysis and deferred mitigation. CEQA provides the Commission with authority to analyze and mitigate these impacts to air quality, coastal access and traffic, hazards, water quality, and biological resources now, not later.

Further, northern Orange County's water demand has decreased over time, and much more is known about the shear mortality impacts of linear brine diffusers, the Project's impacts on marine organism mortality, and the local near-term impacts of climate change. Alternatives – such as reliance on conservation measures, a smaller project, and the Carson Project – are now feasible. Finally, mitigation measures such as slant wells have proven feasible at other sites. The conditions for subsequent environmental review – whether through the Commission's CDP process or otherwise – are met. Since certification of the 2010 SEIR, additional changes to the Project, circumstances, and substantial new information include, but are not limited to:

- Orange County Water District (OCWD) has announced expansion of the Groundwater Replenishment System to add 30 million more gallons per day to local water supplies as an alternative.

[35] Attachment 1, 2013 Staff Report, p. 26.

- OCWD has taken responsibility for developing a system to deliver the Poseidon product water. OCWD has added 5 new alternative delivery options to the 2 options considered in the 2010 SEIR. These new delivery options include using the Poseidon water to recharge the groundwater basin.[36] Irvine Ranch Water District found that introduction of the Poseidon product water can have adverse impacts on water quality in the groundwater basin, and alternatives were preferable.[37] However, OCWD does not plan to prepare CEQA review of the new alternatives until **after all discretionary approvals are complete. Further, as explained below, these new delivery options have not been considered nor found consistent with LCP Policy C6.1.1 mandating protection of basin water quality.**

- An investigation by the Irvine Ranch Water District (IRWD) quantified significant water quality impacts to the regional groundwater basin caused by injecting Poseidon's water that has not been analyzed in compliance with the CEQA. IRWD's expert report demonstrated that avoiding boron exceedances in the groundwater aquifer will require subjecting 80 to 100 percent of the Poseidon Project to a second pass reverse osmosis treatment process. According to the investigations, "these second pass treatment requirements will significantly increase the flow rates through the seawater intake and brine discharge facilities proposed by Poseidon."[38] The Regional Board never analyzed the foreseeable increased flow rates through Poseidon Water's seawater intake and brine discharge facilities that will be needed to avoid the identified significant impacts to water quality.

- Three major demolition and development projects will occur on properties adjacent to the project site either concurrently or consecutively with the proposed Poseidon project: AES power station demolition and re-power project; Ascon Toxic Waste Site remediation, Magnolia Tank Farm demolition and multi-use development. The 2010 SEIR does not include cumulative impacts analyses for these new projects.

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[36] Attachment 10, OCWD Workshop 3: Distribution of Poseidon Resources Ocean Desalinated Water, July 2, 2016.
[37] Attachment 9, Irvine Ranch Water District Letter to OCWD, July 6, 2016.
[38] Irvine Ranch Water District, Comments on the NPDES Permit Renewal for Proposed Huntington Beach Desalination Project, pg. 2 (Dec. 4, 2019); *available at* https://www.irwd.com/images/pdf/about-us/Desalination/12_4_19_irwd_letter_to_rwqcb.pdf.

- Proposed landside refinements to the Project involve the addition of an emergency generator, revisions to the original grading plan and layout, and revisions to the electrical substation component of the Project.

- The Project would now involve fiber optic cables and a conduit, requiring thousands of feet of previously undisclosed trenching, plus new overhead poles.

- Removal and replacement of hardware to accommodate upgraded substations, installing underground duct banks, trenching and installing would occur.

- The updated grading plan proposes the removal of the exterior berms on the site. The majority of soils from the removal of the berm will be retained onsite and used to raise the elevation of the site from the 2010 design elevation of approximately 11 feet to between 14 and 16 feet (NAVD88).

- Initial site grading would take approximately 4 months, with 5,200 total construction worker and haul trips, and a maximum of 60 one-way truck trips per day. The haul trucks were assumed to have a capacity of 14 CY; grading refinements would require an additional 6,400 CY of export; result in 10 - 21 days of additional grading that will have air quality, coastal access, and environmental justice impacts, among others.

- The extent of potential DDT contamination near the Palos Verdes shelf, in relatively close proximity to the proposed artificial reef mitigation project is now understood to be much greater than initially understood.[39]

These items were not analyzed in the State Lands Commission addendum to the CEQA review.

The Regional Board made significant changes to the project to meet the new requirements in the Ocean Plan Amendment by adding "projects" to "mitigate" intake and mortality. Additional environmental review of the Marine Life Mitigation Plan and other as-yet unreviewed Project components is necessary before the Commission may

[39] See, e.g, https://www.latimes.com/projects/la-coast-ddt-dumping-ground/, https://www.theguardian.com/environment/2021/apr/29/californias-legacy-of-ddt-waste-underwater-dump-site-uncovers-a-toxic-history, and https://www.smithsonianmag.com/smart-news/deep-sea-robots-kick-start-ddt-ocean-floor-clean-south-californian-coast-180977237/

grant approvals for the Project. If the Commission wishes to undertake this analysis, it must analyze the Marine Life Mitigation Plan projects for environmental impacts and propose alternatives and mitigation measures to eliminate any adverse environmental impacts it finds.

b. CEQA Requires the Commission to Analyze and Incorporate Feasible Alternatives and Mitigation Measures.

Section 13096 of the Commission's administrative regulations requires Commission approval of CDP applications to be supported by a finding showing the application, as modified by any conditions of approval, to be consistent with any applicable requirements of CEQA. CEQA prohibits approval of developments when there are feasible alternatives or feasible mitigation measures available that would substantially lessen any significant environmental impacts of the Project. Thus, the Commission cannot find that the Poseidon Project is consistent with the Coastal Act unless it is also consistent with CEQA.

While the Commission is governed by its certified regulatory process, CEQA principles remain relevant. One of [an EIR's] major functions . . . is to ensure that ***all reasonable alternatives*** to proposed projects are thoroughly assessed by the responsible official." (*Laurel Heights Improvement Ass'n. v. Regents of the University of California* (1988) 47 Cal.3d 376, 400.) Further, "Under CEQA, the public agency bears the burden of affirmatively *demonstrating* that…the agency's approval of the proposed project followed meaningful consideration of alternatives and mitigation measures." (*Mountain Lion Foundation v. Fish and Game Commission* (1997) 16 Cal.4th 105, 134, emphasis added.) The Commission can and must analyze the relative environmental impacts of providing water through conservation, through a smaller project, and through use of the Carson indirect potable reuse project.

CEQA differs from the National Environmental Policy Act (NEPA) in its substantive mandate. Under this mandate, a less damaging feasible alternative or mitigation measure ***must*** be adopted by the lead agency unless the lead agency can demonstrate that the mitigation is "truly infeasible." (*City of Marina v. Board of Trustees of the California State University* (2006) 39 Cal.4th 341, 368; see also Pub. Resources Code § 21002 ["public agencies should not approve projects as proposed if there are feasible alternatives or feasible mitigation measures available which would substantially lessen the significant environmental effects of such projects"].) Notably, CEQA requires agencies to evaluate offsite alternatives when they are feasible, will achieve reasonable project objectives, and "significant effects of the project would be avoided or lessened by putting the project in another location." (14 CCR § 15126.6(f)(2)(A); (See, for example, *Citizens of Goleta Valley v. Board of Supervisors* (1990) 52 Cal.3d 553 [upholding EIR in part because of adequate analysis of an off-site alternative] and *Save Round Valley Alliance v. County of Inyo* (2007) 157 Cal.App.4th 1437 [EIR found inadequate for failure to assess an offsite alternative that would have reduced impacts].) This is particularly relevant to the Commission's consideration of the Carson potable reuse project as a water supply alternative for the region.

Ultimately, the Commission cannot support, with the requisite substantial evidence, findings that there are no feasible alternatives or mitigation measures available which would substantially lessen the significant adverse impacts the Poseidon Desalination Project would have on the environment. On the contrary, feasible alternatives and mitigation measures exist in the form of increased water conservation, a smaller plant, and the Carson potable reuse project. The Commission cannot find the Project consistent with CEQA and, consequently, cannot find that it is consistent with the Coastal Act. The CDPs must be denied.

III. As Proposed, the Poseidon Project Fails to Satisfy Standards for Risk Category IV Critical Infrastructure Necessary to Ensure Emergency Function.

It is hard to overstate the importance of ensuring that the facility is designed and constructed to remain safe and operable in the event of an emergency. The Poseidon Project would provide fresh water, and fresh water is necessary for life, not to mention public safety and fire suppression. The Project would construct important water infrastructure on the Huntington Beach coast, along the active Newport-Inglewood fault. Thus, the desalination plant would be subject to seismic hazards, as well as threats from sea level rise, flooding, and tsunami. If constructed, it must meet International Building Code Risk Category IV standards.[40]

Scientists have determined that the Newport-Inglewood fault is capable of generating magnitude 7.5 earthquakes. Even smaller earthquakes may damage water treatment facilities and conveyance systems. The Environmental Protection Agency warns, "For a drinking water system, an earthquake can cause hundreds ... even thousands ... of breaks in water pipelines, ruptures in storage and process tanks and the collapse of buildings. This can cause a loss of water system pressure, contamination and

[40] See, International Building Code Table 1604.5, Risk Category of Buildings and Other Structures, https://www.fandr.com/wp-content/uploads/2020/07/Speaking-in-Code-August-2020.pdf.

drinking water service disruptions…"[41] Earthquakes also frequently cause fires that require water for suppression. It is crucial that the Project be designed to withstand seismic damage and continue operation during and after these types of events.

The State of California has recently found, "Sea level rise poses a significant threat to the state's infrastructure located within and near the coast."[42] Specifically, the Ocean Protection Council and the California Coastal Commission have issued guidance that recommends "evaluating the expected impacts to critical infrastructure that would be caused by approximately 10 feet of sea level rise by 2100 (using what is known as the extreme risk or "H++" scenario)."[43] In May 2020, the agency further adopted "Principles for Aligned State Action (State SLR Principles)" which recommend planning to address "a minimum of 3.5 feet of sea level rise in the next 30 years."[44] The expected impacts of sea level rise are compounded by the threat of a tsunami event at the site. While rare, Southern California has experienced several tsunamis in the last decade, most recently in January 2022. The 2011 tsunami event caused an estimated $100 million worth of damage to California harbors.[45] Even the smaller 2022 event caused significant damage in some California harbors. The Project must be designed to withstand damage from sea level rise, coastal flooding, and tsunami – and continue operating.

The likelihood of continued Project operation, and the ability to maintain public safety in the event of an emergency, is much greater when infrastructure is designed to meet Risk Category IV standards. Table 1604.5 of the International Building Code assigns buildings risk categories, each of which triggers certain design and building standards related to earthquake, flood, wind loads, and other risks. One explanation of the Risk Categories explains:

> The value of the importance factor generally increases with the importance of the facility. Structures assigned greater importance factors must be designed for larger forces. The result is a more robust structure that would be less likely to sustain damage under the same conditions than a structure with a lower importance factor.

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[41] EARTHQUAKE RESILIENCE GUIDE for Water and Wastewater Utilities, Environmental Protection Agency, March 2018, https://www.epa.gov/sites/default/files/2018-02/documents/180112-earthquakeresilienceguide.pdf, p. 1.

[42] "Sea-Level Rise Guidance for Critical Infrastructure" August 2021 Public Review Draft, Page vii, https://documents.coastal.ca.gov/assets/slr/SLR%20Guidance_Critical%20Infrastructure_8.16.21_FINAL_FullPDF.pdf.

[43] Ibid.

[44] Ibid.

[45] https://www.latimes.com/california/story/2022-01-22/the-tsunami-that-battered-santa-cruz-highlights-the-threat-facing-californias-coast

> The intent is to enhance a structure's performance based on its use or need to remain in operation during and after a disaster. [46]

In particular, Risk Category IV buildings are "buildings that are considered to be essential in that their continuous use is needed, particularly in response to disasters," including "water storage facilities and pump structures required to maintain water pressure for fire suppression" as well as "facilities required for emergency response." This definition clearly includes the Project, which is being treated as an essential water supply and backup supply, and which would provide the City's only reservoir shoreward of the Newport-Inglewood Fault Zone.

Poseidon claims that the Project would provide a "community facility" and that it need only meet design and building standards applicable to a "community facility." In reality, according to Poseidon, the City of Huntington Beach, and the Orange County Water District's own documents, plans, and agreements, the Project is intended to be a critical facility.[47] Critical facilities are those necessary for health and safety. Because residents rely on these facilities to provide necessities such as water, critical facilities are constructed according to more stringent building standards. This ensures that the facilities needed to support health and safety remain operational at all times, including during emergency situations. The availability of potable water is especially important. Not only is it vital to sustain life at all times, but water supplies are critical during periods of emergency response. As discussed above, the Project site is located near portions of the Newport-Inglewood Fault, which is capable of up to a magnitude 7.5 earthquake. In 1933, the magnitude 6.4 Long Beach Earthquake ruptured approximately nine miles of the Newport-Inglewood Fault south of Huntington Beach, levelling thousands of buildings and killing 120 people. Fires erupted from broken gas lines, and thousands of people were left without water service. Disruption of water supplies impedes fire response.

Decades of documents prove that the Poseidon Project is intended to be a critical facility. The City of Huntington Beach's 2010 environmental impact report states that the Poseidon facility will provide an emergency water supply.[48] The City required Poseidon to enter into a water purchase agreement that allows the City to purchase up to seven million gallons per day during declared water emergencies. (CCC 2013 Staff

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[46] See, International Building Code Table 1604.5, Risk Category of Buildings and Other Structures, https://www.fandr.com/wp-content/uploads/2020/07/Speaking-in-Code-August-2020.pdf.
[47] Huntington Beach Desalination Project Sea Level Rise Analysis, Poseidon, pp. 6, 13.
[48]Huntington Beach SEIR, e.g., p. 6-40, https://www.huntingtonbeachca.gov/files/users/planning/Sec06_Alternatives.pdf.

Report p. 27.) The Project will also construct a 10-million-gallon reservoir onsite to be integrated into the City's water system. (CCC 2013 Staff Report p. 27.) Notably, at one point, the stated purpose of the reservoir was to provide a water supply shoreward of the Newport-Inglewood Fault in the event seismic activity severs access to water supplies inland of the fault. The City of Huntington Beach's CDP approvals and environmental findings further characterize the Project as an emergency supply. The Santa Ana Water Board also specifically found that the Poseidon Facility's water is needed water supply and must be integrated into the rest of the existing water system. While we disagree that 50 mgd is actually needed, the Board's reliance on this water supply, and its approval of this supply in lieu of less impactful alternatives, means that the community will become reliant on this supply and therefore renders it "critical." Thus, this is exactly the type of critical facility that must remain operational in the emergency situation that would arise after an earthquake or a tsunami. This requires that the facility be designed to meet heightened standards including the Ocean Protection Council's sea level rise scenarios and Risk Category IV "critical facility" standards.

It is undisputed that the Carlsbad Desalination Plant ***is*** considered a critical facility.[49] Similarly, the desalination plant proposed for Huntington Beach is not a mere community facility, but a critical one. That the Project would be constructed in a location vulnerable to documented geological and coastal hazards, including, but not limited to earthquake, flooding, sea level rise, and tsunami, makes it even more crucial that the facility is built to meet critical infrastructure standards. Allowing the facility to proceed without meeting critical infrastructure requirements would be inconsistent with approvals granted by the Santa Ana Water Board, entitlements granted by the City of Huntington Beach, past practice with other nearby desalination plants, and common sense. A Project that proceeds according to mere "community facility" standards would endanger the public. As discussed below, designing and constructing the Project to standards below Risk Category IV Critical Infrastructure not only defeats the purpose of the Project and wastes public funds, but violates both the Coastal Act and the Huntington Beach certified LCP.

[49] See SDCWA's 2019-2023 Business Plan and Fact Sheet – Overview [n.d.]. identifies the facility as a critical local water resource; 2 2017 San Diego County Multi-Jurisdictional Hazard Mitigation Plan, and as defined in the County's April 2013 Integrated Floodplain Management Planning [defining a "critical facility" as including both public and private potable water facilities]; Poseidon March 18, 2020 press release, "Carlsbad Desalination Plant Staff Take Extraordinary Step to Shelter in Place to Ensure Operational Continuity at Critical Facility" [facility manager describing [Project as a "critical regional facility"]

IV. The Poseidon Project is Inconsistent with the Huntington Beach Certified LCP and the California Coastal Act.

The Commission must ensure strict adherence to the Coastal Act. California "courts are enjoined to construe the statute liberally" because "The highest priority must be given to environmental consideration in interpreting the statute." (*Bolsa Chica Land Trust v. Superior Court* (1999) 71 Cal.App.4th 493, 506.) As proposed, Poseidon's Huntington Beach Desalination Project violates Coastal Act policies related to the protection of and mitigation of impacts to wetlands and ESHA, marine life, recreation and coastal access, coastal armoring, community safety, aesthetics, and environmental justice. Coastal Act section 30233 grants the Commission authority to find that conservation, the Carson Project, or a combination of the Carson Project and a downsized desalination facility operating with slant wells are feasible and less environmentally damaging alternatives to the Project. In particular the Carson Project is consistent with Coastal Act policies to "enhance and restore" marine resources (Section 30230) and "maintain optimum populations of marine organisms" (Section 30231) by improving ocean habitat through reduced ocean discharges from the Carson Wastewater Treatment Plant. The CDP must be denied pursuant to the Commission's retained jurisdiction.

The existence of feasible, less environmentally damaging alternatives precludes the need to impose mitigation measures because the Commission may deny the Project CDPs as proposed. However, if the Commission finds alternatives infeasible, it can and must impose the maximum mitigation available to avoid and reduce the Project's myriad environmental impacts.

Further, the Huntington Beach Certified LCP lays out specific requirements for coastal development occurring within the City's coastal jurisdiction. Many of these LCP policies are similar to Coastal Act policies or outright replicate them. The Poseidon Project is inconsistent with a number of LCP policies, including those related to the protection of wildlife, wetlands, and ESHA, tsunami and coastal flooding, community safety, and recreation. These inconsistencies provide the Commission with yet another ground for rejecting this harmful project.

a. The Commission Should Resolve Open Enforcement Actions Prior to Considering the Project's CDPs.

The Project site has an open violation of the Coastal Act for destruction of wetlands in blatant disregard of the Act.[50] Although the City's environmental review has not disclosed the presence of wetlands on the site, the Commission's biologist determined

[50] Attachment 1, 2013 Staff Report, pp. 61-65.

that there were approximately 3.5 acres of wetlands within the project site and there remain an additional approximately 0.5 acres on the east side of the project site that may be impacted by the Project.[51] Prior to development of the AES plant, the Project site was part of the tidal marsh, dune habitat, and floodplain of the Santa Ana River. Despite disturbance, wetlands have reemerged and reappeared throughout the area, due in part to "the area's relatively high groundwater table, the continued presence of hydric soils beneath much of the area, anthropogenically influenced topography and hydrology in some areas, and the presence of nearby wetland vegetation that provides an ongoing seed source."[52] This is what occurred onsite, wherein disuse of the site's storage tanks and containment areas after the mid-1990s permitted reemergence of wetlands that the Commission documented in site visits and photographs taken in 2009. Sometime prior to 2012, and without obtaining a permit, these wetlands were disked, and all vegetation was removed. While subject to Commission enforcement action, the Project site's unpermitted removal of wetlands has never been resolved or remediated. This open violation should have been resolved prior to the consideration of an application that would impose additional impacts on coastal resources and wetlands. Instead, we are concerned that this violation will be swept under the proverbial rug and permitted after-the-fact. Approval of Poseidon's application for CDPs on a site with an open enforcement action, prior to the resolution of these violations, will incentivize future disregard of the Act. In addition to requiring full restoration of the past destruction, we ask the Commission to levy fines for the unpermitted wetlands destruction as authorized by SB 433.

b. The Project is Not Designed to Avoid, Minimize, or Remediate Impacts to On-site Wetlands and ESHA.

i. The Project's Dredge and Fill of Wetlands Violates the Coastal Act and Numerous LCP Policies.

The Coastal Act provides robust protection of wetlands. The overarching principle is contained in Section 30231, which requires, "The biological productivity and the quality of coastal waters, streams, wetlands, estuaries… appropriate to maintain optimum populations of marine organisms and for the protection of human health shall be maintained and, where feasible, restored…" (See also, Sections 30240, 30607.1.) This principle is implemented, in part, through Section 30233, which limits "[t]he diking, filling, or dredging of open coastal waters, wetlands, estuaries, and lakes." Such dredge and fill are only permitted (1) "where there is no feasible less environmentally damaging alternative, and where feasible mitigation measures have been provided to minimize

[51] Id. at p. 61.
[52] Ibid.

adverse environmental effects" and (2) for facilities enumerated in Section 30322. The Commission cannot make findings to support allowing the Project pursuant to this section.

The Project would involve dredge and fill to retrofit the existing intakes for Poseidon's use, to place the linear brine diffusers on the outfalls, to construct the artificial reef provided but not studied in the Marine Life Mitigation Plan, and for continued maintenance of the Project. As currently proposed, these activities would violate the Coastal Act. Conservation, the Carson Project, and a smaller facility present feasible, less environmentally damaging alternatives that have never been studied or evaluated in good faith. Likely feasible mitigation measures also exist in the form of slant wells, which the ISTAP process never truly analyzed for economic feasibility. Moreover, the Project is not one of the enumerated facility types eligible under section 30233. Of the options, the Project could only be considered "New or expanded port, energy, and coastal-dependent industrial facilities, including commercial fishing facilities." But a water source is not coastal-*dependent* by nature. Water is available through other means including conservation, the Carson Project, and continued Metropolitan Water District imports, all without implicating the coast. Section 30233(a)(4) provides for "Incidental public service purposes, including but not limited to, burying cables and pipes or inspection of piers and maintenance of existing intake and outfall lines," but the Project is not an "incidental" public use. "Incidental" means "accompanying but not a major part of something" per the Oxford English Dictionary. Yet the existing intake and outfall structures are the entire reason the Project is being proposed, despite the existence of cheaper and less environmentally damaging alternative water sources. Retrofitting the intakes and outfalls and extending their use for decades is also more than mere "maintenance." On the other hand, the structures are not *even* incidental to the AES power plant operation. State and federal laws require the AES power plant intakes and outfalls to be decommissioned to eliminate their adverse effects on marine life, and the AES plant is being modified to no longer need them.

Approval of the current Poseidon Project would also violate various LCP policies designed to ensure protection of wetlands. Violated provisions of the LCP include, but are not limited to:

- LCP Policy C6.1.4 states, "The biological productivity and the quality of coastal waters, streams, wetlands, estuaries, and lakes appropriate to maintain organisms and for the protection of human health shall be maintained and, **where feasible, restored**."

- LCP Policy C6.1.20 requires Poseidon to "Limit diking dredging, and filling of coastal waters, wetlands, and estuaries to the specific activities outlined in Policy

30233 and 30607.1 of the Coastal Act" and "Conduct any diking dredging and filling activities in a manner consistent with Section 30233 and 30607.1 of the Coastal Act."

- LCP Policy C7.2.6 states, "Prohibit fill in any wetland areas for the purpose of road construction, except for roads allowed pursuant to Section 30233 of the Coastal Act or when required to serve uses allowed in wetlands pursuant to and consistent with Sections 30260-30264 of the Coastal Act for coastal dependent and energy uses."

- Finally, LCP Policy I-C 8(c), states, "For proposed projects within the Coastal Zone, utilize the development review/environmental review process to accomplish the following: … Permit resource dependent and incidental public service related land uses within wetlands and environmentally sensitive habitat areas only if consistent with the following Coastal Act policies: Section 30233 and Section 30240."

- LCP Policy C1.1 requires the Commission to "[e]nsure that adverse impacts associated with coastal zone development are mitigated or minimized to the greatest extent feasible."

As re-iterated in the Commission's June 29, 2021 letter, the Commission's 2013 Staff Report identified several acres of on-site wetlands—already previously adversely affected—that the Poseidon Project would permanently fill. Poseidon is responsible for ensuring adequate mitigation of impacts to the on-site and adjacent wetlands. In June 2021, the Commission requested further information regarding the Project's treatment of previous adverse effects on, and proposed fill of, Coastal Act wetlands within the project footprint and its proposed mitigation approach. (p. 3.) Since that request, Poseidon has not offered any further on-site project design changes or additional mitigation for impacts to on-site wetlands.

In violating Coastal Act sections 30233 and 30240 (discussed below), the proposed Project also runs afoul of LCP Policy I-C 8(c). The CDP must be denied for failing to conform to the Huntington Beach certified LCP's clear policies.

ii. The Project Fails to Protect ESHA.

The Coastal Act's protections for ESHA are paramount. Section 30240 provides that environmentally sensitive habitat areas (ESHA) "**shall be protected** against any significant disruption of habitat values," and development adjacent to ESHA "shall be sited and designed to prevent impacts which would significantly degrade those areas, and shall be compatible with the continuance of those habitat and recreation areas." The courts have been clear: "The Coastal Act does not permit destruction of an environmentally sensitive habitat area [ESHA] simply because the destruction is mitigated offsite." (*Bolsa Chica Land Trust v. Superior Court* (1999) 71 Cal.App.4th 493, 499.) Where the Project will adversely impact wetlands and ESHA, the Project must be modified to eliminate those impacts, an alternative must be chosen, or the CDPs must be denied.

The Huntington Beach LCP protects ESHA via LCP Policy C7.1.2, which provides, "Environmentally sensitive habitat areas shall be protected against any significant disruption of habitat values…" Further, LCP Policy C7.1.3, requires that "Development in areas adjacent to environmentally sensitive habitat areas and parks and recreation areas shall be sited and designed to prevent impacts which would significantly degrade those areas, and shall be compatible with the continuance of those habitat and recreation areas."

The Commission has identified tidally influenced wetlands and associated ESHA "just outside" the Project footprint. (Commission June 2021 letter, p. 3.) The Project, as proposed, will have significant indirect impacts on adjacent wetlands and ESHAs during Project construction and operations. (Commission 2013 Staff Report, p. 66, Commission August 2021 Notice of Incomplete CDP Application). Unless avoided or fully mitigated, the Project's approval would violate the Coastal Act and LCP provisions requiring ESHA protection. When the Commission requested further information about how Poseidon will address direct and indirect impacts to ESHA in June 2021, Poseidon failed to respond – it made no Project changes and has failed to provide any new evidence that the Project will alleviate impacts to ESHA raised by Commission Staff. The CDP should be denied.

In its Consistency Analysis, Poseidon claims that the City's 2010 SEIR did not identify ESHA on or near the Project site that would be impacted by the proposed Project; therefore, it concluded, the Project is consistent with Section 30240. (p. 7.) This "analysis" fails to meaningfully address or remedy the Commission's concerns, especially those detailed in the Commission's 2013 Staff Report. The Commission is required to enforce Coastal Act protections of adjacent ESHA, and its prior declaration of ESHA cannot be ignored. The City of Huntington Beach's dismissal of the Commission's photographs and evidence of ESHA does not mean ESHA does not exist.

The Commission has already found, the "SEIR did not fully describe the important habitat values of the adjacent ESHA/wetland areas to the approximately two dozen sensitive species known or presumed to use that habitat, and did not adequately evaluate.

. . dewatering, noise, and the required buffer. . ." (p. 66.) Furthermore, CEQA does not require the Commission to abdicate its protection of coastal resources to the City and rely wholly on the City's analysis of environmental impacts. On the contrary, CEQA authorizes the Commission to provide additional analysis in its evaluation of CDPs, the functional equivalent of a CEQA document, and to require additional mitigation as appropriate. (14 CCR § 15096(g)(1).)

Further, Poseidon's claims that the Project's location within an existing industrial facility "avoids and minimizes" potential impacts to nearby coastal resources (July 2021 Letter p. 6), does not address the Commission's concerns nor provide information about on-site improvements to address these impacts. Rather, Poseidon admits it is not proposing any changes to the project design, layout, or operations to address direct or indirect noise/vibration impacts to adjacent wetlands and sensitive receptors. (*Ibid*, Exhibit A p. 2.) For example, Poseidon refused to provide the requested Sound Mitigation Plan requested by Commission staff *now*, deferring its preparation until *after* project approval. The location within an industrial facility further fails to address the entrainment and impingement impacts to public trust marine resources, which would be better minimized through operation of a smaller-capacity facility.

The Commission was aware that the Project would be sited on an existing industrial facility when it detailed the Project's construction and operation impacts in its 2013 Staff Report and when it requested information about how Poseidon will address these impacts in its June 2021 letter. Instead of detailing how the Project will minimize the construction and operational impacts, however, Poseidon points to findings and measures from the 2010 SEIR and CDP. Its failure to adequately address impacts to adjacent ESHA violates Coastal Act Section 30240.

Poseidon is not proposing any on-site or operational changes in response to the Commission's recently raised concerns over the on-site wetlands and indirect impacts to adjacent wetlands and ESHAs, including the Project's lack of the required buffers. The Commission's 2013 Staff Reported requires Poseidon to provide "for Executive Director review and approval, a delineation of all ESHA and wetland areas within 200 feet of the project footprint conducted by a qualified biologist approved by the Executive Director. The approved delineation shall serve as the basis for the 100-foot setback." (p. 10.) Based on the correspondence between Poseidon and the Commission, Poseidon has not completed this review to identify nearby ESHA, instead pointing to the City's 2010 SEIR finding that no wetlands exist within 100 feet of the project site.

The 2013 Staff Report cautioned that "[e]levating the facility or its components would also likely increase noise levels at the adjacent wetlands and ESHA during project operations, thereby adversely affecting listed special status species. Elevating would also require additional electricity to pump water to the higher elevations, which would increase the project's indirect greenhouse gas emissions." (p. 85.) Poseidon now proposes to increase the Project's finished floor elevations to 14-16 ft due to hazard risks—this will exacerbate the impacts on surrounding ESHA.

Not only does the Project fail to prevent adverse impacts to ESHA, but the Applicant denies the very existence of ESHA. The CDPs should be denied.

iii. Mitigation for Dredge and Fill Impacts is Insufficient.

The Commission must ensure adequate mitigation of project impacts to coastal resources, especially where a Project requires dredge and fill development. Here, the Project will require Poseidon to construct and retrofit the Project's intakes and outfalls and grading and fill to raise the foundation of the proposed desalination plant above projected sea level rise, flood, and tsunami danger. The Project will require additional dredge and fill-related activities associated with construction of the artificial reef. Under the Coastal Act Section 30607.1, any permitted dike and fill development must require the following mitigation, **at a minimum**: "either acquisition of equivalent areas **of equal or greater biological productivity** or opening up equivalent areas to tidal action" where there are appropriate restoration sites available. The Project, as proposed, does not ensure adequate mitigation for the planned filling of on-site wetlands, or the indirect impacts to adjacent wetlands. Proposed mitigation is insufficient in size and is unlikely to exist in the future. Moreover, the Coastal Act prohibits destruction of ESHA.

The Project's failure to provide adequate buffers further exacerbates impacts on adjacent wetlands. Yet, Poseidon has failed to provide any new mitigation measures or Project design changes to address the Project's direct and indirect impacts to on-site and adjacent wetlands. The Commission typically requires a wetland mitigation ratio of 4:1. (June 2021 letter, p. 3.) Poseidon has not demonstrated that it will provide the required mitigation. In its August 2021 Notice of Incomplete CDP Application, the Commission raised concerns over Poseidon's planned mitigation in Bolsa Chica. Poseidon has already received mitigation credit at Bolsa Chica, and the Bolsa Chica wetlands will be heavily impacted by sea level rise and unlikely to provide long-term mitigation for wetlands impacted at the Project site. (*Id*, p. 2.) Instead of addressing these concerns, in its September 20, 2021 response to the Commission, Poseidon questioned whether on-site wetlands even exist and labeled the concerns over sea level rise impacts on Bolsa Chica as "speculative." Yet, a recent study of the Bolsa Chica Lowland Restoration Project recently found that, without intervention, the majority of the wetlands will be inundated by sea level rise between 2060 and 2100.[53] The Project is inconsistent with section 30607.1 of the Coastal Act, and the CDPs should be denied.

c. The Project Does Not Contain Buffers to Protect Wetlands and ESHA.

The Project fails to include a Coastal Act and LCP-compliant ESHA and wetland buffer and should be denied on that ground, alone. The Project is located among sensitive coastal resources and ESHA, as Commission Staff has repeatedly found.

Coastal Act section 30231 provides for the protection of the biological productivity of wetlands through "maintaining natural vegetation buffer areas that protect riparian habitats." Section 30240 subd. (b) requires the Applicant to design development "to prevent impacts which would significantly degrade [ESHA]" such that it "shall be compatible with the continuance of those habitat…areas." Similarly, the certified LCP requires "that new development contiguous to wetlands or environmentally sensitive habitat areas include buffer zones" that "shall be a minimum of one hundred feet setback from the landward edge of the wetland." (LCP Policy C 7.1.4.) Larger buffers may be required "if substantial development or significantly increased human impacts are anticipated." (*Ibid.*) The LCP contains a detailed explanation of factors that justify requiring a larger wetland or ESHA buffer. These factors include:

- Biological significance of adjacent lands: The buffer should be sufficiently wide to protect the functional relationship between the wetlands and the adjacent upland.

- Sensitivity of species to disturbance: The buffer should be sufficiently wide to ensure that the most sensitive species will not be disturbed significantly by permitted development, based on habitat requirements of both resident and migratory species and the short- and long-term adaptability of various species to human disturbance.

- Use existing cultural features to locate buffer zones: The buffer zones should be continuous with the environmentally sensitive habitat areas and make use of existing features such as roads, dikes, irrigation canal, and flood control channels where feasible.

All of these factors justify a larger buffer than 100 feet. The Project site is located in the wetlands and dune complex located at the mouth of the Santa Ana River, adjacent

[53] Attachment 3, Bolsa Chica Lowland Restoration Project, Sustainable Alternatives Study Analysis, December 2021, Fig. 4-4.

to Magnolia Marsh, Commission-determined ESHA, and proximate to the Bolsa Chica and other productive wetlands along the Pacific Flyway. The immediate area provides habitat for 23 listed and sensitive species, including the burrowing owl (Species of Special Concern), western snowy plover (federally threatened), Belding's Savannah Sparrow (state endangered), California brown pelican (Species of Special Concern), and California least tern (federally endangered).[54] The California Department of Fish and Wildlife recommends a 300-foot buffer to protect passerine species, and a 500-foot buffer is typically recommended to prevent impacts to raptor species. Even so, the Project currently fails to contain buffers at all. Poseidon's July 7, 2021 letter to the Commission accompanying its application claims that buffers are not needed because the City did not designate ESHA in its SEIR. Again, the Commission has deemed locations on- and off-site to be ESHA, regardless of whether the City did so in the past. Poseidon's claim that the adjoining land does not contain ESHA lacks support. The Commission is the agency charged with designating ESHA, and the Commission has specifically found areas on and off-site to be ESHA. The Project fails to contain LCP-required buffers, and the CDP should be rejected on those grounds.

d. The Project Violates LCP Policies Designed to Protect Marine Life.

The Project's entrainment of 108 million organisms each year, or ***5.4 billion***[55] organisms during its operating life, will lead to violations of Coastal Act and LCP policies that have not been resolved or adequately mitigated. Section 30230 of the Coastal Act requires:

> Marine resources shall be maintained, enhanced, and **where feasible, restored**. Special protection shall be given to areas and species of special biological or economic significance. Uses of the marine environment shall be carried out in a manner that will sustain the biological productivity of coastal waters and that will maintain healthy populations of all species of marine organisms adequate for long-term commercial, recreational, scientific, and educational purposes.

Section 30231 similarly provides:

> The biological productivity and the quality of coastal waters, streams, wetlands, estuaries, and lakes appropriate to maintain optimum populations of marine organisms and for the protection of human health shall be maintained and, **where feasible, restored** through, among other means,

[54] Attachment 1, 2013 Staff Report, p. 67.
[55] This is likely an underestimate, based on aging datasets.

> **minimizing adverse effects of waste water discharges and entrainment**…

The LCP provides similar protection. Goal C6 of the LCP is to "Prevent the degradation of marine resources in the Coastal Zone from activities associated with an urban environment." Objective C.6.1 is to "Promote measures to mitigate the adverse impacts of human activities on marine organisms and the marine environment through regulation of new development, monitoring of existing development, and retrofitting necessary and feasible." This policy provides wide latitude for conditioning the Poseidon Project to limit harm to marine life. The LCP implements this goal through policies that include, but are not limited to:

- Policy C6.1.1 requires, "that new development include mitigation measures to enhance water quality, if feasible; and, at a minimum, prevent the degradation of water quality of groundwater basins, wetlands, and surface water.

- Policy C6.1.2 echoes the Coastal Act: "Marine resources shall be maintained, enhanced, and where feasible, restored. Special protection shall be given to areas and species of special biological or economic significance.

- Policy C6.1.3 states, "Uses of the marine environment shall be carried out in a manner that will sustain the biological productivity of coastal waters and that will maintain healthy populations of all species of marine organisms adequate for long-term commercial, recreational, scientific, and educational purposes.

- Policy C6.1.4 also reproduces the Coastal Act: "The biological productivity and the quality of coastal waters, streams, wetlands, estuaries, and lakes appropriate to maintain organisms and for the protection of human health shall be maintained and, **where feasible, restored**."

- Policy C 6.1.19 addresses the Project with specificity: "Prior to approval of any new or expanded seawater pumping facilities, require the provision of maximum feasible mitigation measures to minimize damage to marine organisms due to entrainment in accordance with State and Federal law.

The Project fails to maintain the biological productivity of wetlands and coastal waters and will cause significant adverse effects to marine life and water quality through intake, discharge, and construction. (See, Staff Report 2013, pp. 32-37.) An estimated 108 million organisms will be killed during each year of operation. As Coastal Commission staff found in 2013:

> The source water areas of species entrained in this intake extend up to about 100 miles of the Shoreline. The Areas of Production Foregone calculated for the sampled species range from about seven acres to about 350 acres, with an average of about 110 acres. For example, the APF for queenfish, with a source water extending along about 53 miles of shoreline, is about 164 acres, while the source water distance and APF for the California halibut are 19 miles and 23.7 acres, respectively. The various source water areas encompass at least nine State Marine Conservation Areas (SMCAs) or State Marine Reserves (SMRs) established pursuant to California's Marine Life Protection Act Initiative – those within 50 miles upcoast or downcoast of the intake include Bolsa Bay SMCA, Bolsa Chica Basin SMCA ("no take"), Upper Newport Bay SMCA, Crystal Cove SMCA, Laguna Beach SMR, Laguna Beach SMCA ("no take"), and Dana Point SMCA.[56]

Thus, the Project will adversely affect not only the waters nearest the plant, but it will harm State Marine Conservation Areas and State Marine Reserves. Additional marine life will be killed by brine diffusion. The Project presents a clear conflict with the policies of the Coastal Act and LCP that protect marine life.

While Poseidon claims that the use of wedgewire screens will reduce the wildlife impacts of the intakes, there is no evidence that the screens will restore, or even *maintain* biological productivity. The coastal power plant on the site is set to discontinue use of its "once through cooling" (OTC) system in 2 years. Without the Poseidon project repurposing the intake and discharge conduits, marine life would experience "restoration" benefits. A one percent reduction in mortality from the use of wedgewire screens is insufficient to maintain benefits from the State enforcing regulations to discontinue OTC systems to "restore" marine life populations – especially where alternatives are available, as is the case here. Further, the Commission recently raised concerns with the maintenance and performance of wedgewire screens in response to reports of difficulties at the Carlsbad facility. As of October 2021, the Commission stated it did not have the "necessary information" about maintenance of the proposed intake system. The Commission cannot approve a project without assurance of compliance with the LCP policies and Coastal Act. We request that the Commission disclose how it will move forward despite this information.

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[56] Attachment 1, 2013 Staff Report, p. 33.

The Project incorporates linear brine diffusers on outfall pipes. While wildlife advocates initially believed this approach would reduce overall entrainment mortality as compared to in-plant brine dilution, it is now better understood that linear brine diffusers themselves cause marine life mortality through shear.[57] These are impacts from Project mitigation that themselves need to be analyzed and mitigated.

Alternatives including conservation, a smaller facility, or use of the Carson Project would avoid or entirely eliminate sources of entrainment or brine and diffuser shear and should be adopted instead. In violation of the Coastal Act and the Huntington Beach LCP, as currently proposed, the Project does not contain the maximum mitigation available to avoid devastating impacts to marine resources. Further, the Applicant has not conducted slant well feasibility studies that include test wells to validate computer modeling as occurred with the proposed Cal-Am and Doheny projects and was recommended here[58], nor has there been an economic feasibility analysis conducted by ISTAP nor the Regional Board.

The Coastal Act and LCP call for "restoration" of marine life populations, habitat and water quality where feasible. Water conservation, recycled water from the "Carson Project" and/or a desalination facility using subsurface intakes are feasible alternatives and mandatory.

e. The Project Violates LCP Policies Designed to Avoid the Adverse Effects of Coastal Armoring.

The Commission's June 2021 letter specifically asked whether Poseidon's submittal will assure that its solution for tsunami and sea level rise risks "will not include shoreline protective devices (which the LCP prohibits at this location.)" (p. 5.) Sea walls interfere with natural sand deposition processes and accelerate beach erosion. By armoring the coast, they also prevent beaches and wetlands from migrating inland as sea-level rises. Coastal Act section 30253 prohibits developments that "in any way require the construction of protective devices…" This section has been broadly construed to prohibit not only sea walls, but elevated project platforms that are themselves protective devices.[59]

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[57] Dilution Issues Related to Use of High Velocity Diffusers in Ocean Desalination Plants, pp. 9-15.
[58] See, HydroFocus Reports (1&2).
[59] Staff Report for Application No. 5-18-0788, February 2021, https://documents.coastal.ca.gov/reports/2021/2/Th14a/th14a-2-2021-report.pdf.

LCP Coastal Element Hazards Section C10.1.19 seeks to avoid beach loss by requiring that development "shall be conditioned to prohibit a shoreline protective device." LCP Policy C1.1.9 states, "New development shall be designed to assure stability and structural integrity, and neither create nor contribute significantly to erosion, geologic instability, or destruction of the site or surrounding area ***or in any way require the construction of a protective device***." (emphasis added.) As the City of Huntington Beach, which advertises itself as "Surf City USA" is heavily dependent on beach tourism, this prohibition on sea walls is echoed in Policy C10.1.14. This policy states, "During major redevelopment or initial construction, require specific measures to be taken …to prevent or reduce damage of flooding and the risks upon human safety. Development shall, to the maximum extent feasible...(a) Avoid the use of protective devices; (b) Avoid encroachments into the floodplain, and (c) Remove any encroachments into the floodplain to restore the natural width of the floodplain."

Even so, in direct contravention of Coastal Act section 30253, LCP Policy C.10.1.9, and LCP Policy C10.1.14, the Project contains what it calls a "sound wall" that abuts the tidal wetlands of Magnolia Marsh. Regardless of what Poseidon calls it, the "sound wall" will provide protection to the project from flood and tsunami risks. Poseidon's claim that it is not, in fact, a protective device, is a distinction without a difference. More detail is needed regarding its design and function, especially under future flood scenarios. Poseidon claims that the sound wall is exempt from Policy C.10.1.9's and Coastal Act section 30235 and 30253(b)'s prohibition on protective devices because it is located along Magnolia Marsh and not within the tsunami run-up zone. Again, the wall is being relied upon to reduce coastal flooding hazards so that Poseidon can then claim no such hazards exist. Even along Magnolia Marsh, the wall will prevent wetlands from migrating inland and will contribute to the island effect. Wetland managers are trying to prevent, not exacerbate, the loss of wetlands due to coastal and near-coastal armoring. These losses are already expected at the Bolsa Chica wetlands located just north of the Project site. There, a recent study noted, "Rising sea levels pose a risk to habitats…because the [Bolsa Chica Lowland Restoration Project] site is surrounded by urban development, preventing the inland migration of habitat."[60] Moreover, section 30253(b) prohibits not just protective devices, but any development that will "create [or] contribute significantly to erosion, geologic instability, or destruction of the site or surrounding area."[61] The Project will contribute to erosion and destruction of the site and surrounding area, including wetlands, and cannot be approved.

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[60] Attachment 3, Bolsa Chica Lowland Restoration Project, Sustainable Alternatives Study Analysis, December 2021, p. 46.
[61] Similarly, Chapter 222.04 FP2 of the Huntington Beach Municipal Code prohibits development that will allow flood waters to be diverted onto adjacent properties.

The Project further proposes mass grading to remove existing berms and raise the foundation ***14 to 16 feet***, thereby attempting to elevate the Project above sea level rise and tsunami hazards. This grading also serves as a form of shoreline armoring, as the Project builds what will eventually become an island to avoid foreseeable impacts due to its coastal location. This is twice the height of the 7-foot plinth the Commission found was an impermissible shoreline protective device at the proposed Belmont Pool.[62] The proposed pool was ultimately moved further inland. Experts agree that near-coast armoring will prevent beach and wetland migration at the Project site.

Dr. David Revell states in his memorandum that the proposed project would be maladaptive to sea level rise:

> […] this proposed project discourages longer term adaptation planning by the City of Huntington Beach and the County of Orange to avoid future coastal hazards, by keeping critical infrastructure in a hazardous area.
> […]
> From public trust doctrine principles, it is also in the City/County's best interest to proactively plan for adapting critical infrastructure well in advance of adverse sea-level rise impacts. Impairments to, losses of functionality of, and pollution events from the Poseidon Plant that negatively affect the coastal environment and public recreational resources would be in violation of the public trust doctrine and state and federal environmental laws.[63]

The proposed Project is sited in a sea level rise hazard zone as designated by the City of Huntington Beach Sea Level Rise Vulnerability Assessment (SLRVA) for the Huntington Beach Wetlands Subarea.[64] The SLRVA describes the site as historic tidelands that are low-lying with a high groundwater table, which may result in earlier than predicted flooding for the site and surrounding area as sea levels rise.[65] Notably, the SLRVA describes widespread groundwater emergence for the Huntington Beach Wetlands Subarea:

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[62] Staff Report for Application No. 5-18-0788, February 2021, https://documents.coastal.ca.gov/reports/2021/2/Th14a/th14a-2-2021-report.pdf.
[63]https://law.ucla.edu/sites/default/files/PDFs/Publications/Emmett%20Institute/_CEN_EMM_PUB%20Combatting%20Sea-Level%20Rise.pdf
[64] City of Huntington Beach Final Sea Level Rise Vulnerability Assessment. May 2021. https://huntingtonbeachca.gov/government/departments/planning/major/files/Sea-Level-Rise-Vulnerability-Assessment-May-26-2021.pdf
[65] Ibid.

> Hazard area projections become more widespread with 3.3ft SLR, extending inland in areas between the Huntington Beach Channel and Talbert Channel. Hazard area projections continue to extend landward in these areas under 4.9ft and 6.6ft SLR scenarios, also becoming more widespread in areas south of Talbert Channel. (p.32)

Dr. David Revell describes the “island effect’ as such:

> While the proposed project as revised and described in the Moffat & Nichol report says the site elevation will be graded to 14-16 feet, access to the site and the feasibility of existing distribution infrastructure is not considered. While this grading increase will improve site resilience to sea level rise to some of the coastal hazards, this increased grading further contributes to “an island effect” in which the facility will become more and more inaccessible as sea level rises, with routine flooding as early as 2030 during higher tides.[66]
>
> ***The facility may become an inaccessible island before 2030 due to routine flooding of the surrounding area.*** Simple analyses show that the facility’s isolation will become routine during high tide events of 5.3 MHHW and greater with one foot of SLR. This portion of California’s coast experiences high tides of 5.3 MHHW over 200 times per year, thus the proposed facility could become inaccessible during high tides a majority of the year as early as 2030 when those tides occur along with one foot of sea level rise. Groundwater daylight flooding occurs in many adjacent areas under present day conditions. […] By 2050, all of Edison Avenue is likely to be flooded during daily high tides with water depths of over 2 feet. This greatly reduces the ability to maintain this critical facility or even access the facility which is particularly of concern in the case of an emergency either from a storm event or another oil spill.[67]

The key finding here is that the Project site will ultimately become an island surrounded by lower lying areas. It will not be serviceable in terms of access, water, power, and the burden on the City and taxpayers to maintain.[68] LCP policy C1.1.1 requires that new

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[66] Dr. David Revell, Integral Consulting. Memorandum: Sea level rise concerns for the proposed Poseidon desal project. February 2. 2022. https://california.surfrider.org/wp-content/uploads/2022/02/Comment_letter_on-Poseidon_02022022-Final.pdf

[67] Dr. David Revell, Integral Consulting. Memorandum: Sea level rise concerns for the proposed Poseidon desal project. February 2. 2022. https://california.surfrider.org/wp-content/uploads/2022/02/Comment_letter_on-Poseidon_02022022-Final.pdf

[68] Dr. David Revell. Technical Memorandum: Huntington Beach Desalination Review of Sea Level Rise Hazards. December 14, 2018. https://california.surfrider.org/wp-content/uploads/2022/02/Huntington_Hazards_FINAL_Small.pdf

development "be located in areas with adequate public services, and where it will not have significant adverse effects, either individually or cumulatively, on coastal resources." The LCP does not permit construction of critical facilities where roads and bridges will not allow continuing access.

The Commission addressed the burden of maintaining an infrastructure island at the Morro Bay Wastewater Treatment Plant, which was ultimately relocated inland.[69] In February 2022, the Commission considered a condition requiring demolition of a development when it is reached by the mean high tide line and implicates the public trust.[70] The Commission must assess the Project's future impacts on public trust resources. The Project should be rejected for attempting to shoehorn a prohibited protective device into the facility.

Poseidon may rely on the Project's location near Magnolia Marsh to allege that the sound wall and its raised platform do not currently abut the ocean. However, the Coastal Commission considers areas that are tidally influenced to be "shoreline." The Project site is undoubtedly tidally influenced. In a memorandum dated April 27, 2021, Dr. David Revell concluded that additional shoreline armoring should be anticipated for tidally influenced portions of the proposed Project site:

> […] changes to the flood control channel or enhanced protection to the berm along the triangle wetland site may constitute shoreline armoring because it is tidally influenced. Thus, given the existing site configuration exposure to tides, reliance on the Orange County Flood Control District, and the elevations across the site, that additional shoreline armoring and or alterations to existing shoreline hardening should be anticipated. [71]

In addition, in a January 28, 2022 memorandum, Dr. Revell elaborates on the defenses the proposed Project would rely on for protection from sea level rise related hazards:

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[69] Staff Report for Morro Bay Wastewater Treatment Plant, CDP Application Number A-3-MRB-11-00, January 2013, pp. 4, 33, 46, https://documents.coastal.ca.gov/reports/2013/1/Th23b-1-2013.pdf.

[70] See, Special Condition 2C https://documents.coastal.ca.gov/reports/2022/2/W11d/W11d-2-2022-report.pdf

71 Dr. David Revell, Integral Consulting. Memorandum: Response to Poseidon's comment letter from 2/4/2019 https://california.surfrider.org/wp-content/uploads/2022/02/Comment_letter_to-Poseidon_04272021_Integral-FINAL.pdf

> The proposed Poseidon project must rely on various artificial flood defenses to avoid hazards at the facility. These defenses include the existing maintained beaches resulting from upcoast Army Corps operations, Orange County Flood Control District maintenance of the existing flood control channel, and outlet beach management of the Talbert Channel into the future. Poseidon has no authority to implement or execute these expensive management actions or public works projects – _which involve extensive permitting processes and careful management of impacts on Endangered Species Act listed species. Nor are they contributing financially to the long term maintenance and management costs of these resources. The flood control channel outlet maintenance permit, for example, expires in 2023.[72]

In order to claim the desalination plant will not be at risk due to sea level rise, coastal flooding, and tsunami, the Project must elevate 14 to 16 feet above ground level and construct a "sound wall," in violation of Coastal Act section 30253 and the Huntington Beach LCP. As a result, the Project will ultimately become an island of infrastructure and increasingly difficult to maintain. The Project's protective devices will prevent the inland migration of wetlands as sea levels rise. The CDPs should be denied.

f. The Project Would Not Be Designed and Sited to Avoid Seismic Hazards and Community Harm.

The Project site's seismic hazards are well-documented and include the Newport-Inglewood Fault, now understood to be capable of generating up to a magnitude 7.5 earthquake. Section 30253 of the Coastal Act requires new development to both "Minimize risks to life and property in areas of high geologic, flood, and fire hazard" and "Assure stability and structural integrity." The certified LCP also contains several policies aimed at ensuring the safety and integrity of development. As proposed, the Poseidon Project remains inconsistent with these policies and must be denied.

- LCP Policy C1.1.9 states development must "Minimize risks to life and property in areas of high geologic, flood…and fire hazard through siting and design to avoid the hazard. New development shall be designed to assure stability and structural integrity, and neither create nor contribute significantly to erosion, geologic instability, or destruction of the site or surrounding area or in any way require the construction of a protective device."

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72 Dr. David Revell, Integral Consulting. Memorandum: Sea level rise concerns for the proposed Poseidon desal project. February 2. 2022. https://california.surfrider.org/wp-content/uploads/2022/02/Comment_letter_on-Poseidon_02022022-Final.pdf

- LCP Policy I-C 20 requires authorities to "Enforce and implement the policies of the Environmental Hazards Element of the General Plan…" Huntington Beach's Environmental Hazards Element, in turn, requires that structures be designed to preserve integrity in light of geologic and seismic events.

These policies are intended to protect life and property, and also to encourage the construction of resilient facilities in areas of known hazard. While Poseidon has provided updated seismic studies to the Commission, as of last fall, Poseidon had not analyzed the impact of a fault rupture on the South Branch, nearest to the Project. Furthermore, these studies do not show that the facility would be designed as Risk Category IV "critical infrastructure" that could be relied on to remain safe and functional in the event of a foreseeable large earthquake on the Newport-Inglewood Fault. Risk Category IV buildings are those that must remain in continuous operation in the event of an emergency and therefore must be built to withstand greater seismic and other forces to ensure that emergency function. Instead, the Project is proposed as a "community facility" that need not withstand such an earthquake and maintain continuous operation. Yet, the Project includes construction of a 10-million-gallon reservoir tank intended to provide the City of Huntington Beach with an emergency water supply located on the shoreward side of the fault in the event of an emergency.[73] The placement of a mere "community facility" in an area of hazard, charged with providing critical services, is inconsistent with these policies of the LCP.

Moreover, if damaged, destroyed, or merely rendered nonoperational by a large earthquake because it was not designed to the critical infrastructure standard, the Project would risk life and property, a further inconsistency with these policies. The Project site contains large electrical generation units and would itself be connected to the AES power plant. The Project would also connect a toxic site to the local potable water system and groundwater. If a seismic event damages storage containers for RCRA hazardous wastes, they could be conveyed into the water supply. Flood or tsunami waters could dissolve toxic chemicals in onsite soils, also contaminating the water supply. In any case, the failure to design the Project to Risk Category IV standards conflicts with LCP Objective C8.4, "Minimize the safety and aesthetic impacts of resource production facilities on nonresource production land uses."

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[73] See, https://www.huntingtonbeachca.gov/business/economic-development/redevelopment/southeast_coast_projects.cfm.

g. The Project Does Not Comply with Coastal Act and LCP Policies Directed at Avoiding Tsunami and Flood Hazards.

Recent scientific projections and guidance for adaptation to sea level rise and tsunami risk demonstrates higher projections for expected sea level rise and tsunami runup elevation. The State's most recent guidance recommends planning for expected tsunami runup elevation between 12 and 15 feet plus predicted sea level rise of 3.5 feet by 2050, and up to 13.8 feet by 2120.[74] The January 2022 and 2011 tsunami events caused millions of dollars of damage to coastal California infrastructure. [75]

The Poseidon Project violates Coastal Act and LCP policies aimed at preventing tsunami and flood hazards. For example, contrary to State guidance recommending planning for 3.5 feet of sea level rise by 2050, Poseidon's analysis looks at a 3.5-foot rise over 50 years. And, although the Project's application materials admit that neighboring communities will be flooded under certain conditions in the future, it claims no risks to the Project over the next 100 years. The analysis is deficient and fails to adequately prepare for future conditions, as required by Coastal Act sections 30001.5(f) and LCP section C10.1.19.

Coastal Act section 30001.5(f) enunciates a statewide policy goal of anticipating, assessing, planning for, and, to the extent feasible, "avoid, minimize, and mitigate the adverse environmental and economic effects of sea level rise within the coastal zone." Section 30270 of the Act mandates, "The commission shall take into account the effects of sea level rise in coastal resources planning and management policies and activities in order to identify, assess, and, to the extent feasible, avoid and mitigate the adverse effects of sea level rise." The Project, on the other hand, will contribute to coastal armoring and the island effect, preventing inland migration of coastal wetlands as sea level rises, and exacerbating the adverse environmental effects of sea level rise within the coastal zone. The placement of new key infrastructure in a seismic and flood danger zone is poor planning that fails to act on any realistic anticipation or assessment of sea level rise at the Project site. Since feasible alternatives exist, the Commission should reject the CDPs.

Similarly, in order to protect life and property, LCP Coastal Element Hazards Policy C10.1.19 provides, "Development permitted in tsunami and seiche susceptible

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[74] 2020 California Natural Resources Agency's "Making California's Coast Resilient to Sea Level Rise: Principles for Aligned State Action," https://www.opc.ca.gov/webmaster/_media_library/2021/01/State-SLR-Principles-Doc_Oct2020.pdf .

[75] https://www.latimes.com/california/story/2022-01-22/the-tsunami-that-battered-santa-cruz-highlights-the-threat-facing-californias-coast

areas shall be designed and sited to minimize this hazard…" The Policy further provides, "Identify tsunami and seiche susceptible areas, and require that specific measures be taken by the developer, builder or property owner during major redevelopment or initial construction, to prevent or reduce damage from these hazards and the risks upon human safety." LCP Policy C1.1.9 states development must "Minimize risks to life and property in areas of high geologic, flood…and fire hazard through siting and design to avoid the hazard. New development shall be designed to assure stability and structural integrity, and neither create nor contribute significantly to erosion, geologic instability, or destruction of the site or surrounding area or in any way require the construction of a protective device."

The 2018 update of the Ocean Protection Council's 2018 *State of California Sea-Level Rise Guidance* document recommends that Project analysis include the following:

> For high consequence projects with a design life beyond 2050 that have little to no adaptive capacity, would be irreversibly destroyed or significantly costly to relocate/repair, or would have considerable public health, public safety, or environmental impacts should this level of sea-level rise occur, the ***H++ extreme scenario should be included in planning and adaptation strategies (e.g. coastal power plant)***.[76]

The Sea Level Rise Guidance further provides for use of the H++ planning scenario (extreme risk aversion projection) for "highly vulnerable or critical assets that have a lifespan beyond 2050 and would result in significant consequences if damaged."[77] Finally, the Guidance recommends incorporating the H++ scenario for projects that could result in threats to public health and safety, natural resources and critical infrastructure, should extreme sea-level rise occur.[78]

Where seawater desalination is truly needed (i.e., as a supply option of last resort), or where a Regional Water Board has deemed a project needed and approved it, such that it is pursued instead of or before less impactful and less expensive alternatives, it logically follows that the project be considered a "high consequence project" with public health and safety depending on that project's water. This is particularly so where a project is approved on the understanding that it will provide emergency water supplies. Such a project, with people depending on its water for their health and safety, has a clear low tolerance for risk. Desalination facilities would also be significantly

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[76] 2018 update of the Ocean Protection Council's 2018 *State of California Sea- Level Rise Guidance*, p. 24.
[77] Id. p. 25.
[78] Id. p. 32.

costly to relocate or repair. Accordingly, desalination projects are plainly subject to the H++ scenario under the State's Sea Level Rise Guidance. Poseidon's use of a 3.5-foot sea level rise over 50 years is insufficient to demonstrate that it has been designed and sited to avoid hazards in compliance with the certified LCP or the Coastal Act.

The Commission requested more information on Poseidon's plans to avoid encroachments into the floodplain and to remove existing encroachments where feasible. As with its deficient sea level rise planning, Poseidon has not demonstrated the Project's compliance with floodplain policies of the LCP or the Act, and the CDPs should be denied.

h. The Project Does Not Comply with Coastal Act and LCP Policies Protecting Visual Resources.

Section 30251 of the Coastal Act is clear, "The scenic and visual qualities of coastal areas shall be considered and protected as a resource of public importance." Therefore, "development shall be sited and designed to protect views to and along the ocean and scenic coastal areas, to minimize the alteration of natural land forms, to be visually compatible with the character of surrounding areas, and, where feasible, to ***restore and enhance*** visual quality in visually degraded areas."

The Huntington Beach LCP incorporates the Coastal Act with Goal C4, "Preserve and, where feasible, enhance and restore the aesthetic resources of the City's coastal zone…" Objective C4.1 speaks to providing "opportunities within the Coastal Zone for open space as a visual and aesthetic resource." The LCP implements this objective with several policies aimed at protecting public views. Policy C 4.1.1 echoes the Coastal Act's proclamation that "The scenic and visual qualities of coastal areas shall be considered and protected as a resource of public importance" and provides that "Permitted development shall be sited and designed to protect public views to and along the ocean and scenic coastal areas." Objective C.4.2 further speaks to promoting "the protection of the Coastal Zone's visual and aesthetic resources through design review and development requirements." More specifically, Policy C.4.2.2 speaks to the "massing, height, and orientation of new development" and ***requires*** that such development "be designed to protect public coastal views." Policy C.4.2.3 applies the preservation of public view corridors to "views of the sea and the wetlands" through strict application planning efforts.

LCP visual resource protection policies apply explicitly to industrial facilities, as well. Policy C.4.7.5 requires that "review of new and/or expansions of existing industrial and utility facilities" ensures the resulting facilities will not visually impair the City's coastal corridors. Objective C.8.4 is to "Minimize the safety and aesthetic impacts of resource production facilities on nonresource production land uses." Policy C.8.4.2 implicates the Project site and requires "any power plant expansion or alteration proposals to include adequate buffer and screening measures."

The Project would do nothing to restore or enhance the Project site's visual qualities. Instead, contrary to the Coastal Act, the Project would alter landforms by building up the site's foundation and place an additional industrial facility in the midst of a coastal wetland and dune complex. The Project would become yet another dominant industrial feature to a coastal corridor, next to ESHA and wetlands at Magnolia Marsh. In short, the Project's expansion of industrial facilities in and next to coastal wetlands and without adequate buffers would detract from and not enhance the aesthetic quality of coastal views, in violation of both Coastal Act section 30251 and multiple objectives and policies of the certified LCP.

i. The Project Violates LCP Policies Requiring Cost-Efficient Water Systems.

Huntington Beach's LCP requires that the City "Provide and maintain water, sewer, and drainage systems that adequately serve planned land uses at a maximized cost efficiency." (Objective C.9.1.) Desalinated water is notoriously expensive – more than ***twice*** the cost of imported water and $500 per acre foot more than indirect potable reuse.[79] Accordingly, the Project's water would maximize cost inefficiency, in direct contravention of the City's LCP.

j. The Project Violates LCP Policies Directed at Protecting Recreation and Coastal Access.

The foundation of the California Coastal Act is the preservation of public access to the state's revered coastline. Unfortunately, through construction disruptions, brine discharge, and marine life mortality, the Project would harm recreational access and opportunities in Huntington Beach and may ultimately deter visitors from surfing, swimming, and otherwise recreating nearby.

The Coastal Act derives its protection of public access from the California Constitution. Section 30210 states, "In carrying out the requirement of Section 4 of Article X of the California Constitution, maximum access, which shall be conspicuously posted, and recreational opportunities shall be provided for all the people…" Section 30211 prohibits development from interfering "with the public's right of access to the sea where acquired through use or legislative authorization, including, but not limited to, the use of dry sand and rocky coastal beaches to the first line of terrestrial vegetation."

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[79] See, https://www.eenews.net/articles/could-la-water-recycling-be-a-miracle-for-parched-west/.

Section 30220 protects areas suited for water-oriented recreational activities. Section 30253 subd. (e) requires that new development "protect…popular visitor destination points for recreational uses." Section 30234.5 provides, "The economic, commercial, and recreational importance of fishing activities shall be recognized and protected."

Likewise, the Huntington Beach LCP is protective of coastal access and recreation. Goal C3 is to "Provide a variety of recreational and visitor commercial serving uses." Objective C 3.1 is to "Preserve, protect and enhance, where feasible, existing public recreation sites in the Coastal Zone." Policy C 3.2.1 is to encourage "facilities, programs and services that increase and enhance public recreational opportunities." Objective C3.4 is to "Encourage and protect water oriented recreational activities that cannot readily be provided at inland water areas."

Policy C7.1.3, requires that "Development in areas adjacent to …parks and recreation areas shall be sited and designed to prevent impacts which would significantly degrade those areas, and shall be compatible with the continuance of those … recreation areas." LCP Policy C1.1.6 regulates construction in the coastal zone that might affect recreation. Policy C2.6.6 discusses promoting public access to coastal wetlands. Additional provisions encourage public boating and fishing.

Huntington Beach is not only popular for coastal recreation, but recreation is integral to the local economy. The calls itself "Surf City," and is home to the U.S. Open of surfing. Huntington Beach is also a very popular beach and swimming destination for worldwide visitors and locals alike. The Junior Lifeguard program is located at Huntington Beach and meets near the Project site.[80] The area is also utilized by recreational fishermen, given the proximity to harbors and moorings for watercraft.

The Project would adversely affect coastal access and recreation, contrary to the Coastal Act and LCP. The Commission recognized the potential for Project construction to impede beach access through traffic and parking in 2013.[81] These considerations remain. The Project's brine discharge into the Pacific Ocean will also alter salinity with potentially harmful impacts to swimmers, surfers, and Junior Lifeguards. The LCP specifically calls out continuation of the Junior Lifeguard program in Policy I-C.16-F. Interest in a wide swath of the coast for recreational fishing will also diminish if fish populations decline due to entrainment mortality, brine exposure mortality, or shear mortality caused by the Project's linear brine diffusers. The Commission's 2013 Staff Report specifically noted California halibut as a species entrained by the intakes.[82]

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[80] See, http://hsbjg.com/huntington-beach-jgs/ .
[81] Attachment 1, 2013 Staff Report, pp. 113-115.
[82] 2013 staff report, p. 33

Ocean swimming, surfing, lifeguarding, and fishing are not easily replicable inland. These coastal-dependent recreational uses must be protected.

The adverse impacts of brine discharges must be minimized, or the CDPs must be denied. Unless the Project's capacity is strictly tailored to actual, demonstrated capacity (i.e., demand that exceeds supply), those brine impacts haven't been minimized, and will harm Huntington Beach's surfing, swimming, and fishing opportunities."

Additional public access impacts may occur during construction because the Project site's soils are likely extremely toxic. Hydrocarbon tanks sat on the site for decades, leading Commission Staff to acknowledge the near certainty of contamination.[83] Safe public access to the beach will not likely be possible while toxic soils are being moved and removed during mass grading. The Applicant has not analyzed this impact, provided a remediation plan, or disclosed how access will be affected during construction.

Unless very carefully conditioned to avoid construction and brine impacts, the Project will conflict with Coastal Act and LCP policies concerning public access and recreation. The Project should be rejected.

k. The Project Would Vastly Increase Energy Consumption and Greenhouse Gas Emissions, in Violation of the Coastal Act and the LCP.

It is undisputed that climate change poses an existential threat to the livelihoods of Californians and to the coast itself. Associated sea level rise and coastal erosion further erode opportunities for recreation and habitat for Californians and the state's unique and sensitive wildlife. It is also undisputed that climate change is caused by greenhouse gas emissions, such as those the Project would emit. Accordingly, section 30253(d) of the Coastal Act provides that the Project must minimize energy consumption. Coastal Act policies aimed at protecting coastal resources, recreation, and marine life further support minimizing energy use. Instead, in direct violation of the Coastal Act, the Project's electricity demand would be indirectly responsible for 68,745 metric tons per year of carbon dioxide (CO_2) emissions.[84] Further, Poseidon's proffered "Energy Minimization and Greenhouse Gas Reduction Plan" will not actually prevent its high energy

[83] 2013 Staff Report, p. 26.

[84] Powers Engineering, Assessment of Energy Intensity and Greenhouse Emissions of Proposed Poseidon Huntington Beach Desalination Plant – 2022 Update Report, January 19, 2022 p. 1, https://documents.coastal.ca.gov/assets/upcoming-projects/environmental-coalition/2022_Powers%20Engineering%20Review%20of%20Poseidon%20HB%20GHG%20reduction%20strategy.pdf.

consumption or its creation of greenhouse gas emissions. The Project would be a net contributor to climate change. Given the feasibility and availability of water supply alternatives that would not impact the coastal zone, this, alone, justifies rejecting the Project's CDPs.

The Project violates section 30253(d) in several ways. First, the Project is not sized to meet the actual water demand of the area. A smaller plant would use less energy. Second, less energy-intensive alternatives are available. Recent trends in water demand have led to reductions in greenhouse gas emissions.[85] The Project would reverse these trends, without justification. Desalinated water is four times more energy intensive – and therefore has four times the carbon footprint – of available alternatives, such as the purified recycled water the Carson Project would produce.[86] The Carson indirect potable reuse project will occur regardless of the Commission's decision on Poseidon and has offered 60 mgd to OCWD that will be produced through less-carbon-intensive recycling processes. Third, the Project fails to incorporate renewable energy to reduce or eliminate its greenhouse gas footprint onsite and instead proposes an upfront payment to acquire offsets. This is putting the cart before the horse as the incorporation of renewable energy is completely feasible.[87] If approved, the Project must incorporate demonstrably feasible renewable energy sources including 150 megawatts of rooftop solar within Huntington Beach.[88] Fourth, Poseidon's alleged off-site mitigation through purchased offsets fails to ensure greenhouse gas reductions as claimed. Even though offset credits are its only proposal for reducing greenhouse gas emissions, Poseidon drastically underestimates the

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[85] See, The Future of California's Water-Energy-Climate Nexus, Pacific Institute, https://pacinst.org/wp-content/uploads/2021/09/Water-Energy-Report_Sept-2021.pdf .
[86] Powers Engineering, Assessment of Energy Intensity and Greenhouse Emissions of Proposed Poseidon Huntington Beach Desalination Plant – 2022 Update Report, January 19, 2022 pp. 9-10, https://documents.coastal.ca.gov/assets/upcoming-projects/environmental-coalition/2022_Powers%20Engineering%20Review%20of%20Poseidon%20HB%20GHG%20reduction%20strategy.pdf.
[87] The annualized cost of 150 MW rooftop and parking lot solar and 30 MW of battery storage will be less than three percent of Poseidon's projected pross annual revenue. See, Powers Engineering, Assessment of Energy Intensity and Greenhouse Emissions of Proposed Poseidon Huntington Beach Desalination Plant – 2022 Update Report, January 19, 2022 p. 21, https://documents.coastal.ca.gov/assets/upcoming-projects/environmental-coalition/2022_Powers%20Engineering%20Review%20of%20Poseidon%20HB%20GHG%20reduction%20strategy.pdf.
[88] Powers Engineering, Assessment of Energy Intensity and Greenhouse Emissions of Proposed Poseidon Huntington Beach Desalination Plant – 2022 Update Report, January 19, 2022 p. 18, https://documents.coastal.ca.gov/assets/upcoming-projects/environmental-coalition/2022_Powers%20Engineering%20Review%20of%20Poseidon%20HB%20GHG%20reduction%20strategy.pdf.

cost of these offset credits. Poseidon estimates paying a ceiling cost of $10 per metric ton, far lower than the California Air Resources Board's 2021 cap-and-trade allowance settlement price of $28.26, and 2022 ceiling of $72.29.[89] In addition to this *present* undervaluation of the cost of carbon, Poseidon's proposed offset plan assumes a static price of carbon, despite the fact that the price of carbon offsets will only continue to increase each year as Poseidon continues to inefficiently consume energy and create greenhouse gases.[90]

Further, Poseidon provides no assurances or enforceable performance standards to ensure the validity of the purchased "offsets," and allows the purchase of offsets—including international offsets—from the Climate Registry (TCR), the Climate Action Reserve (CAR) or any other registry "in the event that sufficient offsets are not available. . . at a price that is reasonably equivalent to the price for offsets in the broader domestic market."[91] Poseidon's Plan allows the Planning Director to choose any different registry, without providing adequate performance standards.[92] A Court of Appeal recently overturned an agency's reliance on some of the same voluntary registries and improper discretion, and detailed the reasons why voluntary registries do not actually ensure greenhouse gas emission reductions. (*Golden Door Properties, LLC v. County of San Diego* (2020) 50 Cal.App.5th 467, 510-518l [expressing concerns with international offsets in particular].)

Adding the final nail on the coffin, Poseidon allows itself to not even purchase offsets at all. Its GHG Reduction Plan provides an escape hatch to put funds in escrow at $10.00 per metric ton if offsets are "economically infeasible," which likely means costing over $10 (this "contingency" option also lacks any performance standards).[93] Offsets cost more than $10 and only will continue to increase. Poseidon's plan does not fully

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[89] Powers Engineering, Assessment of Energy Intensity and Greenhouse Emissions of Proposed Poseidon Huntington Beach Desalination Plant – 2022 Update Report, January 19, 2022 pp. 15-17, https://documents.coastal.ca.gov/assets/upcoming-projects/environmental-coalition/2022_Powers%20Engineering%20Review%20of%20Poseidon%20HB%20GHG%20reduction%20strategy.pdf.
[90] Carbon Offset Prices Could Increase Fifty-Fold by 2050, https://about.bnef.com/blog/carbon-offset-prices-could-increase-fifty-fold-by-2050l; Summary of California-Quebec Joint Auction Settlement Prices and Results (November 2021), https://ww2.arb.ca.gov/sites/default/files/2020-08/results_summary.pdf [Advance Auction Settlement Price (i.e cost to purchase future credit) of $34.01].)
[91] Huntington Beach Seawater Desalination Project Energy Minimization and Greenhouse Gas Reduction Plan (February 27, 2017), p. 5, 14, 16. Further, the Annual "True-Up" Process should not occur outside of public review.
[92] *Ibid*. at p. 16.
[93] *Ibid*. at p. 17-18.

reduce its inefficient energy consumption as claimed.[94] The Commission must enforce section 30253(d) and require direct on-site reductions, especially considering Poseidon's faulty claimed off-site reduction plan.

Nothing precludes the Commission from using its authority to require the Project to directly reduce its greenhouse gas impacts. Reducing the Project's energy-use would produce co-benefits[95] including the reduction of other pollutant emissions at the Project site and the reduction of pollution associated with the generation of the Project's electricity source. Electrical generation often occurs in communities already facing higher pollution burdens. Thus, reducing Project electricity use will have environmental justice benefits.[96] If the Commission chooses to allow the purchase of offsets, at all, it must require the purchase of in-state offsets pursuant to legally adequate performance standards and protocols.

The availability of feasible, less carbon-intensive water sources justifies entirely rejecting the CDPs for the Project. However, if the Commission considers approving a desalination project at the site, it must size the Project to the minimum size necessary and condition the Project to offset all of its energy use with the installation of local renewables.

The Project's electrical demand will also destabilize the electrical grid, in violation. Powers Engineering estimates that the Project will add a continuous 30.34-megawatt load to the electrical grid, the equivalent of 38,732 homes, thereby jeopardizing the grid's reliability.[97] The Project's enormous electrical load would be offset if

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[94] Powers Engineering, Assessment of Energy Intensity and Greenhouse Emissions of Proposed Poseidon Huntington Beach Desalination Plant – 2022 Update Report, January 19, 2022 p. 15, https://documents.coastal.ca.gov/assets/upcoming-projects/environmental-coalition/2022_Powers%20Engineering%20Review%20of%20Poseidon%20HB%20GHG%20reduction%20strategy.pdf.

[95] Co-benefits of mitigating global greenhouse gas emissions for future air quality and human health, https://www.nature.com/articles/nclimate2009; Public health co-benefits of greenhouse gas emissions reduction: A systematic review, https://www.sciencedirect.com/science/article/abs/pii/S0048969718302341.

[96] Health Cobenefits of Achieving Sustainable Net-Zero Greenhouse Gas Emissions in California, https://www.osti.gov/servlets/purl/1734873.

[97] Powers Engineering, Assessment of Energy Intensity and Greenhouse Emissions of Proposed Poseidon Huntington Beach Desalination Plant – 2022 Update Report, January 19, 2022 p. 13, https://documents.coastal.ca.gov/assets/upcoming-projects/environmental-coalition/2022_Powers%20Engineering%20Review%20of%20Poseidon%20HB%20GHG%20reduction%20strategy.pdf.

Poseidon developed 30 megawatts of battery storage in Huntington Beach and must be included as a condition of the Project if approved.

Requiring the inclusion of battery storage and solar energy would also bring the Project into conformity with Huntington Beach LCP policies encouraging solar and the incorporation of new energy technologies. Policy C.8.2.1 supports, the "application of new energy technologies so long as public health, safety and welfare are not jeopardized and environmental impacts are mitigated to the maximum extent possible." If anything, a combination of renewable solar energy and battery storage technology would improve the public health, safety and welfare. Policy C.8.3.1 explicitly "Promote[s] the use of solar energy and encourage[s] energy conservation." An energy-intensive desalination plant discourages energy conservation and would be in conflict with the LCP absent strong conditions about renewable energy.

In 2017, with the support of Governor Newsom, members of the State Lands Commission called on Poseidon to make the Project 100 percent greenhouse gas emission-free, and to do it through technology, innovation, or any means outside of merely writing a check.[98] Given the Governor's leadership on climate change, it is disappointing that Poseidon has done little more than rename its offset plan a "Climate Change Action Plan" and submit it to the Santa Ana Regional Water Quality Control Board in 2019 and to the Commission last summer. Expert reports demonstrate that far more can be done to reduce or even eliminate the Project's greenhouse gas emissions, and the Coastal Act requires no less.

l. The Project Would Adversely Impact Groundwater Basin Water Quality.

LCP Policy C6.1.1 mandates protection of water quality in the groundwater basin. OCWD is proposing delivery systems that would use Poseidon water for groundwater recharge.[99] However, the Irvine Ranch Water District determined that introducing Poseidon water to the basin would degrade water quality.[100] Thus, the Project violates LCP protections for groundwater quality and must be denied.

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[98] Transcript, State Lands Commission Meeting, October 19, 2017, p. 316, ln. 5, https://documents.coastal.ca.gov/assets/upcoming-projects/environmental-coalition/10-19-2017_Transcripts.pdf.
[99] Attachment 10.
[100] Attachment 9.

m. Coastal Act Section 30260 Does Not Authorize the Project.

Claims have been made that the Project can be authorized subject to Section 30260 of the Coastal Act, but the Commission cannot make the three requisite findings. This section provides, "Coastal-dependent industrial facilities shall be encouraged to locate or expand within existing sites and shall be permitted reasonable long-term growth where consistent with this division."

Preliminarily, there is no reason why a water source need be coastal dependent. Section 30101 defines coastal dependent as a "development or use which requires a site on, or adjacent to, the sea to be able to function at all." If a project aims can be satisfied at a location that is not on or adjacent to the sea, even if it is not an applicant's particular proposal, then the project is not a coastal-dependent industrial use and should not qualify for the possible exemption from full mitigation provided in Section 30260. Development of a water source is not coastal dependent. We discuss several non-coastal alternatives. Further, the evidence in the Project record argues against this water source. Available alternatives such as water conservation and reliance on the Carson project eliminate the need for the Project, and with it, all of the Project's adverse impacts on coastal resources. Section 30260 was not intended to apply to developments like the Project. Instead, this provision of the Coastal Act exists for two reasons – (1) California's past reliance on water to cool electrical power plants; and (2) the need for federal approval of the state's program under the Coastal Zone Management Act, which, at that time, was contingent on continued coastal oil production.[101]

Section 30260 next requires that an industrial facility subject to its terms be "consistent with this division." The Poseidon Project is inconsistent with Coastal Act policies concerning marine life, wetlands, ESHA, greenhouse gases, coastal hazards, seismic hazards, and more. The Project is inconsistent with the Act. Section 30260 continues:

> However, where new or expanded coastal-dependent industrial facilities cannot feasibly be accommodated consistent with other policies of this division, they may nonetheless be permitted in accordance with this section and Sections 30261 and 30262 if (1) alternative locations are infeasible or more environmentally damaging; (2) to do otherwise would adversely affect the public welfare; and (3) adverse environmental effects are mitigated to the maximum extent feasible.

[101] 16 U.S.C. Section 1451 et. seq. See, 16 U.S.C. Section 1455 (d) (8); see also *American Petroleum Institute v. Knecht* (1978) 456 F. Supp. 889, affirmed. (1979) 609 F. 2nd 1306.

The Commission cannot make any of the required findings, and it certainly cannot support them with substantial evidence, as required. First, as discussed at length above, alternative water sources located elsewhere are available and are less environmentally damaging. Conservation of water to increase supply brings net environmental benefits, as would the Carson Project.

Second, reliance on an alternative to the Poseidon Project would not adversely affect the public welfare. The test requires more than a finding that, on balance, a project as proposed is in the interest of the public. It requires that the Coastal Commission find that there would be a detriment to the public welfare were the Coastal Commission to deny a permit for the project proposal. If anything, denial of the CDPs would drastically reduce ratepayer costs, reduce greenhouse gases that contribute to sea level rise and drought (and water scarcity), and eliminate a burden on the electrical system. Preventing the deaths of 108 million marine organisms each year is another great public benefit.[102]

Third, as also discussed above, the Commission cannot find that the Project's adverse environmental effects are mitigated to the maximum extent feasible. The Project includes no ESHA buffers, greenhouse gas mitigation is weak, wedgewire screens will reduce entrainment impacts by a maximum of one percent, and linear brine diffusers cause shear mortality to marine organisms.

Commission staff recently applied this test to the CalAm Desalination proposal, and found that the Project did not satisfy the requirements for approval pursuant to section 30250. The staff recommendation was that, because the project did not meet either of the first two tests of that section ("alternative locations," and "public welfare"), there was no need to determine whether it met the "mitigated to the maximum extent feasible" test.[103]

Ultimately, Commission approval under Section 30260 is entirely discretionary. The section provides that the Commission ***may permit***, rather than ***shall permit*** a Project once effects are mitigated to the maximum extent feasible. The Commission can and must impose far more mitigation for the Project and must do so before it may consider authorizing the Project pursuant to section 30260.

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[102] Even if the Commission does find that the public welfare would be adversely affected by denial of the Project, this does not affect Poseidon's mitigation obligations. There is no reason that Poseidon cannot bear or pass to its customers the cost of full mitigation.
[103] Staff Report for Cal-Am Desalination Project, September 2020, https://documents.coastal.ca.gov/reports/2020/9/Th3a&4a/Th3a&4a%20Staff%20Report.pdf

V. Environmental Justice Requires the Commission to Deny the CDPs.

The Project implicates critical environmental justice and tribal consultation requirements. Recognizing the serious harms wrought by environmental racism, the Commission has taken a laudable stand in favor of environmental justice. Government Code section 65040.12 defines environmental justice as "the fair treatment of people of all races, cultures, and incomes with respect to the development, adoption, implementation, and enforcement of environmental laws, regulations, and policies." Since the signing of AB 2616 (Burke) (Ch. 578, Stats. 2016), the Coastal Commission has had authority to specifically consider environmental justice when making permit decisions, and it has done so to great effect.[104] Coastal Act section 30604(h) now provides, "When acting on a coastal development permit, the issuing agency, or the Commission on appeal, may consider environmental justice, or the equitable distribution of environmental benefits throughout the state."[105]

In March 2019, the Commission unanimously adopted an Environmental Justice Policy to guide implementation of this authority[106]. The Commission's policy provides:

- "Commission staff shall consider, when applicable, whether and how proposed development will positively or negatively affect marginalized communities, and will be fully transparent in that analysis in staff reports and presentations."

- "Where project impacts to disadvantaged or overburdened communities are identified, and where otherwise consistent under the Coastal Act, civil rights and environmental justice laws, the ***Commission staff shall propose permit conditions to avoid or mitigate those impacts to underserved communities to the maximum extent feasible*** while protecting coastal resources.

- "If viable alternatives are available, consider those in permitting decisions."

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[104] Staff Report for Cal-Am Desalination Project, September 2020, pp. 86-101, https://documents.coastal.ca.gov/reports/2020/9/Th3a&4a/Th3a&4a%20Staff%20Report.pdf; see also Staff Report for Application No. 5-18-0788, February 2021, https://documents.coastal.ca.gov/reports/2021/2/Th14a/th14a-2-2021-report.pdf. [conditioning pool on outreach and development of a plan to enhance recreation and coastal access for underserved communities in Long Beach.]

[105] Section 30107.3 (a) of the Coastal Act, defines "environmental justice" as "the fair treatment and meaningful involvement of people of all races, cultures, incomes and national origins, with respect to the development, adoption, implementation, and enforcement of environmental laws, regulations, and policies."

[106] California Coastal Commission Environmental Justice Policy, March 2019, https://documents.coastal.ca.gov/assets/env-justice/CCC_EJ_Policy_FINAL.pdf.

The Commission, therefore, has a duty to conduct robust analysis of the Project and its environmental justice implications. In light of the Commission's specific environmental justice policies, it cannot simply rely on another agency's analysis of this issue. (See, for example, *Friends of Buckingham v. State Air Pollution Control Bd.* (4th Cir. 2020) 947 F.3rd 86 [NEPA requires an agency to conduct its own environmental justice analysis].) The Commission prepared an evaluation of the environmental justice-related impacts of another project, the Cal-Am Desalination proposal, in its September 2020 Staff Report.[107] The Commission can and must prepare an analysis of the Poseidon Project, which will have significant impacts on disadvantaged communities throughout the region.

The Project will disproportionately affect disadvantaged or overburdened communities in several ways. The high cost of project water[108] will have the greatest impact on those least able to afford it. The Commission analyzed ratepayer costs in September of 2020 during its consideration of the Cal-Am Desalination Project.[109] The Project will also require very large amounts of energy, energy produced through polluting processes. The Project will also reduce free recreational opportunities during construction and as its greenhouse gas emissions exacerbate sea level rise and beach loss and as its beach armoring prevents beach and wetland migration inland. The loss of free recreational opportunities hits disadvantaged communities the hardest.

The Huntington Beach LCP further implicates environmental justice considerations of water cost. Section I-C 18 of the LCP requires implementation of "the programs and policies contained in the Public Facilities and Services Element of the General Plan to the extent that these programs and policies are not inconsistent with the City's Local Coastal Program." Goal PSI-6B of the City's General Plan is to "Ensure that the costs of water and wastewater infrastructure improvements are borne by those

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[107] Staff Report for Cal-Am Desalination Project, September 2020, pp. 86-101, https://documents.coastal.ca.gov/reports/2020/9/Th3a&4a/Th3a&4a%20Staff%20Report.pdf.
[108] https://www.dailybreeze.com/2021/07/31/west-basin-reveals-costs-of-desalination-as-public-meeting-set-for-monday/;
https://www.desertsun.com/story/news/environment/2016/10/14/desalination-costliest-california-water-solution-study-finds/91973414/
[109] See, Staff Report for Cal-Am Desalination Project, September 2020, pp. 8-9, 92-96, 113-114, 134,
https://documents.coastal.ca.gov/reports/2020/9/Th3a&4a/Th3a&4a%20Staff%20Report.pdf
["Water from Cal- Am's proposed Project could significantly raise water rates for low-income ratepayers in Seaside and other low-income ratepayers throughout the service area."]

who benefit, through adequate fees and charges or the construction of improvements."[110] The Commission must conduct a robust analysis to determine whether the Project is consistent with LCP Section I-C 18.

The Environmental Justice Policy requires the Commission to consider viable alternatives to projects, such as this one, that will adversely affect disadvantaged and overburdened communities. Viable alternatives exist in the form of conservation, the Carson Project, and in a smaller plant used for emergency purposes only, sized to meet the area's demonstrated need. Supplying water through conservation is both cost- and energy-efficient and has environmental justice benefits. The Carson Project's less expensive water supply[111] would avoid the Poseidon Project's water bill increases for lower-income residents, construction and recreation impacts that might have disproportionate impacts, and greenhouse gas emissions that contribute to sea level rise. A smaller plant would require less dredge and fill, use less energy, and also avoid some of the contributions to climate change and sea level rise. The Commission should use its Environmental Justice Policy authority to recommend viable alternatives to the Project.

Alternatively, the Commission must condition the Project to avoid or mitigate these impacts to the maximum extent feasible. This means that the Project must limit cost increases to end-users, drastically reduce energy consumption, greenhouse gas production, and prohibit reductions in beach access or brine-related recreational impacts. If not conditioned to avoid these impacts, we urge the Commission to deny the Project CDPs.

We also note that the Project must comply with AB 52 and the Commission's Tribal Consultation Policy. We ask the Commission to thoroughly analyze the Project for potential impacts to tribal cultural resources and traditional cultural landscapes.

The Project further implicates the environmental justice definitions contained in SB 115, SB 535, AB 1550, SB 1000, and AB 1628.

VI. Executive Order N-82-20 Requires State Agencies to Preserve Lands and Coastal Waters to Limit Climate Change, Protect Biodiversity, and Increase Climate Resilience.

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[110] https://www.huntingtonbeachca.gov/files/users/planning/Public-Services-and-Infrastructure.pdf

[111] See, https://www.eenews.net/articles/could-la-water-recycling-be-a-miracle-for-parched-west/ [Carson water cost of $1,800/af v. desalination water cost of $2,300/af or more].

On October 7, 2020, Governor Newsom issued Executive Order N-82-20, which enlisted all state agencies – including the Coastal Commission – to preserve thirty percent of California's coastal waters to fight climate change, protect California's astonishing biodiversity, and increase the State's climate resilience. As discussed above and throughout a decade of documents submitted to the Commission, the Poseidon Project's desalination process is inherently energy-intensive. The Project would generate 68,745 metric tons per year of carbon dioxide (CO2) emissions that would accelerate climate change.[112] Even if the proposed offsets are reliable, verifiable, and otherwise enforceable, these offsets would not prevent or minimize the emissions of greenhouse gases due to the Project. The desalination facility's intakes would kill billions of marine organisms during the facility's lifetime, thereby reducing the productivity and biodiversity of Orange County's remaining coastal wetlands and nearby Marine Protected Areas. Finally, although only constructed to "community facility" standards, the facility is intended to provide critical infrastructure services in a coastal area subject to geological and increasing sea level-rise hazards. Thus, the Poseidon Project threatens to accelerate climate change, diminish biodiversity, and increase climate vulnerability by contributing to sea level rise. In addition to the Coastal Act and LCP provisions discussed above, approval of the CDPs by the Coastal Commission would violate Executive Order N-82-20.

VII. Conclusion

We thank you for your consideration of these comments and urge you to reject Poseidon's application for CDPs for the Huntington Beach Desalination Plant on a site with open violations of wetlands protection policies. The Project cannot be approved until it is brought into conformity with the California Coastal Act, the Huntington Beach certified LCP, and regulations intended to safeguard critical and emergency infrastructure such as that surrounding water supply, environmental justice and Tribal consultation policies, and Poseidon has not demonstrated that such conformity is possible. The continuing recovery of this important marine estuary, the supremacy of Huntington Beach's certified LCP, and the safety and security of the region's people depend on the Commission's willingness to see the Poseidon Project for what it is, permission to build the largest marine predator in California.

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[112] Powers Engineering, Assessment of Energy Intensity and Greenhouse Emissions of Proposed Poseidon Huntington Beach Desalination Plant – 2022 Update Report, January 19, 2022 p. 1, https://documents.coastal.ca.gov/assets/upcoming-projects/environmental-coalition/2022_Powers%20Engineering%20Review%20of%20Poseidon%20HB%20GHG%20reduction%20strategy.pdf.

Sincerely,

Michelle N. Black, on behalf of California Coastal Protection Network, California (and/or OC) Coastkeeper, and the Surfrider Foundation

Attachments:

1. Coastal Commission Staff Report, Appeal No. A-5-HNB-10-225, November 2013.
2. Appellant Comment Letter, November 3, 2013.
3. Bolsa Chica Lowland Restoration Project, Sustainable Alternatives Study Analysis, December 2021, prepared by Anchor QEA, LLC.
4. Regional Recycled Water Program: Institutional and Financial Considerations, White Paper 2, October 13, 2020, p. 12.
5. Santa Ana Regional Water Quality Control Board, Poseidon Staff Report, July 30, 2020, p. 4.
6. Letter from OCWD to Regional Board, May 18, 2018.
7. HydroFocus Report, March 10, 2020.
8. Appendix GGGGGG, Geosyntec Response to HydroFocus Report, Attachment Table 1.
9. Letter from Irvine Ranch Water District to OCWD, July 6, 2016.
10. OCWD Water Delivery Study, July 2016.

Los Angeles / Orange Counties Building and Construction Trades Council
Affiliated with the Building & Construction Trades Dept., AFL-CIO

1626 Beverly Boulevard
Los Angeles, CA 90026-5784
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Fax (213) 483-4419

March 21, 2022

The Hon. Donna Brownsey
Chair, California Coastal Commission
455 Market Street, Suite 300
San Francisco, CA 94105

Re: APPROVE the Poseidon Water Desalination Project in Huntington Beach

Dear Chair Brownsey:

The Huntington Beach Seawater Desalination Plant is the right project in the right place at the right time. Several authoritative public water districts such as the Orange County Water District and the Metropolitan Water District of Southern California have indicated that this project is needed to help Orange County reduce its reliance on imported water and become more water independent. This project is without question the single largest source of new, drought-proof water supply available to Orange County.

In addition to the billions of gallons of new drinking water and millions of dollars in new tax revenue, this project will also result in thousands of new jobs for the hard-working men and women in the building trades. Pipefitters, electricians, cement masons and countless other trades men and women will bring this project to fruition on time and on budget.

The California Coastal Commission granted a Coastal Development Permit for the Carlsbad Seawater Desalination plant, which uses the same technology that is proposed for this plant and has been a regional success story. The Huntington Beach Desalination Facility complies with the new state desalination regulations under the Ocean Plan.

I ask you to simply follow the science and follow the law and approve the permit immediately.

Sincerely,

Ernesto Medrano
Council Representative
Los Angeles-Orange County Building and Construction Trades EM: ag/OPEIU#537/afl-cio

cc: Vice Chair Dr. Caryl Hart
Commissioner Danya Bochco
Commissioner Effie Turnbull-Sanders
Commissioner Sara Aminzadeh
Commissioner Steve Padilla
Commissioner Mike Wilson
Commissioner Catherine Rice
Commissioner Linda Escalante
Commissioner Megan Harman
Commissioner Roberto Uranga
Commissioner Carole Groom
Mr. Jack Ainsworth, Executive Director

March 31, 2022

The Hon. Donne Brownsey
Chair, California Coastal Commission
455 Market Street, Suite 300
San Francisco, CA 94105

Re: Huntington Beach Seawater Desalination Facility – APPROVE CDP

Dear Chair Brownsey:

The Association of California Cities – Orange County (ACC-OC) has long supported the Huntington Beach Seawater Desalination Plant. Orange County has a proud reputation as a regional leader when it comes to water use efficiency and water reuse and recycling. Our Groundwater Replenishment System (GWRS) is world renown for being the most technologically advanced Indirect Potable Reuse (IPR) project on earth.

Yet even with GWRS and our reduction in water use, Orange County still imports about half of its drinking water from Northern California and the Colorado River. This supply of imported water is reliant on rainfall and snowpack, which can vary wildly from year to year. Additionally, a natural disaster such as an earthquake can cut this supply off for months or even years. And our growing populations in other western states further strains the Colorado River water supply.

Orange County is proud of its ability to build its infrastructure independent of outside support. Whether it's our Toll Roads, our Measure M transportation improvement sales tax or the Orange County Water District's (OCWD) GWRS, developing our own infrastructure to support our growing residential communities and businesses is a hallmark of Orange County.

The Huntington Beach Seawater Desalination Plant is the single largest source of new drought-proof water supply for our county. This project is identified in both the Municipal Water District of Orange County's Urban Water Management Plan and the Orange County Water District's Groundwater Management Plan as a planned future water supply.

This project will reduce Orange County's reliance on imported water and has the support of the Metropolitan Water District of Southern California.

ACC-OC encourages the California Coastal Commission to approve the Coastal Development Permit. This project complies with every part of the Ocean Plan and will establish a locally-controlled, climate-resilient water supply for years to come. I ask that you vote to approve the Coastal Development Permit to create regional solutions for water supply.

Sincerely,

Barbara Delgleize
President
Association of California Cities – Orange County

cc:

Vice Chair Dr. Caryl Hart
Commissioner Danya Bochco
Commissioner Effie Turnbull-Sanders
Commissioner Sara Aminzadeh
Commissioner Steve Padilla
Commissioner Mike Wilson
Commissioner Catherine Rice
Commissioner Linda Escalante
Commissioner Megan Harman
Commissioner Roberto Uranga
Commissioner Carole Groom
Mr. Jack Ainsworth, Executive Director
ACC-OC Board of Directors

Bolsa Chica Conservancy

April 6, 2022

The Hon. Donna Brownsey, Chairperson
California Coastal Commission
455 Market Street, Suite 300
San Francisco, CA 94105

Re: Huntington Beach Seawater Desalination Facility – APPROVE Permit

Dear Chair Brownsey,

The Bolsa Chica Conservancy supports the approval of the Huntington Beach Seawater Desalination Coastal Development Permit and urges your commission to vote yes at your hearing in May.

Established in 1990 by a coalition of government, community, business and environmental leaders, the Bolsa Chica Conservancy non-profit organization connects all generations through community involvement and leadership in hands-on restoration and education in wetlands science, watersheds, coastal ecology and environmental sustainability.

The Bolsa Chica wetlands are home to 1,100 species including 23 special status or endangered species. These wetlands are under threat due to lack of funding to protect them. In a 2017 report, the State Lands Commission acknowledged that without continued maintenance dredging, the inlet that allows for necessary tidal flows would likely close off completely and the benefits of wetlands restoration would be lost.

I ask you to simply follow the science and follow the law and approve the permit to allow this needed local drinking water facility to be built and the needed wetlands mitigation projects to proceed.

Sincerely,

Patrick Brenden
CEO
Bolsa Chica Conservancy

cc:

Vice Chair Dr. Caryl Hart
Commissioner Danya Bochco
Commissioner Effie Turnbull-Sanders
Commissioner Sara Aminzadeh
Commissioner Steve Padilla
Commissioner Mike Wilson
Commissioner Catherine Rice
Commissioner Linda Escalante
Commissioner Megan Harman
Commissioner Roberto Uranga
Commissioner Carole Groom
Mr. Jack Ainsworth, Executive Director

Biz Fed Los Angeles County Business Federation
Strengthening the Voice of Business Since 2008

3/29/22

The Hon. Donna Brownsey
Chair
California Coastal Commission
455 Market Street, Suite 300
San Francisco, CA 94105

Re: SUPPORT for Poseidon Water's Coastal Development Permit

Dear Chair Brownsey:

We are contacting you on behalf of BizFed, the Los Angeles County Business Federation. We are an alliance more than 200 business organizations who represent over 400,000 employers who employ more than 4 million workers in Southern California. We are writing to express our support for the Poseidon Water's Coastal Development Permit.

Businesses understand the need for proper and adequate regulation from government agencies. It is a certainty that businesses crave. Provide a set of rules and regulations to follow and allow businesses to comply with those rules to earn the permits necessary to operate.

As noted by the Metropolitan Water District of Southern California (MWD) in its letter of support of the project that was sent to the State Lands Commission, MWD's "long-term Integrated Water Resources Plan (IRP) achieves diversification with an "all of the above" approach (that) includes… developing climate resilient resources such as seawater desalination."

MWD has a goal of producing 2.4 million acre-feet of water from local supplies by the year 2040. Over that same time, Southern California is expected to grow by more than three million people. These residents and businesses need access to locally-controlled, drought-proof and climate-resilient supplies of water. The Huntington Beach Seawater Desalination Project checks every one of those boxes.

LA BizFed encourages the California Coastal Commission to support the Coastal Development Permit and vote to approve the permit for this project.

Thank you for your consideration of our letter. If you have any questions, please contact sarah.wiltfong@bizfed.org.

Sincerely,

Brissa Sotelo-Vargas	David Fleming	Tracy Hernandez
BizFed Chair	BizFed Founding Chair	BizFed Founding CEO
Valero		IMPOWER, Inc

BizFed Association Members

7-Eleven Franchise Owners Association of Southern California
Action Apartment Association
Alhambra Chamber of Commerce
American Beverage Association
Apartment Association of Greater Los Angeles
Apartment Association, CA Southern Cities, Inc.
Arcadia Association of Realtors
AREAA North Los Angeles SFV SCV
Armenian Trade and Labor Association
Associated Builders & Contractors, Inc. Southern California Chapter
Association of Club Executives
Association of Independent Commercial Producers
Azusa Chamber of Commerce
Bell Gardens Chamber of Commerce
Beverly Hills Bar Association
Beverly Hills Chamber of Commerce
Biocom California - Los Angeles
BICEPP
Black Business Association
BNI4SUCCESS
Bowling Centers of Southern California
Boyle Heights Chamber of Commerce
Building Industry Association - Baldyview
Building Industry Association - LA/Ventura Counties
Building Industry Association - Southern California
Building Owners & Managers Association of Greater Los Angeles
Burbank Association of REALTORS
Burbank Chamber of Commerce
Business and Industry Council for Emergency Planning and Preparedness
Business Resource Group
CA Natural Resources Producers Assoc
CalAsian Chamber
Calabasas Chamber of Commerce
California Apartment Association- Los Angeles
California Asphalt Pavement Association
California Bankers Association
California Business Properties Association
California Business Roundtable
California Cannabis Industry Association
California Cleaners Association
California Construction Industry and Materials Association
California Contract Cities Association
California Fashion Association
California Gaming Association
California Grocers Association
California Hispanic Chamber
California Hotel & Lodging Association
California Independent Oil Marketers Association (CIOMA)
California Independent Petroleum Association
California Life Sciences Association
California Manufacturers & Technology Association
California Metals Coalition
California Restaurant Association
California Retailers Association
California Small Business Alliance
California Self Storage Association
California Society of CPAs - Los Angeles Chapter
California Trucking Association
Carson Chamber of Commerce
Carson Dominguez Employers Alliance
Central City Association
Century City Chamber of Commerce
Chatsworth/Porter Ranch Chamber of Commerce
Citrus Valley Association of Realtors
Claremont Chamber of Commerce
Coalition for Renewable Natural Gas
Coalition for Small Rental Property Owners
Commercial Industrial Council/Chamber of Commerce
Construction Industry Air Quality Coalition
Construction Industry Coalition on Water Quality
Council on Trade and Investment for Filipino Americans
Covina Chamber
Crenshaw Chamber Of Commerce
Crescenta Valley Chamber of Commerce
Culver City Chamber of Commerce
Downey Association of REALTORS
Downey Chamber of Commerce
Downtown Center Business Improvement District
Downtown Long Beach Alliance
El Monte/South El Monte Chamber
El Segundo Chamber of Commerce
Employers Group
Encino Chamber of Commerce
Energy Independence Now
Engineering Contractor's Association
EXP
F.A.S.T.- Fixing Angelenos Stuck in Traffic
Friends of Hollywood Central Park
FuturePorts
Gardena Valley Chamber
Gateway to LA
Glendale Association of Realtors
Glendale Chamber
Glendora Chamber
Google Client Services, LLC
Greater Antelope Valley AOR
Greater Bakersfield Chamber of Commerce
Greater Lakewood Chamber of Commerce
Greater Leimert Park Village Crenshaw Corridor Business Improvement District
Greater Los Angeles African American Chamber
Greater Los Angeles Association of REALTORS
Greater Los Angeles New Car Dealers Association
Greater San Fernando Valley Regional Chamber
Harbor Association of Industry and Commerce
Harbor Trucking Association
Historic Core BID of Downtown Los Angeles
Hollywood Chamber
Hong Kong Trade Development Council
Hospital Association of Southern California
Hotel Association of Los Angeles
Huntington Park Area Chamber of Commerce
ICWA
Independent Cities Association
Industrial Environmental Association
Industry Business Council
Inland Empire Economic Partnership
International Cannabis Business Women Association
International Franchise Association
Irwindale Chamber of Commerce
La Cañada Flintridge Chamber
LA Fashion District BID
LA South Chamber of Commerce
Lancaster Chamber of Commerce
Larchmont Boulevard Association
Latin Business Association
Latino Food Industry Association
Latino Restaurant Association
LAX Coastal Area Chamber
League of California Cities
Long Beach Area Chamber
Long Beach Economic Partnership
Los Angeles Area Chamber
Los Angeles County Board of Real Estate
Los Angeles County Waste Management Association
Los Angeles Economic Development Corporation
Los Angeles Gateway Chamber of Commerce
Los Angeles Gay & Lesbian Chamber of Commerce
Los Angeles Latino Chamber
Los Angeles Parking Association
MADIA Tech Launch
Malibu Chamber of Commerce
Marketplace Industry Association
Motion Picture Association of America, Inc.
MoveLA
Multicultural Business Alliance
NAIOP Southern California Chapter
Nareit
National Association of Tobacco Outlets
National Association of Waterfront Employers
National Association of Women Business Owners - CA
National Association of Women Business Owners - LA
National Federation of Independent Business
National Hookah Community Association
National Latina Business Women's Association
Orange County Business Council
Pacific Merchant Shipping Association
Pacific Palisades Chamber
Panorama City Chamber of Commerce
Paramount Chamber of Commerce
Pasadena Chamber
Pasadena Foothills Association of Realtors
PhRMA
Planned Parenthood Affiliates of California
Pomona Chamber
Rancho Southeast Association of Realtors
ReadyNation California
Recording Industry Association of America
Regional Black Chamber-San Fernando Valley
Regional Hispanic Chamber of Commerce
Regional San Gabriel Valley Chamber
Rosemead Chamber
San Dimas Chamber of Commerce
San Gabriel Chamber of Commerce
San Gabriel Valley Economic Partnership
San Pedro Peninsula Chamber
Santa Clarita Valley Chamber
Santa Clarita Valley Economic Development Corp.
Santa Monica Chamber of Commerce
Sherman Oaks Chamber
South Bay Association of Chambers
South Bay Association of Realtors
South Gate Chamber of Commerce
Southern California Contractors Association
Southern California Golf Association
Southern California Grantmakers
Southern California Leadership Council
Southern California Minority Suppliers Development Council Inc.
Southern California Water Coalition
Southland Regional Association of Realtors
Sunland/Tujunga Chamber
Sunset Strip Business Improvement District
The California Business & Industrial Alliance (CABIA)
Torrance Area Chamber
Tri-Counties Association of Realtors
United Cannabis Business Association
United Chambers – San Fernando Valley & Region
United States-Mexico Chamber
Unmanned Autonomous Vehicle Systems Association
US Green Building Council
US Resiliency Council
Valley Economic Alliance, The
Valley Industry & Commerce Association
Vermont Slauson Economic Development Corporation
Vernon Chamber
Veterans in Business Network
Vietnamese American Chamber
Warner Center Association
West Hollywood Chamber
West Hollywood Design District
West Los Angeles Chamber
West San Gabriel Valley Association of Realtors
West Valley/Warner Center Chamber
Western Electrical Contractors Association
Western Manufactured Housing Association
Western States Petroleum Association
Westside Council of Chambers
Whittier Chamber of Commerce
Wilmington Chamber
World Affairs/Town Hall Los Angeles
World Trade Center

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April 18, 2022

The Hon. Donna Brownsey
Chair
California Coastal Commission
455 Market Street, Suite 300
San Francisco, CA 94105

Re: Huntington Beach Seawater Desalination Facility – APPROVE

Dear Chair Brownsey:

The Orange County Taxpayers Association is dedicated to its mission of fighting to make taxes fair, understandable, cost-effective and good for the economy. As the State of California develops infrastructure for the next generation, it is imperative that we leverage public private partnerships as well as tax dollar investment. To date, Poseidon Water has invested tens of millions of dollars over the past twenty years in the regulatory process of the Huntington Beach Seawater Desalination facility. These private dollars protect the taxpayers and ensure that the public water agencies that will decide whether to green-light this project will do so based on need and value and not based on the "sunk-cost" of tax dollar investment during the regulatory process.

This project will provide a new, drought-proof, climate-resilient water supply for Orange County. Additionally, it will create an infusion of millions of dollars in tax revenue to the local community. And the mitigation Poseidon Water is proposing will ensure the protection and restoration of the Bolsa Chica wetlands at no cost to the taxpayers.

I encourage you to support the proposed draft permit and vote on its approval at your May 12, 2022 meeting.

Sincerely,

Carolyn Cavecche
Orange County Taxpayers Association

cc:

Vice Chair Dr. Caryl Hart
Commissioner Danya Bochco

701 E. Chapman Ave., Orange, CA 92866
phone (949) 215-5539 • www.octax.org

Commissioner Effie Turnbull-Sanders
Commissioner Sara Aminzadeh
Commissioner Steve Padilla
Commissioner Mike Wilson
Commissioner Catherine Rice
Commissioner Linda Escalante
Commissioner Megan Harman
Commissioner Roberto Uranga
Commissioner Carole Groom
Mr. Jack Ainsworth, Executive Director

April 27, 2022

Honorable Donna Brownsey
Chair, California Coastal Commission
455 Market Street, Suite 300
San Francisco, CA 94105

SUBJECT: Huntington Beach Seawater Desalination Facility - APPROVE

Dear Chair Brownsey:

On behalf of CalDesal, I strongly urge your approval of the Huntington Beach Seawater Desalination Facility in Orange County when it comes before the California Coastal Commission on May 12, to provide an important step forward in ensuring this region of the state is able to make advancements in water resiliency and to insulate its community and economy from the devastating impacts of prolonged and ongoing drought.

CalDesal is a statewide association comprised of nearly 60 organizations, representing public and private sector entities as well as non-profit organizations, integrating the use of desalination to ensure a sustainable water future for communities throughout California. CalDesal is dedicated to helping California advance improved statewide water resilience which has been impacted by a changing climate, water supply challenges, and continued population growth.

As you all know well, California is experiencing increasingly extreme weather conditions, with less predictable precipitation patterns, followed by longer and more frequent dry and hot periods. Climate change is reducing the reliability of our precipitation and snowpack. As a result, California is entering a new era of water management, and the state's water managers must change the way they plan for a water resilient future that is very different from the past. Implementation of focused water conservation and water use efficiency programs has been the priority for water managers, and those efforts are increasingly being coupled with development of alternative water supplies, such as water recycling and desalination.

Produced locally, desalinated water provides new, high-quality water, and is resilient to both climate change and drought. Desalination can transform inland brackish water as well as coastal seawater into a drinkable supply. Desalination's ability to generate new water supplies in the face of an unrelenting drought is a valuable attribute that should be a strong component in our state's efforts to improve drought resiliency and water sustainability.

Your approval of the Huntington Beach Seawater Desalination Facility on May 12, 2022 is critical to protecting the quality of life and economy within the Orange County region that will benefit from this important new water supply. Not only will the project provide up to 50 MGD of reliable, locally-controlled water supplies for the region, it will do so using the best available site, design, technology, and mitigation measures feasible to protect marine life. The facility – sited on industrial land and safe from the effects of sea level rise – will be 100 percent carbon neutral and is seeking to be the first desalination facility in the Western Hemisphere to be powered with 100 percent renewable energy resources.

Governor Gavin Newsom and his Administration have provided clear signals – through the Water Resilience Portfolio and in many other venues – that diversifying the state's water portfolio through an "All of the Above" approach to water supply sustainability includes desalination as an important water resilience strategy. While water conservation and water use efficiency remain important priorities for a water resilient future, the state has acknowledged that it must embrace the ongoing development of new water supplies, such as stormwater and water recycling along with desalination, where feasible.

While the stark reality is that the drought conditions that California is experiencing may be the "New Normal," the good news is that you have it in your hands as the California Coastal Commission to make decisions – through approval of the Huntington Beach Seawater Desalination Facility – to help one region of the state move forward in the pursuit of a water resilient future that helps sustain the quality of life and regional economy.

Again, CalDesal strongly urges your approval of the Huntington Beach Seawater Desalination Facility at your May 12, 2022 hearing. Please don't hesitate to contact me at glennf@caldesal.org or at (916) 216-1747 if you have any questions regarding CalDesal's comments on these matters.

Sincerely,

GLENN A. FARREL
Executive Director, CalDesal

cc: Vice Chair Dr. Caryl Hart
Commissioner Danya Bochco
Commissioner Effie Turnbull-Sanders
Commissioner Sara Aminzadeh
Commissioner Steve Padilla
Commissioner Mike Wilson
Commissioner Catherine Rice
Commissioner Linda Escalante
Commissioner Megan Harman
Commissioner Roberto Uranga
Commissioner Carole Groom
Mr. Jack Ainsworth, Executive Director

Elsinore Valley Municipal Water District

Our Mission…
The EVMWD team delivers total water management that powers the health and vibrancy of its communities so life can flourish.

April 27, 2022

ELECTRONIC MAIL

Honorable Donna Brownsey
Chair, California Coastal Commission
455 Market Street, Suite 300
San Francisco, CA 94105

SUBJECT: HUNTINGTON BEACH SEAWATER DESALINATION FACILITY - APPROVE

Dear Chair Brownsey:

On behalf of the Elsinore Valley Municipal Water District (EVMWD), we respectfully request your approval of the Huntington Beach Seawater Desalination Facility during your May 12 hearing.

California is experiencing increasingly extreme weather conditions, with less predictable precipitation patterns, followed by longer and more frequent dry and hot periods. Climate change is reducing the reliability of our precipitation and snowpack. Now in the third straight year of drought, our reservoirs are depleted and we're seeing water shortages both from our own California supply in the Sierra Nevada mountains, as well as the entire western United States with reduced flows in the Colorado River.

Produced locally, desalinated water provides new, high-quality water, and is resilient to both climate change and drought. Desalination can transform inland brackish water as well as coastal seawater into a drinkable supply. Desalination's ability to generate new water supplies in the face of an unrelenting drought is a valuable attribute that should be a strong component in our state's efforts to improve drought resiliency and water sustainability.

The Huntington Beach Desalination Facility will produce up to 50 million gallons per day of drinking water – enough for 400,000 residents – and address an identified need within the region, while helping to reduce reliance on water imported from distant locations. This desalination plant will be privately financed, built, and operated, which protects the taxpayers and provides substantial revenue enhancements for the local communities through taxes and fees that this project will generate. Additionally, the 3,000 new jobs that will be created during construction will provide significant economic benefit to the region. The Huntington Beach Desalination Facility will be the most technologically advanced

951.674.3146
Fax 951.674.9872
www.evmwd.com

31315 Chaney Street
P.O. Box 3000
Lake Elsinore, CA 92530

desalination plant in North America, and the construction and operation of the facility will be 100 percent carbon neutral. The project will fully mitigate any environmental impacts and will protect and preserve the Bolsa Chica wetlands for the next generation.

While the reality is that California's ongoing and persistent drought conditions may be a new way of life for our state, you have it within your ability as the California Coastal Commission to make decisions – through approval of the Huntington Beach Seawater Desalination Facility – to help one region of the state move forward in the pursuit of a water resilient future that helps sustain the quality of life and regional economy.

Again, EVMWD strongly urges your approval of the Huntington Beach Seawater Desalination Facility at your May 12, 2022 hearing. Please don't hesitate to contact me at gthomas@evmwd.net or 951-674-3146 if you have any questions regarding our organization's comments on these matters.

Sincerely,

Greg Thomas
General Manager

GT/se

cc: Vice Chair Dr. Caryl Hart
Commissioner Danya Bochco
Commissioner Effie Turnbull-Sanders
Commissioner Sara Aminzadeh
Commissioner Steve Padilla
Commissioner Mike Wilson
Commissioner Catherine Rice
Commissioner Linda Escalante
Commissioner Megan Harman
Commissioner Roberto Uranga
Commissioner Carole Groom
Mr. Jack Ainsworth, Executive Director

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January 21, 2022

Tom Luster, Senior Environmental Scientist
California Coastal Commission
455 Market Street St, Ste 300
San Francisco, California 94105
Sent via email: Tom.Luster@coastal.ca.gov

Re: Expert Reports on Poseidon Seawater Desalination Project – Huntington Beach Coastal Hazard Analysis

Dear Mr. Luster,

On behalf of the environmental coalition, we appreciate your consideration of the attached expert reports regarding coastal hazards and their inclusion into the administrative record. Poseidon has submitted application materials asserting that sea level rise and coastal hazards associated with the proposed seawater desalination plant in Huntington Beach (proposed project) are insignificant. The expert reports enclosed within are evidence to be considered as part of the administrative record and demonstrate that Poseidon's 2020 sea level rise analysis by Moffat and Nichol is incomplete and incorrectly concludes that there are no significant coastal hazards associated with the project proposal. Poseidon also conducted an ex parte with Chair Brownsey and included a chart that essentially dismisses any significant impacts to the proposed project over its 50-year permit term.

Shocking findings at the Thwaites Glacier in Antarctica recently made headlines as scientists warn that newly discovered fracturing may lead to significant loss of the glacier in three to ten years and result in two to ten additional feet of sea level rise within the century. As emerging evidence mounts, it is anticipated that SLR and related coastal hazards will increase at a more rapid pace than initially anticipated in current projects. As a result, coastal development - especially critical infrastructure - must take the extreme sea level rise scenario into account; however, it is absent from the Project proposal application materials.

The enclosed resources include expert reports commissioned by Surfrider Foundation and Orange County Coastkeeper to offer an independent third- party analysis of the technical accuracy of Poseidon's application materials with regard to coastal hazards.

1. **2018 Ocean Protection Council Sea Level Rise Guidance.** This updated document provides a science-based methodology for state governments to assess sea level rise risk. In particular, the document states that the extreme sea level rise scenario, known as H++, is unassociated with a probabilistic projection but warrants careful consideration for high-stakes, long-term decisions.
2. **2021 City of Huntington Beach Final Sea Level Rise Vulnerability Assessment**. This assessment by the City of Huntington Beach finds that 4.9 and 6.6 feet of sea level rise

will bring devastating effects to the City including the surrounding public infrastructure that would provide public services and access to the proposed Project site.

3. **2018 Technical Memorandum from Dr. David Revell**. The memorandum evaluates the impacts of coastal hazards and sea level rise on the proposed Project site. Key findings include: an "Island Effect" where coastal hazards impact access and public services to the surrounding areas, isolating the site; 6 of the 18 proposed structures on site may be flooded by 2070 in the H++ scenario; tidal inundation may occur several times a year with only 3 feet of sea level rise; and that the entire site will be reliant on maintenance of the flood control channel including possible extensive retrofits and maintenance of the barrier beach outlet. The report also identifies that more research is needed into the H++ scenario, groundwater daylighting, fluvial impacts not yet incorporated into available modeling and impacts to the water distribution pipeline network which has not yet been identified by Poseidon.
4. **2021 Technical Memorandum by Dr. Dave Revell.** This Technical Memorandum responds to Poseidon's 2/4/2019 comment letter. The Memorandum highlights the need to consider the H++ scenario, tsunami exposure, FEMA flooding map updates, barrier beach flooding, shoreline definition and shoreline armoring, groundwater daylighting and concludes that the proposed Project is maladaptive to sea level rise and discourages resilient long-term planning for the City of Huntington Beach and surrounding communities.
5. **2022 Comment Letter by Dr. Dave Revell.** This letter reaffirms the need to evaluate H++, the risks of reliance on the flood control channel and shoreline armoring associated with the flood control channel, road access to the plant risks, and risks to the distribution network.
6. **2017 Fact Sheet by Robert Young.** This memo reviews NOAA sea level rise flood maps, FEMA flood maps and USACE LiDAR as well as tsunami data and concludes that the location of the proposed project will prove impossible to maintain due to the vulnerability of the surrounding area to coastal hazards, including over a 50-year lifespan.
7. **2021 News Report by Cooperative Institute for Research in Environmental Sciences.** This report, titled, "The Threat of Thwaites: The Retreat of Antarctica's Riskiest Glacier", describes the newfound discovery that the Thwaites Glacier may experience rapid melting within three to ten years and poses the biggest threat for increasing sea level rise this century. It also includes a link to the AGU Fall Meeting press conference recording with more information from leading climate scientists studying the glacier.
8. **2021 Antarctic Ice Sheet Articles**. This document includes links with further analysis regarding the Thwaites Glacier and recent discoveries.

We respectfully request these expert reports and additional resources be considered by the Coastal Commission as part of the administrative record. The reports individually, and in whole, demonstrate that Poseidon's application materials are legally flawed and do not meet their burden of demonstrating that the proposed Project site is in compliance with the Coastal Act or City of Huntington Beach LCP policies regarding coastal hazards, critical infrastructure, shoreline armoring or the siting and design of new development.

Sincerely,

A. Sackett

Mandy Sackett
California Policy Coordinator
Surfrider Foundation

A-5-HNB-10-225 / 9-21-0488

(Poseidon Water, Huntington Beach)

CORRESPONDENCE:

Orange County

Coastkeeper Reports

January 21, 2022

Tom Luster, Senior Environmental Scientist
California Coastal Commission
455 Market Street, Suite 300
San Francisco, California 94105

Sent via email: Tom.Luster@coastal.ca.gov

Re: Expert Report of Poseidon – Seismic Risks of the Poseidon Desalination Plant

Dear Mr. Luster,

On behalf of the environmental coalition, we appreciate your consideration of the attached expert report and its inclusion into the administrative record. Poseidon has submitted application materials asserting that the seismic risks to the Poseidon – Huntington Beach Project are minimal. The expert report and earthquake simulation enclosed within are evidence to be considered as part of the administrative record and demonstrate that the seismic risks at the site have not been adequately examined.

The enclosed expert report prepared by Lettis Consulting was commissioned by Orange County Coastkeeper to offer an independent third-party analysis of the potential seismic risks to the Poseidon-Huntington Beach Project. The California ShakeOut earthquake simulation for Huntington Beach was produced by the USGS and the Southern California Earthquake Center.

- **Huntington Beach Earthquake Simulation Video**. The Great Southern California ShakeOut earthquake drill for Huntington Beach is based on a magnitude 7.8 scenario earthquake on the San Andreas fault in southern California. This portion of the San Andreas fault has been identified as the most likely source of a very large earthquake in California (Working Group on California Earthquake Probabilities). As part of the earthquake drill, computer simulations of the ground shaking from this scenario earthquake were constructed through a collaborative effort between the USGS and the Southern California Earthquake Center. These computer simulations capture the shaking at length scales larger than about 300 ft and provide detailed pictures of the shaking for this scenario earthquake. The simulation demonstrates that Huntington Beach would experience 'severe' and 'extreme' shaking in the vicinity of the proposed plant and would reach level X Shaking Intensity on the MMI scale. It should be noted that there are other faults that are closer to the proposed plant that could cause similar seismic impacts.

- **Assessment of the Newport-Inglewood Fault Zone AES Electrical Generation Facility, Poseidon Desalination Project Newland Street and Pacific Coast Highway Huntington Beach, California.** This report, prepared by Lettis Consulting, documents a "desktop" assessment of the Newport-Inglewood fault zone and the potentially active fault strands proximal to the proposed Poseidon Water Huntington Beach desalination project site in Huntington Beach, California. The report is based on published scientific literature, maps, and available consultant reports. The purpose of the study is to summarize existing information on the Newport-Inglewood fault zone and the geology, location, and activity of local faults that may impact the proposed Poseidon project, if such information is known. The report concludes the following:

    - The South Branch fault at the site is not the principal active strand of the Newport-Inglewood fault zone. The principal active strand is located about 0.6 km (.37 of a mile) east of the site and projects offshore near the mouth of the Santa Ana River. The largest surface displacements from future earthquake ruptures on the Newport-Inglewood fault zone are expected on the principal active fault strand, with relatively minor displacements expected on other secondary strands.

- Data do not exist to adequately assess whether the South Branch fault at the site has ruptured in the Holocene Epoch (past 11,700 yrs) and would be considered an active fault by the California Geological Survey (CGS). This fault strand has not yet met the criteria of "sufficiently active and well defined" to be included in an Alquist-Priolo Earthquake Fault Zone (APEFZ) by the CGS.
- Past studies at the Poseidon site by GeoLogic (2002), Ninyo & Moore (2011), and Geosyntec Consultants, Inc. (2013) have consistently concluded an "absence of evidence" for the presence of Holocene faulting on site. However, the subsurface exploration methods employed do not definitively preclude the presence of minor secondary Holocene fault activity at the site.
- Although there is no information that directly implicates the "South Branch" as being active, there are no data that demonstrably preclude Holocene activity. As a result, Orange County Coastkeeper believes that additional subsurface investigations should be performed to evaluate for the presence or absence of Holocene active faults.

We respectfully request that the Lettis report be considered by the Coastal Commission as part of the administrative record. The report demonstrates that additional analysis is needed to adequately assess the seismic risks at the Poseidon – Huntington Beach Project site.

Sincerely,

Raymond Hiemstra
Associate Director of Programs
Orange County Coastkeeper

Huntington Beach Earthquake Simulation

The magnitude 7.8 scenario earthquake ruptures 186 miles (300 km) of the San Andreas fault from Bombay Beach at the edge of the Salton Sea in the south to Lake Hughes northwest of Palmdale in the north. The final slip (offset across the fault) ranges from 6-23 ft (2-7 m). The colors in the movies indicate the peak intensity of the shaking up to the current time at each location. See Explanation of Colors for a more detailed description of the color scheme.

Huntington Beach Simulation

https://escweb.wr.usgs.gov/content/learn/topics/shakingsimulations/shakeout/ShakeOut_HuntingtonBeach_hd.mp4

Shakeout Simulations Page

https://earthquake.usgs.gov/education/shakingsimulations/shakeout/

Assessment of the Newport-Inglewood Fault Zone

AES Electrical Generation Facility, Poseidon Desalination Project

Newland Street and Pacific Coast Highway
Huntington Beach, California

Prepared for:

Orange County Coastkeeper
3151 Airway Avenue, Suite F-110
Costa Mesa, California 92626

Prepared by:

Lettis Consultants International, Inc.
27441 Tourney Road, Suite 220
Valencia, California 91355

May 13, 2020, Revision 1

LCI
EARTH SCIENCE CONSULTANTS

Lettis Consultants International, Inc.
27441 Tourney Road, Suite 220
Valencia, CA 91355
(661) 287-9900; fax (661) 287-9909

May 13, 2020

Mr. Ray Hiemstra
Associate Director of Programs
Orange County Coastkeeper
3151 Airway Avenue, Suite F-110
Costa Mesa, CA 92626

SUBJECT: **Assessment of the Newport-Inglewood Fault Zone**
AES Electrical Generation Facility, Poseidon Desalination Project
Newland Street and Pacific Coast Highway, Huntington Beach, California
LCI Project No. 1966.000

Dear Mr. Hiemstra:

Lettis Consultants International, Inc. (LCI) is pleased to present to you this revised report on our desktop assessment of the Newport-Inglewood fault zone (NIFZ). The report summarizes the geology and activity of the Newport-Inglewood Fault Zone (NIFZ), including the "South Branch" fault strand that has been mapped beneath the proposed AES Corporation electrical generation facility for the Poseidon Desalination Project. This version of the report (Revision 1) includes minor editorial changes, including recommendations by you to improve overall report clarity for the non-technical reader.

Please do not hesitate to contact us with any questions, comments, or concerns that you may have regarding this report. You may contact us directly at (661) 287-9900.

Respectfully,
Lettis Consultants International, Inc.

CERTIFIED ENGINEERING GEOLOGIST
SCOTT C. LINDVALL
NO. 1711
STATE OF CALIFORNIA

Scott Lindvall, C.E.G. 1711, Sr. Principal Geologist
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Chelsea M. Blanton, Staff Geologist
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EXECUTIVE SUMMARY

This report documents our "desktop" assessment of the Newport-Inglewood fault zone and fault strands proximal to the proposed Poseidon Water Huntington Beach desalination project site in Huntington Beach, California. Our study is based on published scientific literature, maps, and available consultant reports. We performed no field work for this study. The purpose of our study is to summarize existing information on the Newport-Inglewood fault zone and the geology, location, and activity of local faults that may impact the proposed Poseidon project, if such information is known.

A strand of the Newport-Inglewood fault zone, named the "South Branch" in some reports, has been mapped beneath the proposed AES Corporation electrical generation facility and is of particular interest. Little information, however, has been published on the recent history of this fault strand.

Based on our desktop assessment, we conclude the following:

- The South Branch fault at the site is not the principal active strand of the Newport-Inglewood fault zone. The principal active strand is located about 0.6 km east of the site and projects offshore near the mouth of the Santa Ana River. The largest surface displacements from future earthquake ruptures on the Newport-Inglewood fault zone are expected on the principal active fault strand, with relatively minor displacements expected on other secondary strands.

- Data do not exist to adequately assess whether the South Branch fault at the site has ruptured in the Holocene Epoch (past 11,700 yrs) and would be considered an active fault by the California Geological Survey (CGS). This fault strand has not met the criteria of "sufficiently active and well defined" to be included in an Alquist-Priolo Earthquake Fault Zone (APEFZ) by the CGS.

- Past studies at the Poseidon site by GeoLogic (2002), Ninyo & Moore (2011), and Geosyntec Consultants, Inc. (2013) have consistently concluded an "absence of evidence" for the presence of Holocene faulting on site. However, the subsurface exploration methods employed cannot definitively preclude the presence of minor secondary Holocene fault activity at the site.

- Although there is no information that directly implicates the "South Branch" as being active, there are no data that demonstrably preclude Holocene activity. Additional subsurface investigations could be performed to evaluate for the presence or absence of Holocene-active faults. However, thick Holocene deposits in the Santa Ana Gap could make such an evaluation difficult.

1.0 INTRODUCTION

Lettis Consultants International, Inc. (LCI) is pleased to submit this report documenting our desktop assessment of the Newport-Inglewood fault zone (NIFZ) and fault strands in close proximity to the proposed Poseidon Water Huntington Beach desalination project site ("the site", Figure 1). The site is located near the intersection of Newland Street and Pacific Coast Highway in Huntington Beach, California.

The purpose of this investigation is to summarize existing information on the NIFZ and the geology, location, and activity of local faults that may impact the proposed Poseidon project, if such information is known. The scope of work for this project included: (1) literature research and data review, (2) synthesis and interpretation of the literature and data, and (3) preparation of this report. The literature review included both publicly available publications as well as reports for the Poseidon project site provided to us by Mr. Ray Hiemstra of Orange County Coastkeeper (OCCK). No new data were collected for this project, and there remain open questions as to the recency of activity for multiple fault strands of the NIFZ in the Huntington Beach area.

A strand of the NIFZ, named the "South Branch" in some reports, has been mapped beneath the proposed AES Corporation electrical generation facility and is of particular interest. Little information, however, has been published on the recent history of this fault strand. The Poseidon site lies in the Santa Ana Gap (also called the Talbert Gap), a low area traversed by the Santa Ana River which is underlain by a very thick sequence of young alluvium that records aggradation during post-glacial sea level rise. The consequence of the thick Holocene deposits and shallow groundwater is that there have been no trenching studies to definitively resolve recency of surface ruptures on the South Branch of the fault zone. Given the difficulty in assessing the recent age of faults in the Santa Ana Gap area and that they are not well-defined at the ground surface, the California Geological Survey (CGS) has not defined Alquist-Priolo Earthquake Fault Zones (APEFZs) for a major part of the NIFZ across the Gap, including in the vicinity of the Poseidon site.

The project team for this study included geologists Scott Lindvall and Chelsea Blanton from LCI. Dr. Thomas Rockwell of San Diego State University provided independent subject matter expertise and review. Jeffery Hemphill of LCI provided GIS and graphics support.

2.0 GEOLOGIC AND TECTONIC SETTING

The NIFZ is part of a broad system of faults, including the San Andreas fault (Figure 1), that comprises the plate boundary between the Pacific and North American lithospheric plates. Together, this system transfers approximately 50 mm/yr of dextral shear, of which the NIFZ accommodates a minor fraction. In the Los Angeles basin region (Figure 2), which is considered part of the Peninsular Ranges Province (Wright, 1991), the NIFZ and related strike-slip faults translate crustal blocks to the northwest and impinge on the Transverse Ranges, an east-west domain of crustal shortening.

The Los Angeles basin is a long-lived crustal feature in southern California that has sustained as much as 6 km of subsidence and consequent deposition of strata in the late Neogene (Wright, 1991), with 1.5 to 2 km of sediment accumulation in the Quaternary (Yeats and Rockwell, 1991). Beneath the sedimentary strata, the NIFZ juxtaposes Catalina Schist basement rocks on the west against granitic and metagranitic rocks on the east (Yerkes et al., 1965), indicating an earlier history of motion, with the modern motion on the fault propagating up through the very thick section of sedimentary rocks, resulting in its en echelon stepping pattern with localized uplifts (Wilcox et al., 1973). In this context, the term en echelon refers to closely spaced, parallel or subparallel, overlapping or step-like fault strands that lie oblique to the overall structural trend.

3.0 NEWPORT-INGLEWOOD FAULT ZONE

The Newport-Inglewood Fault Zone (NIFZ) is the northern part of a longer zone of coastal strike-slip faults that extends from south of San Diego to the northern Los Angeles basin, terminating against the Transverse Ranges (Figure 1). The entire fault zone includes the Rose Canyon fault (Figure 3) and is commonly referred to as the Newport-Inglewood/Rose Canyon (NIRC) fault zone or fault system (e.g., Fischer and Mills, 1991; Grant and Rockwell, 2002; USGS and CGS, 2018; Sahakian et al., 2017; Singleton et al., 2019). The three main portions of the NIRC fault system are the onshore Newport-Inglewood (length ~65 km), offshore Newport-Inglewood (length ~67 km), and Rose Canyon (length ~75 km) faults (Figure 1). Although this terminology is common in the literature, the three-part division does not necessarily reflect separate or isolated fault sections that rupture independently of each other. At a local scale, the NIRC includes many named and unnamed individual fault strands or fault segments. The naming conventions for individual fault strands and fault sections vary by both scale as well as between different publications.

The NIFZ is a major tectonic boundary that defines the western margin of the deep central trough of the Los Angeles basin (Hill, 1971; Wright, 1991) (Figure 2). At the surface, the NIFZ is expressed as a linear, approximately N45°W trending series of low hills and mesas associated with domal uplifts and oil fields. The fault zone consists of a series of discontinuous strike-slip faults and shorter secondary normal and reverse faults (Barrows, 1974; Bryant, 1988). The northern portion of the NIFZ consists of a series of left-stepping, en echelon faults. In contrast, the NIFZ appears to be a single main strand with local secondary fault “splays” from the Long Beach oil field and to the south (Wright, 1991) (Figure 2). In this report we use the term “splay” to refer to a relatively minor fault strand that branches off from or is otherwise separate from the principal main fault strand. Some have proposed that the pattern of en echelon faults and folds at the surface along the northern NIFZ is the result of an underlying deep-seated strike-slip fault (e.g., Moody and Hill, 1956; Harding 1973; Wilcox et al., 1973). Wright (1991), however, demonstrates that detailed mapping of oil fields along the NIFZ has revealed a variety of structural patterns and histories that cannot be simply explained by pure strike-slip faulting. Wright (1991) argues that classic wrench-fault deformation cannot produce most of the anticlinal structures, and other factors, such as local basement geometry, pervasive shear within the basement, and interaction with adjacent fault blocks, has contributed to the fold development along the NIFZ.

3.1 Seismicity

The largest historical earthquake produced by the NIFZ was the March 10, 1933 moment magnitude (Mw) 6.4 Long Beach earthquake (Richter, 1958; Hauksson and Gross, 1991). The moment magnitude (Mw) scale is the standard magnitude scale for ranking earthquakes by size, and largely replaces earlier scales such as the Richter scale, which is also known as the local magnitude (M_L) scale. The 1933 earthquake caused extensive damage in the southern Los Angeles basin area and resulted in 120 deaths and several hundred injuries (Wood, 1933). The 1933 Long Beach earthquake was so named because of the extensive damage to the City of Long Beach. The distribution of aftershocks defined the section of the fault that ruptured. The majority of the seismic moment released in 1933 was limited to a 13- to 16-km-long reach of the fault between Newport Beach and Long Beach (Hauksson and Gross, 1991). The mainshock hypocenter (-117.976°, 33.659°) is located in Huntington Beach (Figure 1) at a depth of 13 km, which suggests unilateral rupture from Huntington Beach northward toward Long Beach (Hauksson and Gross, 1991). Given a ~16-km rupture length, unilateral rupture, and the mainshock location from Hauksson and Gross (1991), the primary subsurface rupture of the 1933 earthquake is constrained to approximately the portion of the fault that extends from near the boundary between the cities of Huntington Beach and Newport Beach on the south to near the boundary between Orange and Los Angeles Counties (San Gabriel River) on the north (Figure 1). The estimated subsurface rupture is about half the length of the aftershock zone. Uplift produced by the 1933 earthquake (Barrows, 1974), as determined by precise leveling data, suggests that rupture may have extended a little farther to the northwest, which is more consistent with the extent of aftershocks.

The best constrained nodal plane has a strike of N45°W and a dip of 80°NE with nearly pure right-lateral slip (Hauksson and Gross, 1991). The subsurface average slip estimate from the seismic moment is 85 to 120 centimeters (2.8 to 3.9 ft) (Hauksson and Gross, 1991). Surface rupture was not reported for this earthquake (Wood, 1933), although Guptill and Heath (1981) suggest that surface displacement may have occurred near the south end of rupture on the North Branch fault strand on west Newport Mesa.

Since 1920, at least five earthquakes of magnitude 4.9 or larger (including the 1933 Long Beach earthquake) have been attributed to the NIFZ (Barrows, 1974). The first of these events was the 1920 local magnitude (M_L) 4.9 Inglewood earthquake, which caused moderate damage in the town of Inglewood (Hauksson, 1987). A (M_L) 5.4 aftershock of the 1933 Long Beach earthquake occurred under Signal Hill on October 2, 1933. In 1941, two earthquakes of magnitude 5.0 and 5.4 caused damage in the Torrance Gardena area (Richter, 1958).

Hauksson (1987) analyzed small earthquakes from 1977 to 1985 along the NIFZ trend and determined that the maximum principal stress axis is oriented N10–25°E. Of the 39 focal mechanisms, most show strike-slip faulting with some reverse faulting for those located north of Dominquez Hills, and some normal faulting for those located south of Dominquez Hills to Newport Beach (Hauksson, 1987). Inversion of focal mechanism data indicates that minimum principal stress is vertical north of Dominguez Hills and the intermediate stress is vertical south of

Dominguez Hills. Hauksson (1987) suggested that the occurrence of both strike-slip and reverse faulting events observed along the northernmost NIFZ may be related to an increase in both north-south and east-west horizontal stresses adjacent to the Transverse Ranges.

3.2 Paleoseismic Information

The record of prehistoric activity on a fault from paleoseismic studies can provide useful information for evaluating seismic hazards, such as earthquake magnitude estimates, fault slip rates, and the repeat times of large surface-rupturing earthquakes. Very little paleoseismic information has been developed for the northern NIFZ. Slip rate estimates and paleo-earthquake records have been obtained at paleoseismic sites farther south along the NIRC fault system in Orange County and San Diego (Figure 3). In San Diego, Lindvall and Rockwell (1995) documented a minimum Holocene slip rate of 1.1 to 2.0 mm/yr for the Rose Canyon fault based on paleoseismic trenching. The Rose Creek site (Figure 3), located on a Holocene terrace to Rose Creek, also revealed evidence for three surface-rupturing earthquakes in the past 8.1 thousand years before present (ka), with the most recent event (MRE) occurring within the past ~500 years. Based on radiocarbon data from additional La Jolla and San Diego trench sites (Rockwell and Murbach, 1999), the Rose Canyon fault MRE was constrained to AD 1650 ± 125 (Grant and Rockwell, 2002). Based on this information, Rockwell (2010) further interpreted the Lindvall and Rockwell (1995) three-dimensional trench observations to: (1) estimate up to 3 m of right-lateral displacement in the MRE, and (2) a total of six earthquake ruptures in the past 9.3 ka. However, a new trenching study in Old Town (Figure 3) revealed that there have been several middle to late Holocene surface ruptures (Singleton et al., 2019), indicating that the Rose Creek site contained an incomplete record, likely due to non-deposition. At the Old Town site, large events are interpreted to have occurred with an average recurrence interval of about 700 years, with at least two smaller (magnitude ~6) events also having occurred. The most recent moderate event was the 1862 magnitude 6 earthquake described as the “Day of Terror in San Diego”, as reported in the Los Angeles Star (Singleton et al., 2019).

The Rose Canyon fault slip rate also appears to be higher than originally estimated, based on new assessments of campaign and continuous GPS data (Singleton et al., 2020 in review). Re-occupation of 20-year-old campaign stations combined with continuous GPS data suggests a modern strain rate across the Rose Canyon fault of 3-4 mm/yr, which is nearly half of the total strain measured across the Inner Borderland system of faults in the offshore between San Clemente Island and Monument Peak in eastern San Diego County.

In Huntington Beach (Figure 1), Grant et al. (1997) used cone penetrometer test (CPT) and borehole transects to identify paleo-earthquakes on the North Branch fault. The study identified three, and most likely five, Holocene surface rupturing earthquakes within a graben produced by a transtensional stepover of ~0.5 km width. The timing of the oldest three events is best constrained by radiocarbon dating as: between 11.7 and 10.5 ka, about 10.5 ka, and between 7.8 and 5.5 ka. The penultimate event is estimated to have occurred at about 4.3 ka and the MRE could postdate 4.3 ka by several millennia (Grant et al., 1997). These estimated ages of NIFZ earthquakes match closely with events identified on the Compton-Los Alamitos fault by Leon et al. (2009), which may suggest a structural connection between these structures as suggested by Wright (1991), but is in contrast to interpretations by Shaw and Suppe (1996) that interpret the Compton-Los Alamitos system as a low-angle blind thrust.

A minimum slip rate was estimated as 0.34 to 0.55 mm/yr, but Grant et al. (1997) stress that the actual rate could be significantly higher. The minimum estimated Holocene slip rate is similar to a long-term (post-Miocene) slip rate estimate of 0.5 mm/yr (Freeman et al., 1992), although the long-term rate is based solely on brittle offset of piercing points and does not consider folding and plastic deformation, which could exceed the amount of brittle offset. Critical from an earthquake generation point of view is the slip rate at basement depths where earthquakes nucleate, which is almost certainly higher than the rates measured in the near surface, which do not account for off-fault plasticity and folding.

In Seal Beach, located northwest of Huntington Beach and along the NIFZ (Figure 1), Leeper et al. (2017) cored, dated, and mapped salt marsh stratigraphy to recognize three abrupt changes in sedimentation during the past 2,000 years. These changes record burials of fine salt marsh strata with coarser terrestrial sediment and are presumed to represent rapid subsidence during surface rupturing earthquakes (Leeper et al., 2017). The most recent event at this Seal Beach salt marsh site is contemporaneous with the most recent Rose Canyon surface rupture that exhibited ~3 m of dextral slip in San Diego (Lindvall and Rockwell, 1995; Rockwell and Murbach, 1999; Singleton et al., 2019). Leeper et al. (2017) suggest that only one of the interpreted events at the Seal Beach salt marsh may correlate with the Huntington Beach site MRE (< 4.3 ka) (Grant et al., 1997), although it should be pointed out that the Huntington Beach record is based solely on CPT data and some events that exhibited purely strike-slip displacement could have been missed; therefore, it should be interpreted as a minimum record of Holocene earthquakes. Further, comparison of the Leeper et al. (2017) record on the NIFZ with that from San Diego (Singleton et al., 2019) suggests that these earthquakes occurred at similar times, although as Singleton et al. (2019) point out, they are not likely the same events as that would require very large ruptures on long faults with significantly more displacement than is supported by their recurrence intervals and slip rates.

The large uncertainties in the timing of past surface ruptures and large distances between the few paleoseismic sites along the NIRC (Figures 1 and 3) preclude the development of a correlation chart to estimate past ruptures and their lengths with any reasonable confidence. There is also a lack of data on the timing of surface ruptures for the ~65-km-long offshore section of the fault zone (Figure 1). Studies of the offshore reach of the fault zone by Sahakian et al. (2017) using marine seismic reflection data to refine the fault zone's continuity and geometry, however, have observed along-strike differences in the depth of the most recent deformation below the seafloor, which may have implications on the extent and timing of offshore ruptures. The Carlsbad strand (Figure 1) does not appear to reach shallow sediment near the seafloor as adjacent sections do. Sahakian et al. (2017) suggest that the absence of surface deformation on this reach of the fault may have persisted for over 100 ka or more and may not experience surface deformation, which would support independent rupture of the Newport-Inglewood and Rose Canyon faults.

3.3 Potential for Multi-Fault Ruptures

Given that the ~65-km-long onshore NIFZ is part of a much longer fault system (NIRC) that extends south through San Diego for a length of over 200 km (Figure 1), it has the potential to rupture in large, multi-segment earthquakes. The timing of paleo-earthquakes on the Newport-Inglewood and Rose Canyon faults support this possibility. Seismic reflection studies have been used to map a relatively continuous zone of faulting offshore with only minor steps (≤ 2 km wide), suggesting that large multi-segment ruptures should be considered in seismic hazard analyses (e.g., Fischer and Mills, 1991; Sahakian et al., 2017). Empirical studies of historical ruptures worldwide demonstrate that earthquakes commonly rupture through steps of this dimension (e.g., Wesnousky, 2008), and Coulomb stress modeling of rupture scenarios illustrate that rupture of the entire NIRC fault zone is possible (Sahakian et al., 2017). The southernmost stepover between the La Jolla and Torrey Pines fault strands (Figure 1), however, may act as an inhibitor to through-going rupture due to width and geometry of the step (Sahakian et al., 2017).

Regional seismic source models have incorporated the possibility of linked, multi-fault ruptures along the NIRC. The UCERF2 model included both individual ruptures on the NIFZ, offshore NIFZ, and Rose Canyon fault, as well as a combined fault source that included all three sections (Field et al., 2008). The more recent UCERF3 model relaxes segmentation constraints and allows ruptures on faults to cascade from portions of one fault to many faults (Field et al., 2013). The more varied UCERF3 ruptures and the faults that participate in them are limited by a set of rules that include step-over width, distance between fault tips, and fault intersection angle. This model allows for numerous rupture combinations involving the NIRC.

4.0 FAULTS MAPPED IN THE SITE VICINITY

The Poseidon site is located within in the Santa Ana Gap, a topographic low area carved by the Santa Ana River between the elevated topography of the Huntington Beach and Newport Mesas (Figure 4). Mapping of the NIFZ strands within the Santa Ana Gap is primarily based on mismatches in the Miocene and Pliocene strata from oil field exploration, and from groundwater barriers in Pliocene and Pleistocene strata. The gap contains a thick late Pleistocene and Holocene fill associated with aggradation of the Santa Ana River during post-Marine Isotope Stage (MIS) 2 sea level rise (beginning about ~17–20 ka). Surficial deposits within the gap consist of young, Holocene deposits (Figure 5). Consequently, as the sediments are so young, it has been difficult to assess the recency of individual strands of the NIFZ in the Santa Ana Gap, as the base of the Holocene fill may be tens of feet in depth. Based on calibrated ages from radiocarbon dating at the site (GeoLogic Associates, 2002), the Holocene-Pleistocene boundary is located at a depth of approximately 80 ft.

There are several interpretations of faults at different structural levels in the Santa Ana Gap and naming of these faults varies with each interpretation. The North Branch and South Branch terminology has been used for faults in both the Huntington Beach and West Newport oil field areas, which can lead to confusion in describing the fault zone (Figure 6). The principal fault strand, highlighted yellow in Figure 6, represents the fault exhibiting the largest cumulative vertical separations of Miocene and Pliocene strata (see cross-sections in Figures 6 and 7). This principal fault consists of the North Branch in the Huntington Beach oil field and the zone of more southerly striking faults exiting the shoreline near the mouth of the Santa Ana River, which has also been called the South Branch (Figure 6). The North Branch in the West Newport oil field crosses the Santa Ana River and exhibits a similar strike as the North Branch in the Huntington Beach oil field, making it appear to be a continuous extension of the same fault in map view (Figure 6). However, in cross-section, this fault crossing the Santa Ana River exhibits significantly less vertical separation than the principal fault located southwest (Figure 7). Therefore, the North Branch in the West Newport oil field does not appear to be a continuation of the same large slip fault, the principal fault, which diverges to the south. The South Branch mapped through the Poseidon site is based on interpreted offsets in aquifers and represents a secondary fault of the NIFZ. Throughout this report, we refer to the fault mapped crossing the Poseidon site as the "South Branch" and the main fault of the NIFZ as the "principal fault" (Figure 6). To minimize confusion, we retain the North Branch and South Branch names in the Huntington Beach area, but try to avoid using these names for faults in the West Newport oil field in this report. Reproduction of some previously published figures do retain these names in the West Newport oil field (e.g., Figure 7).

Faults interpreted in the shallow subsurface and at greater depth were differentiated and named in subsequent studies conducted by the California Department of Water Resources (DWR) and others. The NIFZ in the Santa Ana Gap according to DWR (1966), from north to south, consists of the Bolsa-Fairview, Yorktown, Adams Avenue, Indianapolis, North Branch (the "principal fault"), and South Branch faults (Figure 4). The basis for mapping these faults is primarily groundwater and stratigraphic differences between wells. DWR (1966) describes that fault locations in the Santa Ana Gap were determined from "major lithologic and faunal discontinuities between exploratory wells, major stratigraphic discontinuities in deeper oil-bearing materials, marked changes in mineral character and quality of groundwater, abrupt piezometric level differences in aquifers, and anomalies in aquifer performance test data."

The Bolsa-Fairview fault was first mapped by Poland and Piper (1956), who inferred a fault in the northern Newport Mesa based on water well data. In this report, the term "inferred" is used in reference to the standard convention in geologic mapping that depicts faults that are not directly visible at the ground surface with a dashed, dotted, or queried line. Such faults are classified as concealed or inferred. DWR (1966) connected the inferred fault of Poland and Piper (1956) with a fault in the Santa Ana Gap mapped by Loken (1963). The Yorktown, Adams Avenue, and Indianapolis faults were inferred from hydrologic data and mapped by DWR (1966). Through-going faults were not mapped in the Santa Ana Gap between the Adams Avenue fault and the North Branch fault of Hunter and Allen (1956), which led Bryant (1985) to suggest that this zone of faults does not extend at depth. The South Branch fault was first inferred by Poland and Piper (1956) and was assumed to be a right-lateral strike-slip fault by DWR (1966, 1968). Poland and Piper (1956) inferred the location of the South Branch fault across Huntington Beach Mesa based on a gentle topographic slope and other deep structural features (Bryant, 1985). Then, DWR (1966) used groundwater data from exploratory wells to illustrate displaced or mismatched aquifers across all six faults mapped in the Santa Ana Gap (Figure 4).

4.1 Oil Field Data (Post-Miocene Faulting)

The main structural feature of the Huntington Beach and West Newport oil fields is the Newport-Inglewood fault zone (Figures 2 and 6). In the Huntington Beach oil field, the NIFZ is expressed as a single major fault (North Branch) with about five lesser faults to the southwest (Figure 6), which are depicted as terminating at the base of the Pliocene Lower Pico formation or within the Pliocene Repetto formation (DOGGR, 1992). The principal fault extends to the surface and separates a more steeply dipping section on the northeast from more gently dipping units on the southwest. The vertical separation on the contoured horizon (green contours in map and green horizon in cross-section A-B) is not significant, which implies a dominant horizontal component of slip on this principal strand (Figure 6).

Farther southeast in the West Newport oil field, the fault system appears to diverge southeastward into two major zones of faults (Figure 6). Both fault zones are interpreted with west-side-down normal separations and dip steeply to the southwest; however, the North Branch labeled in cross-section A-A' (Figure 7), has an order of magnitude less vertical separation than the other branching fault zone that strikes more southerly (Figures 6 and 7). The more southerly, large displacement fault is interpreted as the principal strand of the NIFZ at this location. The principal fault exhibits up to 2,000 ft of vertical separation across the Miocene top of “A” zone horizon (brown horizon in Figure 7). This fault represents the principal fault within the NIFZ, as it exhibits the greatest amount of cumulative displacement. The change in strike of the principal fault strand from the Huntington Beach oil field to the West Newport oil field likely explains the greater vertical separation observed in the West Newport oil field and is consistent with a releasing or transtensional bend in the right-lateral NIFZ.

Structure contour maps and faults interpreted at depth in the oil fields do not identify the South Branch fault as mapped through the Poseidon site. Figure 6 shows the faults mapped at depth in the oil fields in black and Quaternary faults mapped near the surface in red. Note how there is no through-going oil field fault that is interpreted along the length of the inferred Quaternary South Branch fault (Figure 6). The oil field data do not allow for the interpretation of stratigraphy younger than Pliocene age (Hunter and Allen, 1956; Allen and Joujon-Roche, 1958; Beyer, 1988; DOGGR, 1992) and therefore, do not depict faults in the younger Pleistocene and Holocene deposits near the surface. The differences observed between the deep oil field data and shallower fault interpretations suggest that either: (1) the South Branch fault is a small displacement fault that is difficult to recognize from the spacing of oil wells, or (2) the South Branch fault does not exist as a continuous, through-going fault as has been previously depicted in various maps.

4.2 Groundwater and Early Mapping Studies (Post-Plio-Pleistocene Faulting)

Various groundwater and early mapping efforts resulted in the delineation of faults within the Santa Ana Gap between the Huntington Beach Mesa to the northwest and the Newport Mesa to the southeast (Figure 4). In 1966, the Department of Water Resources Bulletin No. 147-1 concluded that direct displacement of recent sediments has not occurred along faults crossing the Santa Ana Gap and that, with the exception of the Talbert aquifer of recent (Holocene) age, other early to late Pleistocene age aquifers in the Santa Ana Gap have been faulted and folded across the Newport-Inglewood fault system. Geologic cross-sections directly east (B-B', Figure 8) and west (C-C', Figure 8) of the site depict all fault strands, including the South Branch of the NIFZ, terminating at the base of the Talbert aquifer (DWR, 1966). Poland and Piper (1956) assert that geologic, hydrologic, and geochemical evidence from water wells does not substantiate whether or not this South Branch transects deposits of Pleistocene age. Geologic cross-sections E-E' and C-C' in the vicinity of the site do not depict the South Branch of the NIFZ; however, the NIFZ is shown as terminating at the base of the Talbert water-bearing zone northeast of the site (Poland and Piper, 1956). To the northwest of the Huntington Beach Mesa in the Bolsa Gap (Figure 6), DWR (1968) does not map the South Branch fault as offsetting the early Holocene Bolsa aquifer. Hazenbush and Allen (1958) mapped faults in the Bolsa Gap sub-parallel to the South Branch fault, but they do not offset deposits younger than lower Pliocene (Bryant, 1985).

The NIFZ has a barrier effect in the lower Pleistocene aquifers along its entire length from Huntington Beach to Newport Mesa (DWR, 1966) (Figure 4). In the Santa Ana Gap, saline water intrusion has occurred in Pleistocene sediments across the North and South Branches of the NIFZ and continues inland. The North Branch fault forms a salinity barrier in late Pleistocene sediments, but groundwater moves freely within the Holocene age Talbert aquifer; therefore, this aquifer has a high salinity content on both sides of the North Branch fault (DWR, 1966). According to both DWR (1966) and Bryant (1985), the South Branch fault is not a saltwater barrier. At the Indianapolis fault, strata of silt and clay are faulted against the Main, lower Rho, and upper Rho aquifer zones, which form a nearly complete impediment to further inland saline intrusion in the lower Pleistocene aquifers. The Adams Avenue, Yorktown, and Bolsa-Fairview faults are partial barriers to groundwater flow (DWR, 1966) in Pleistocene deposits, but not in the Talbert aquifer.

The conceptual model describing aquifers in the Santa Ana River Basin is based on studies by the California Department of Water Resources in the 1960s (DWR, 1966) and the Orange County Water District (OCWD, 2004), which identified three major aquifer systems from middle Miocene through Holocene. Detailed knowledge of the stratigraphic character of the Santa Ana River Basin aquifers is mainly from descriptions of water wells drilled since the late 1930s. Currently, no modern sequence-stratigraphic analysis has been carried out in the Santa Ana River Basin (Edwards et al., 2009). Geologic cross-sections at the south-central (Santa Ana Gap) and western (Alamitos Gap) parts of the basin record a common stratigraphy (Zielbauer et al., 1961; Callison et al., 1991; Callison, 1992; Herndon, 1992). Generally, undeformed Holocene river channel sands and gravels (the Talbert and Recent aquifers) associated with the ancestral San Gabriel and Santa Ana Rivers unconformably overlie aquifers of Pleistocene age. Towards the coast, Pleistocene aquifers are deformed and faulted by the Newport-Inglewood Uplift, where they dip north, and extend to depth into the central Santa Ana River Basin (Edwards et al., 2009). Generalized cross-section B-B' from Edwards et al. (2009) shown in Figure 9 is located directly east of the site and shows the Newport-Inglewood fault system terminating at the base of the Talbert aquifer (Holocene age) in the south-central part of the Santa Ana Gap.

A recent generalized cross-section by OCWD (2016) to illustrate salinity concentrations through the Santa Ana Gap (Figure 10) is located approximately 4,000 ft east of the site and depicts the

South Branch of the NIFZ terminating at the base of the Talbert aquifer. This cross-section depicts all of the regional aquifers below the shallow Talbert aquifer as uplifted, folded, and offset to varying degrees by the NIFZ (OCWD, 2016).

Various recent cross-sections through the Santa Ana Gap (OCWD, 2016; EMA, 2015) are adapted from the California Department of Water Resources Bulletin No. 147-1 (DWR, 1966) and several others (Edwards et al., 2009; Geosyntec Consultants, Inc., 2013) are adapted from the Orange County Water District Groundwater Management Plan (OCWD, 2004). Interpretations from DWR (1966), including aquifer system names and fault interpretation, are still in use today to represent the subsurface geology of the Santa Ana Gap. It is important to note that while these interpretations are still in use, the water well data upon which these interpretations are based are not sufficiently dense to preclude Holocene fault displacement on any of the faults in the Santa Ana Gap.

4.3 Shallow Geologic and Geophysical Investigations (Pleistocene and Holocene)

Recently, several geotechnical and seismic investigations gathered subsurface data in the vicinity of the site to assess fault activity of the NIFZ South Branch. GeoLogic Associates (2002) conducted 21 CPT soundings and six rotary boreholes to depths of 82 to 93 ft below the ground surface at the Orange County Desalination Project site (AES Generating Station) in Huntington Beach, California (Figure 11) as part of preliminary geotechnical and seismic investigations. They obtained radiocarbon dates for selected samples from the boreholes and conducted an evaluation of faulting based on stratigraphic correlations. The investigation did not find evidence of faulting at the site to the maximum depths explored and stated that, “Because the age of the stratigraphic section below the tank sites as determined by radiocarbon dating includes all of Holocene time, the absence of evidence of faulting suggests the risk of future surface faulting at the site is a relative minimum.” The GeoLogic (2002) report we were provided was a draft version dated August 2002 that was missing plates, cross-sections, and logs of CPTs and boreholes. Therefore, we were unable to make an independent review of their data and interpretations regarding the presence or absence of faulting in the Holocene strata at the site. The locations of GeoLogic boreholes shown in Figure 11 were obtained from a map in the Geosyntec Consultants Inc. (2013) report. At face value, the GeoLogic (2002) report stated that they found no evidence for the presence of faults in their explorations across the site, which span the inferred fault strand from the U.S. Geological Survey’s Quaternary fault and fold database (Figure 11). However, with CPT and borehole spacing ranging on the order of 50 to 100 ft, it may be difficult to preclude the presence of minor, secondary faults at the site.

Ninyo & Moore (2011) conducted a subsurface investigation at 21730 Newland Street in Huntington Beach, California (Figure 11) consisting of two hollow-stem auger boreholes to depths of approximately 51.5 ft and four CPTs to depths of approximately 75.5 ft. They concluded that, “Based on the distance of the mapped fault to the area of the proposed re-powering project, the potential for surface fault rupture impacting the project is relatively low.”

In 2013, a geotechnical hazards assessment of the Poseidon site was performed by Geosyntec Consultants, Inc. (2013). Geosyntec performed a review of available literature to assess the likelihood of a subsurface fault rupture at the site and found such fault rupture to be unlikely. Geosyntec also performed a limited field investigation consisting of five CPT soundings, ranging from depths of 50 to 98 ft. The version of the Geosyntec Consultants, Inc. (2013) report we were provided, and which we reviewed, did not include Appendix A containing the Geosyntec Consultants, Inc. (2013), Ninyo & Moore (2011), and GeoLogic (2002) CPT and boring logs. The report also does not include any geologic cross-section figures, and therefore, an independent assessment of the presence or absence of faulting at the site could not be made as part of our review. The locations of borings and CPTs by Geosyntec Consultants, Inc. (2013), Ninyo & Moore (2011), and GeoLogic (2002) are shown in Figure 11.

In order to evaluate the potential impact to proposed structures at the Poseidon site from rupture on the South Branch fault, Geosyntec Consultants, Inc. (2013) performed a finite element analysis and assumed: (1) a moment magnitude Mw 7.1 earthquake scenario, (2) the South Branch fault beneath the site is a secondary fault within the NIFZ, and (3) secondary faults are capable of producing only 25% of the main fault displacement. Displacements of 3.8 ft and 0.95 ft were estimated for the principal fault (located offsite) and the secondary South Branch fault (assumed to be located beneath the site), respectively. The finite element model included an approximately 200-ft-thick section of alluvial sediments through which 0.95 ft of fault displacement was propagated to the ground surface. The analysis demonstrated that, for the fault rupture scenario analyzed, the proposed structures may experience repairable aesthetic and temporary serviceability issues, but significant structural damage is considered to be unlikely (Geosyntec Consultants, Inc., 2013).

A network of shallow seismic reflection surveys was conducted offshore near the mouth of the Santa Ana River by EcoSystems Management Associates, Inc. (EMA, 2015) to provide more accurate information on the characteristics of the offshore subsurface where possible subseafloor intake systems may be constructed. The seismic line located nearest to the shoreline in this network of surveys, HBP-2101, is shown Figure 12 and its approximate location is shown in Figure 6. Many faults are interpreted along the length of HBP-2101 that have upward terminations in both late Pleistocene and Holocene sequences (Figure 12). The most prominent feature in this profile is a graben (South Graben) near the center of the line. Vertical separation on the strong reflection horizon appears to vary from a few to over 90 ft; however, EMA (2015) interpret that a 90-ft vertical separation appears too large for tectonic deformation and suggest that the steep boundary of the South Graben may be erosional rather than tectonic, such as a fault line scarp formed by channel erosion. The broad zone of young faults interpreted in HBP-2101 is consistent with a major strand of the NIFZ crossing the coastline near the mouth of the Santa Ana River (EMA, 2015). The strike of individual strands within this wide, complex, distributed zone of faulting imaged in the offshore seismic line is unknown (Figure 12), and therefore these faults cannot be confidently correlated to faults onshore and it is not known if any project toward the Poseidon site.

4.4 Principal Fault Strand

The principal fault strand, as portrayed in cross-sections by Hunter and Allen (1956), lies approximately 0.6 km east of the subject site. This deep, through-going fault is interpreted to accommodate the majority of slip, and exhibits up to 2,000 ft of vertical separation (Figure 7). The principal fault of the NIFZ, which does not intersect the Poseidon site, is highlighted in yellow in Figure 6. From cross-section A-A', this fault continues northwestward for about 1.5 km and makes a bend to a more westerly direction. South of cross-section A-A', the fault projects offshore near the mouth of the Santa Ana River.

Shallow offshore seismic reflection surveys near the mouth of Santa Ana River by EMA (2015), notably seismic profile HBP-2101, interpret a broad zone of faulting in late Pleistocene and Holocene deposits (Figure 12) that is consistent with the approximate offshore projection of the principal fault strand. The distributed zone of faulting, however, is much wider than the principal fault zone depicted at depth in the oil field (Figure 7), and as the EMA (2015) report points out, some of the interpreted offshore structures may be related to the presence of gas.

4.5 Observations Along the "South Branch" Fault

This section of the report describes additional observations that have been reported along the South Branch fault from Huntington Mesa to the Poseidon site.

Erickson (1976) trenched the inferred location of the South Branch fault on the southwest end of Huntington Beach Mesa based on subsurface oil-well data, located directly south of the Poland and Piper (1956) fault location, and did not find evidence of shallow faulting. Woodward-Clyde Consultants (WCC, 1984) inspected a gully for evidence of recent faulting along the inferred fault of Poland and Piper (1956) and excavated a trench across the trace. They observed no evidence of faulting in late Pleistocene deposits and WCC (1984) concluded that shallow surface faulting in Pleistocene and Holocene deposits has not occurred along the South Branch fault (Bryant, 1985).

A gully that coincides with the South Branch fault on the southwest side of the Huntington Beach Mesa was inspected for the presence of faulting. According to his personal correspondence with Bryant (1985), R. Miller did not observe evidence of significant faulting, but did observe a minor fault with a few centimeters of displacement in late Pleistocene deposits. Miller concluded that oil-well and near-surface hydrologic data do not support a significant fault, but that there may be a fault in the subsurface that could have caused warping in the mesa surface (Bryant, 1985).

Bryant observed a southwest-facing slope, a broad northwest-trending trough, and closed depressions at the mapped location of the South Branch fault on the Huntington Beach Mesa; however, he states that the closed depressions do not seem to be fault related (Bryant, 1985). He also concedes that the southwest-facing slope is gentle and may have formed from warping of the mesa surface or wave erosion. Bryant observed no other geomorphic evidence of recent faulting based on his air photo interpretation and he did not confirm the location of the South Branch fault in the Santa Ana Gap. As the fault is not well defined at the surface and there is insufficient evidence for activity, Bryant recommended that the South Branch fault not be included in an Alquist-Priolo Earthquake Fault Zone (APEFZ).

Evidence of surface landforms purported by Poland and Piper (1956) is weakly supported by Bryant (1985), but these features may not be indicative of tectonic activity. Therefore, the strongest evidence for the South Branch fault appears to be from groundwater data in exploratory wells that identified displaced units (aquifers) of Pleistocene age (DWR, 1966). The location of the South Branch fault in the Santa Ana Gap, which was interpreted as existing between two wells (Figure 8), has a considerable margin of uncertainty.

Although specific studies at the Poseidon site (GeoLogic, 2002; Ninyo & Moore, 2011; Geosyntec Consultants, Inc., 2013) have consistently found an "absence of evidence" for Holocene faulting, the methods employed do not preclude Holocene activity. These methods (CPT soundings and borehole transects) and spacing of explorations are insufficient to resolve minor vertical displacement and larger horizontal displacement in the subsurface. Considering the thick (~80 ft) Holocene section and shallow groundwater, trenching of the fault to the base of the Holocene section is impractical. Hence, the recency of activity on the South Branch of the NIFZ remains undetermined as there have been no studies that have explored the entire Holocene section across the "South Branch" of the fault zone. While it is permissible that the secondary South Branch fault could be active, there is currently no data or direct observations to support this.

5.0 CONCLUSIONS

Based on our review of available information, we can make the following conclusions regarding faults within the Santa Ana Gap and the South Branch fault, which has been mapped at the Poseidon site:

- The South Branch fault at the site is not the principal fault of the NIFZ. The principal active fault is located about 0.6 km east of the site and projects offshore near the mouth of the Santa Ana River. Future NIFZ earthquake ruptures will produce the largest displacements along the principal active main fault zone highlighted yellow in Figure 6.
- Various reports and studies have used the names "South Branch" and "North Branch" to refer to different faults along strike of the NIFZ. North and northwest of the site, the North Branch fault represents the active principal fault within the NIFZ, but this fault is likely not the same "North Branch" fault mapped in the Newport Mesa to the southeast. Likewise, the principal fault, which is located 0.6 km east of the site and crosses the shoreline near the mouth of the Santa Ana River, has been given the "South Branch" name in previous publications. This fault is not the same structure as the secondary South Branch fault mapped at the Poseidon site.
- The South Branch fault does not appear to correlate with any continuous faults mapped at depth from oil field data (Figure 6). This suggests this fault is mapped largely based on apparent offsets in the shallow aquifers and has not produced significant cumulative

displacement that would be more readily recognized in deeper Miocene strata mapped within the Huntington Beach oil field.

- Local geotechnical data do not help constrain accurate locations or ages of faults within the Santa Ana Gap. This is largely because no large cumulative displacements will likely be observed within Holocene and latest Pleistocene deposits in boreholes (to the maximum depth of geotechnical exploration at the site of 98 ft). In addition, shallow groundwater depths prevent trenching, which is the best approach for obtaining continuous exposures for evaluating faults.

- Data do not exist to adequately assess whether or not the “South Branch” fault at the site has ruptured in the Holocene (past 11,700 yrs) and would be considered an active fault by the California Geological Survey (CGS). This fault strand, which continues northwest into the Pleistocene deposits of the Huntington Beach Mesa, has not met the criteria of “sufficiently active and well defined” to be included in an Alquist-Priolo Earthquake Fault Zone (APEFZ) by the CGS.

- Past studies at the Poseidon site by GeoLogic (2002), Ninyo & Moore (2011), and Geosyntec Consultants, Inc. (2013) have consistently concluded an “absence of evidence” for the presence of Holocene faulting on site. However, the subsurface exploration methods and spacing of CPT and borehole explorations employed cannot preclude the presence of minor secondary Holocene activity.

- A wide zone of Holocene faulting was interpreted spanning nearly the entire length of a nearly 3-mi-long seismic reflection survey profile (EMA, 2015) located parallel to the shoreline (Figures 6 and 12). Given that the strike of faults interpreted in HBP-2101 are unknown, we cannot determine if any of these strands may project onshore near the Poseidon site.

- This desktop analysis of available scientific studies on the NIFZ indicates that although there is no information that directly implicates the “South Branch” as being active, there are no data that demonstrably preclude Holocene activity. Additional subsurface investigations could be performed to evaluate for the presence or absence of Holocene-active faults. However, thick Holocene deposits in the Santa Ana Gap could make such an evaluation difficult.

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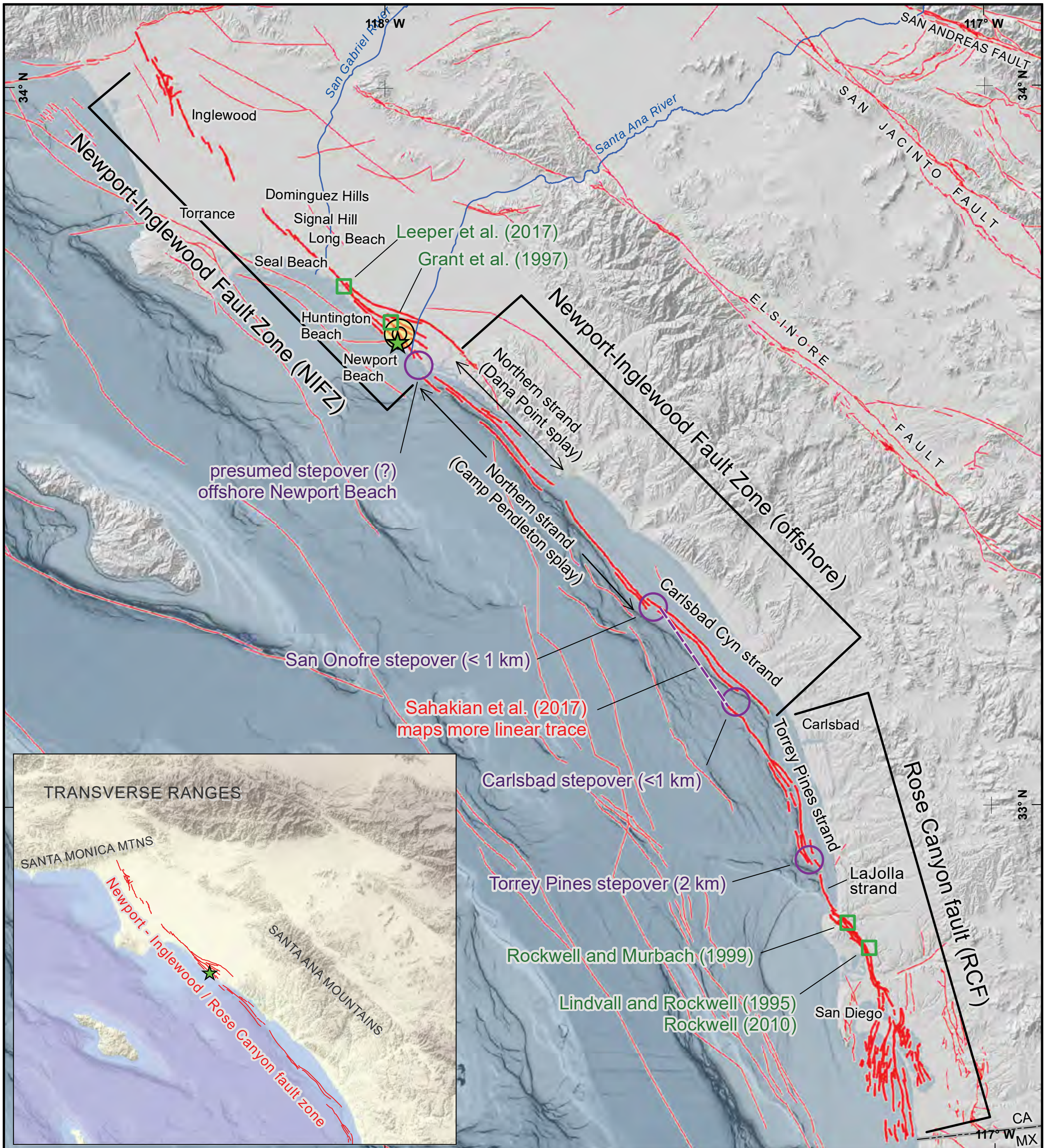


EXPLANATION

- project site
- Paleoseismic study location
- 1933 Long Beach earthquake epicenter

Faults (USGS and CGS, 2018)

- Newport-Inglewood/Rose Canyon (NIRC) fault zone
- Quaternary Fault

0 15 30 mi

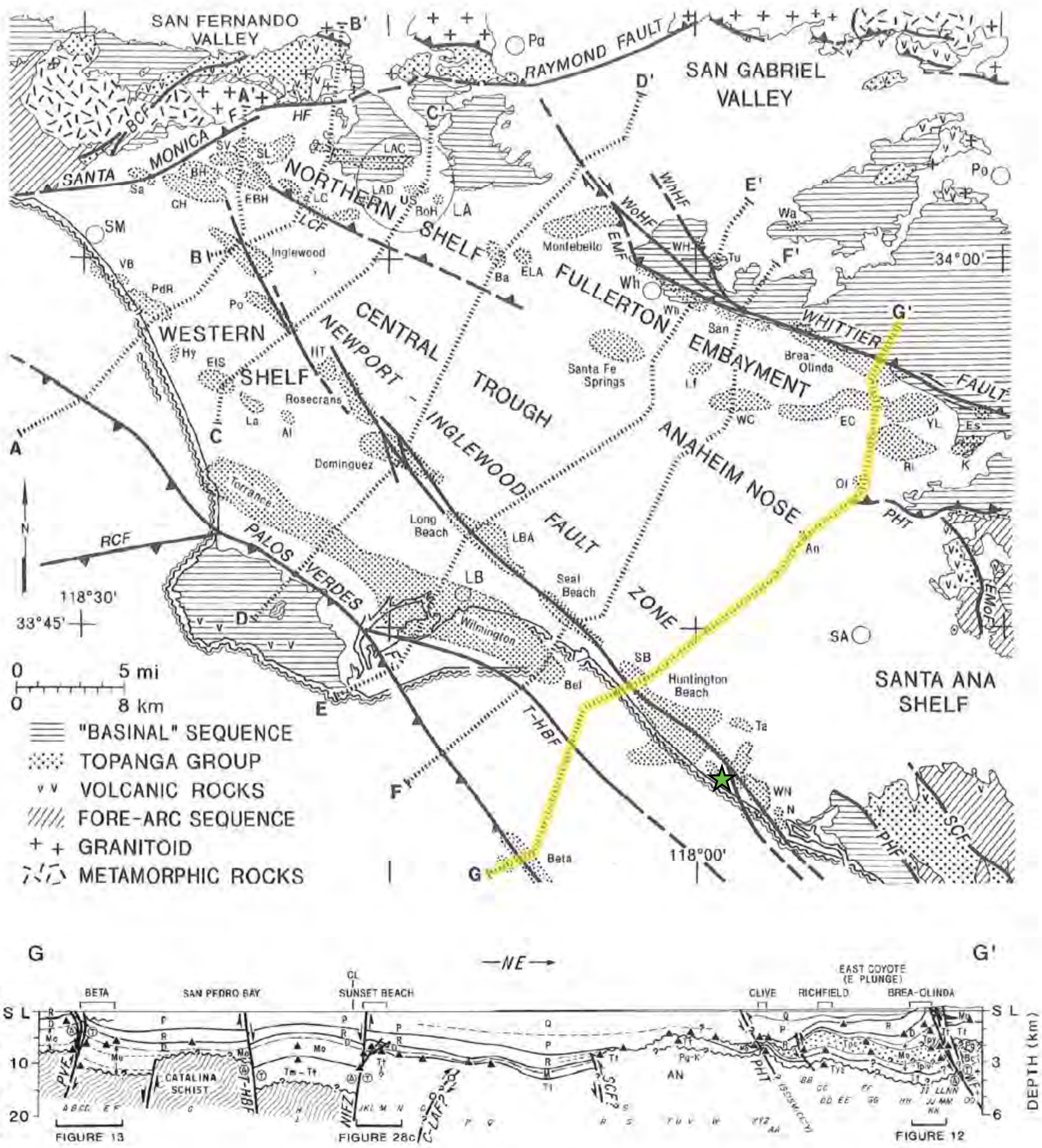
0 25 50 km

Map projection and scale: NAD83 StatePlane Zone 5 feet, 1:900,000

Map of Newport-Inglewood/Rose Canyon (NIRC) fault zone

OCCK ASSESS SOUTH BRANCH NIFZ

Lettis Consultants International, Inc. | Figure **1**



EXPLANATION

★ project site

Key abbreviations of oil fields along NIFZ

BH	Beverly Hills	Po	Potrero
CH	Cheviot Hills	SB	Sunset Beach
EBH	East Beverly Hills	SL	Salt Lake
HT	Howard Townsite	SV	San Vicente
LBA	Long Beach Airport		

0 5 10 mi

0 5 10 km

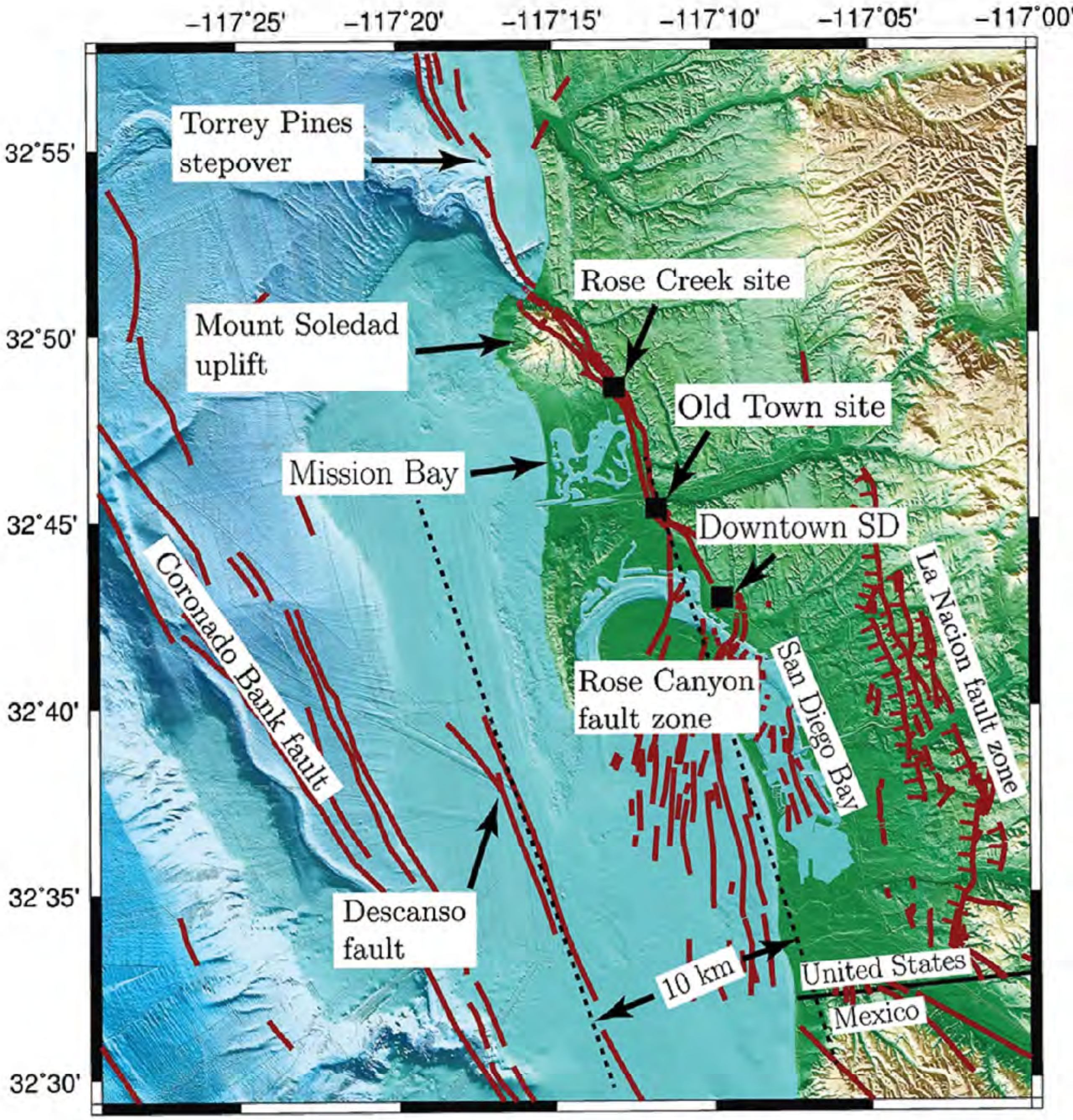
Map projection and scale: NAD83 StatePlane Zone 5 feet, 1:472,000

Major Structural Features and Oil Fields in the greater LA Basin from Wright (1991)

OCCK ASSESS SOUTH BRANCH NIFZ

Lettis Consultants International, Inc. | Figure **2**

File path: I:\Projects\1966.000 OCCK Assess South Branch NIFZ\0700 GIS\2 - Wright (1991) G.mxd; Date: 04/28/2020; User: hemphill, LCI; Rev.1



source: Singleton et al. (2019)

EXPLANATION

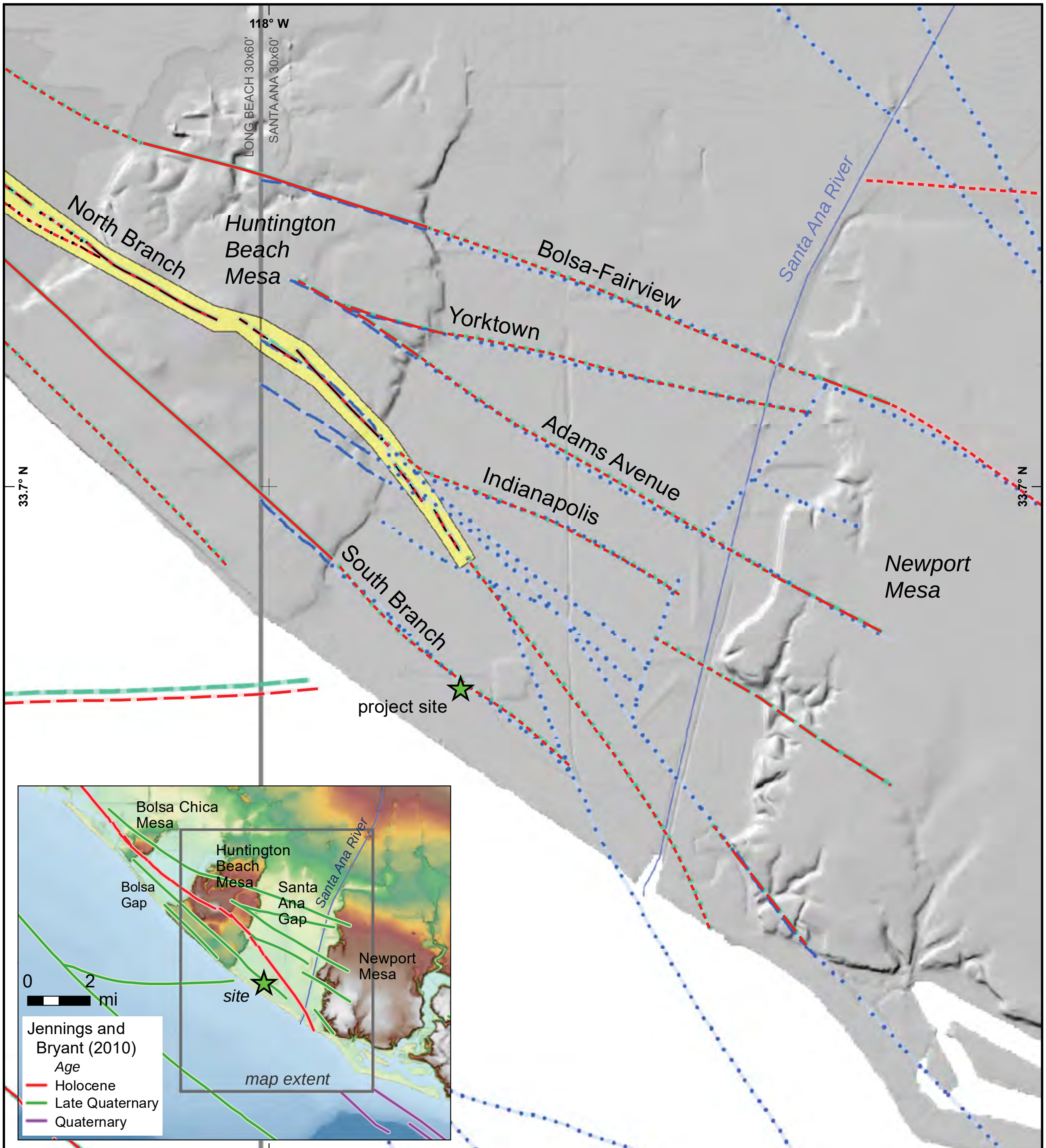
■ Paleoseismic study location

Map projection and scale: NAD83 StatePlane Zone 5 feet, 1:315,000

Rose Canyon Fault Zone (RCFZ) through San Diego

OCCK ASSESS SOUTH BRANCH NIFZ

Lettis Consultants International, Inc. | Figure **3**



EXPLANATION

Alquist-Priolo Fault Trace and Zone (CGS, 1986a, 1986b)
long dash where approximately located, short dash where location inferred, dotted where concealed

Morton (2004), Santa Ana 30x60'
dashed where approximately located, dotted where concealed

Jennings and Bryant (2010)
solid where certain, dashed where approximately located, dotted where concealed

Quaternary Fault and Fold Database (USGS and CGS, 2018)
solid where certain, long dash where approximately located, short dash where inferred or concealed

N W E S

0 1 2 mi
0 1.5 3 km

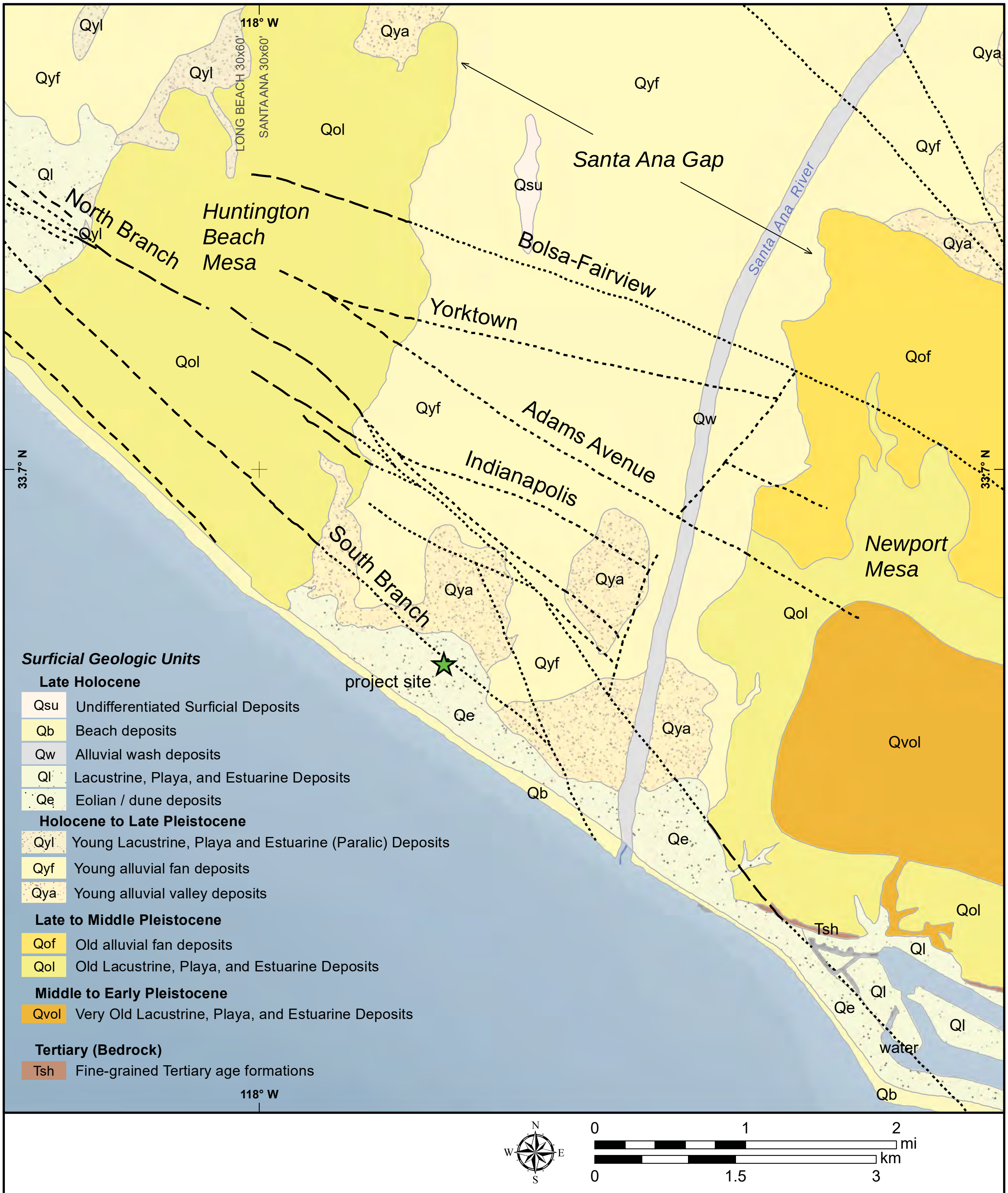
Map projection and scale: NAD83 StatePlane Zone 5 feet, 1:60,000

Santa Ana Gap Faults

OCCK ASSESS SOUTH BRANCH NIFZ

LCI Lettis Consultants International, Inc. | Figure **4**

File path: I:\Projects\1966.000 OCCK Assess South Branch NIFZ\0700 GIS\4 - Santa Ana Gap faults.mxd; Date: 05/04/2020; User: hemphill, LCI; Rev.1



Map projection and scale: NAD83 StatePlane Zone 5 feet, 1:60,000

Note: geologic mapping from Bedrossian et al. (2012)

Surficial Geologic Map

OCCK ASSESS SOUTH BRANCH NIFZ

Lettis Consultants International, Inc. | Figure **5**

— deep structure fault (Huntington Beach and West Newport Oil Field)
— surface fault trace (USGS Quaternary Fault and Fold Database, 2018)
— main fault trace shown at depth of contoured horizons

West Newport Oil Field
- cross-section A - A'
- structure contour
- structure contour (Offshore)

Huntington Beach Oil Field
- cross-section A-B
- structure contour

0 0.5 1 mi
0 0.5 1 km

Map projection and scale:
NAD 1983 StatePlane California V FIPS 0405 Feet, 1:125,000

note: profile A-A' shown on Figure 7

base image: NAIP 2016

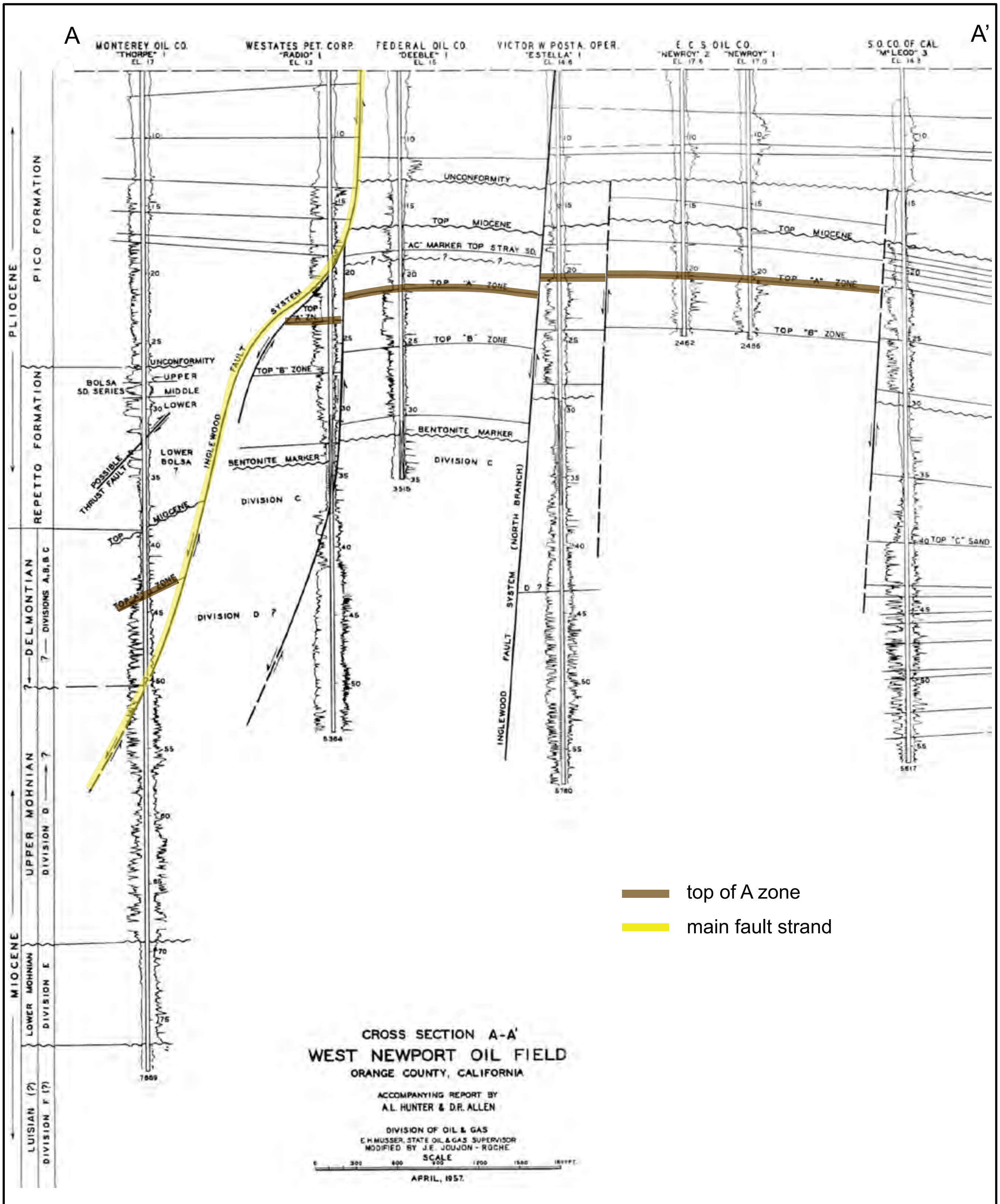
Deep Structures of the Huntington Beach and West Newport Oil Fields

OCCK ASSESS SOUTH BRANCH NIFZ

Lettis Consultants International, Inc.

Figure 6

File path: I:\Projects\1966.000 OCCK Assess South Branch NIFZ\0700 GIS\6 - Deep Structures_11x17P.mxd; Date: 05/04/2020; User: hemphill, LCI; Rev.1

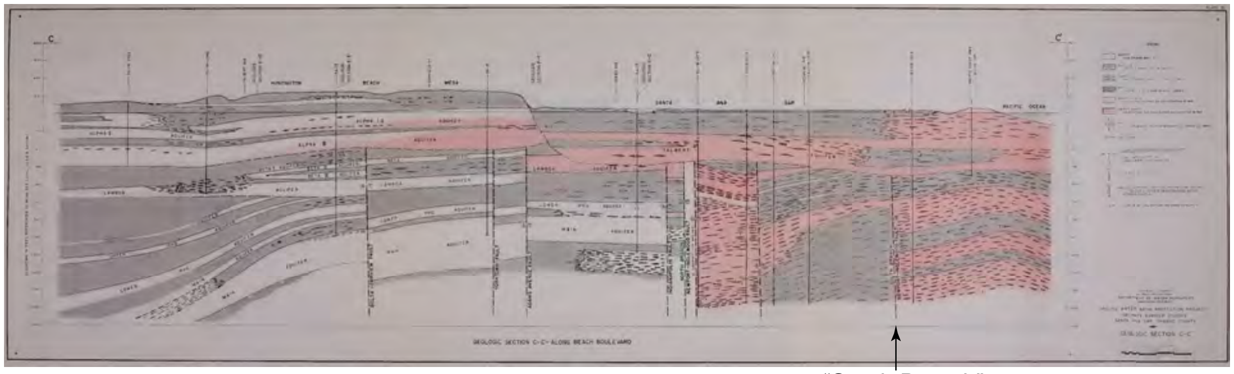


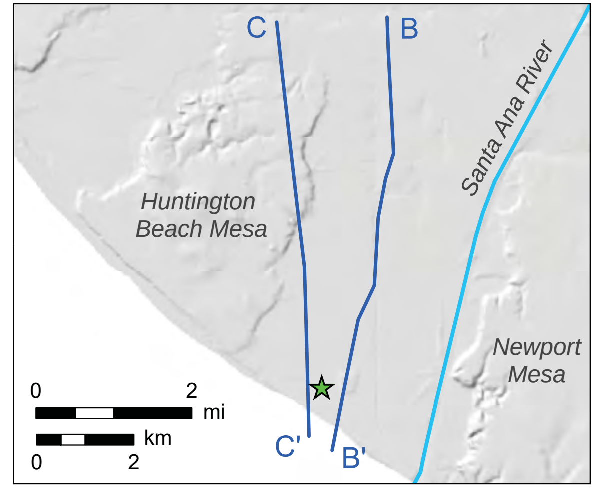
Notes:
1. location shown on Figure 6
2. modified from cross-section A-A' of Hunter and Allen (1956)

West Newport Oil Field
Cross-Section A-A’

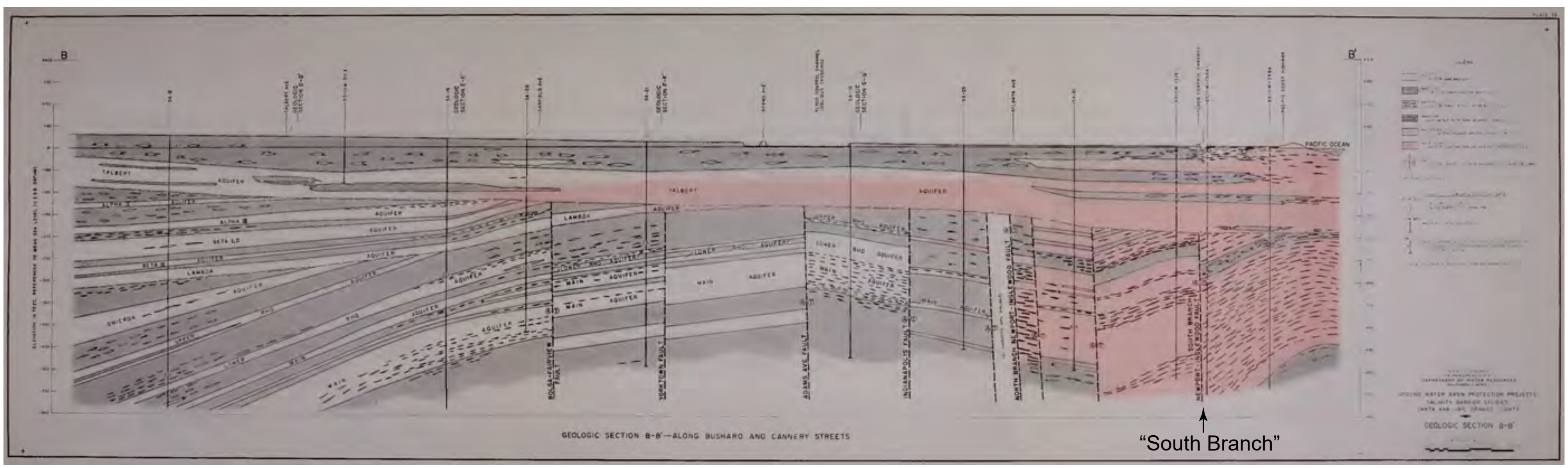
OCCK ASSESS SOUTH BRANCH NIFZ

Lettis Consultants International, Inc. | Figure 7





DWR (1966)



DWR (1966) Geologic Cross-Sections

OCCK ASSESS SOUTH BRANCH NIFZ

LCI Lettis Consultants International, Inc. | Figure **8**

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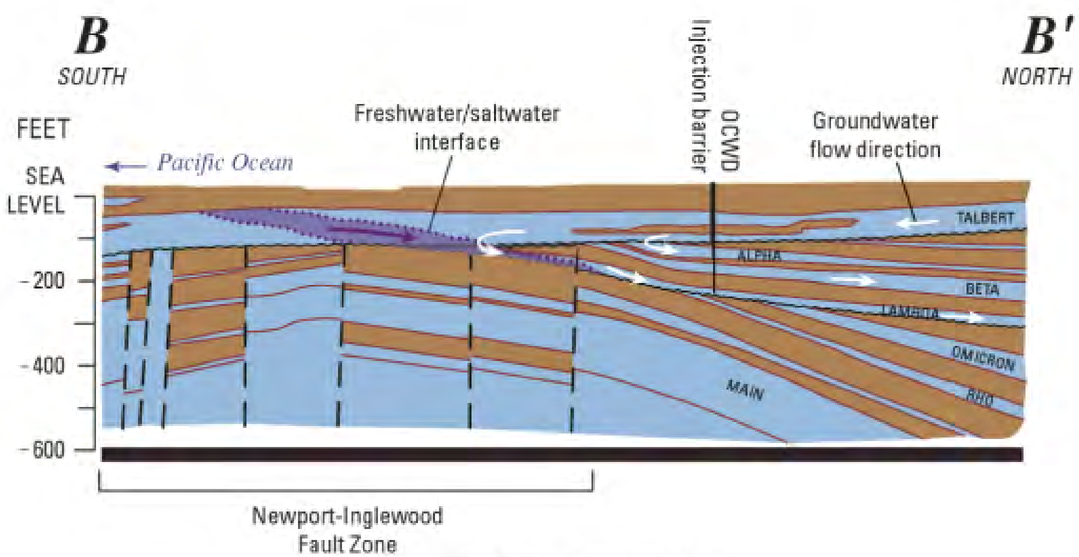
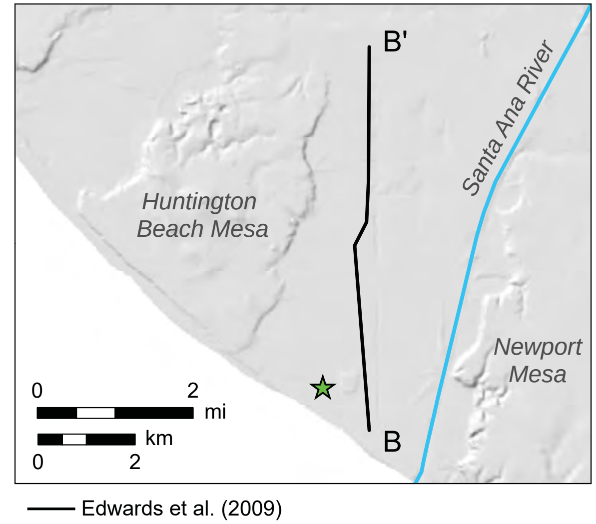


Talbert Barrier (*B-B'*)

Geologic age	**Aquifer system**
Holocene	Talbert
Pleistocene	"Alpha" "Beta" "Lambda" "Omicron" "Rho" "Main"



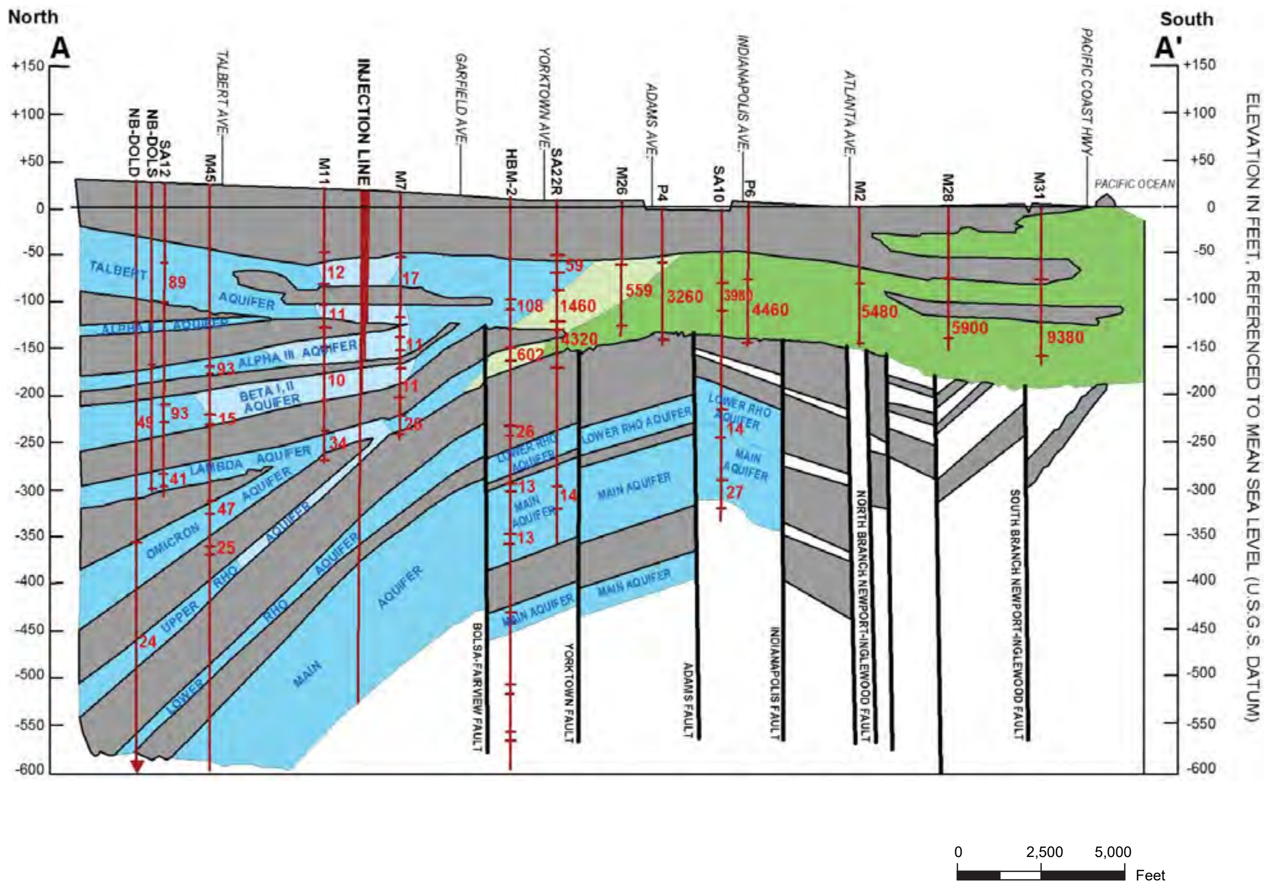
Note: Generalized north-south cross section through the Talbert Gap area. Sources: Callison (1992), Herndon (1992), and Orange County Water District (OCWD, 2004).

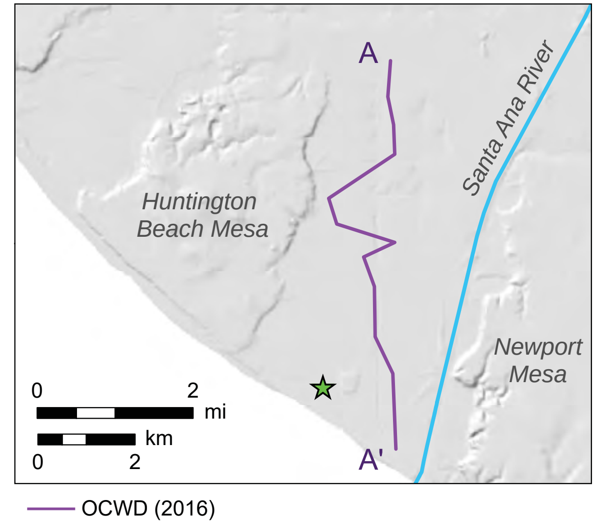
Edwards et al. (2009)
Generalized Cross-Section

OCCK ASSESSMENT SOUTH BRANCH NIFZ

Lettis Consultants International, Inc. | Figure 9

File path: I:\Projects\1966.000 OCCK Assess South Branch NIFZ\0700 GIS\9 - Edwards et al. (2009).ai.pdf Date: 4/28//2020; User: Blanton, LCI; Rev. 0





Note: Adapted from California Department of Water Resources Bulletin No. 147-1. “Santa Ana Gap Salinity Barrier, Orange County”, December 1966, Plate 5B.

OCWD (2016)
Generalized Cross-Section

OCCK ASSESS SOUTH BRANCH NIFZ

Lettis Consultants International, Inc. | Figure **10**

File path: I:\Projects\1966.000 OCCK Assess South Branch NIFZ\0700 GIS\10 - OCWD (2016).ai.pdf Date: 4/28/2020; User: Blanton, LCI; Rev. 0

Quaternary fault trace (location inferred) USGS and CGS (2018)
fault trace (location inferred) Morton (2004)
Project Site

GLA 2002 borehole
GLA 2002 CPT
Ninyo & Moore 2011 borehole
Ninyo & Moore 2011 CPT
Geosyntec 2013 CPT
DOGGR oil & gas well

0 250 500 ft
0 75 150 m

Map projection and scale:
NAD83 StatePlane Zone 5 feet, 1:4,600

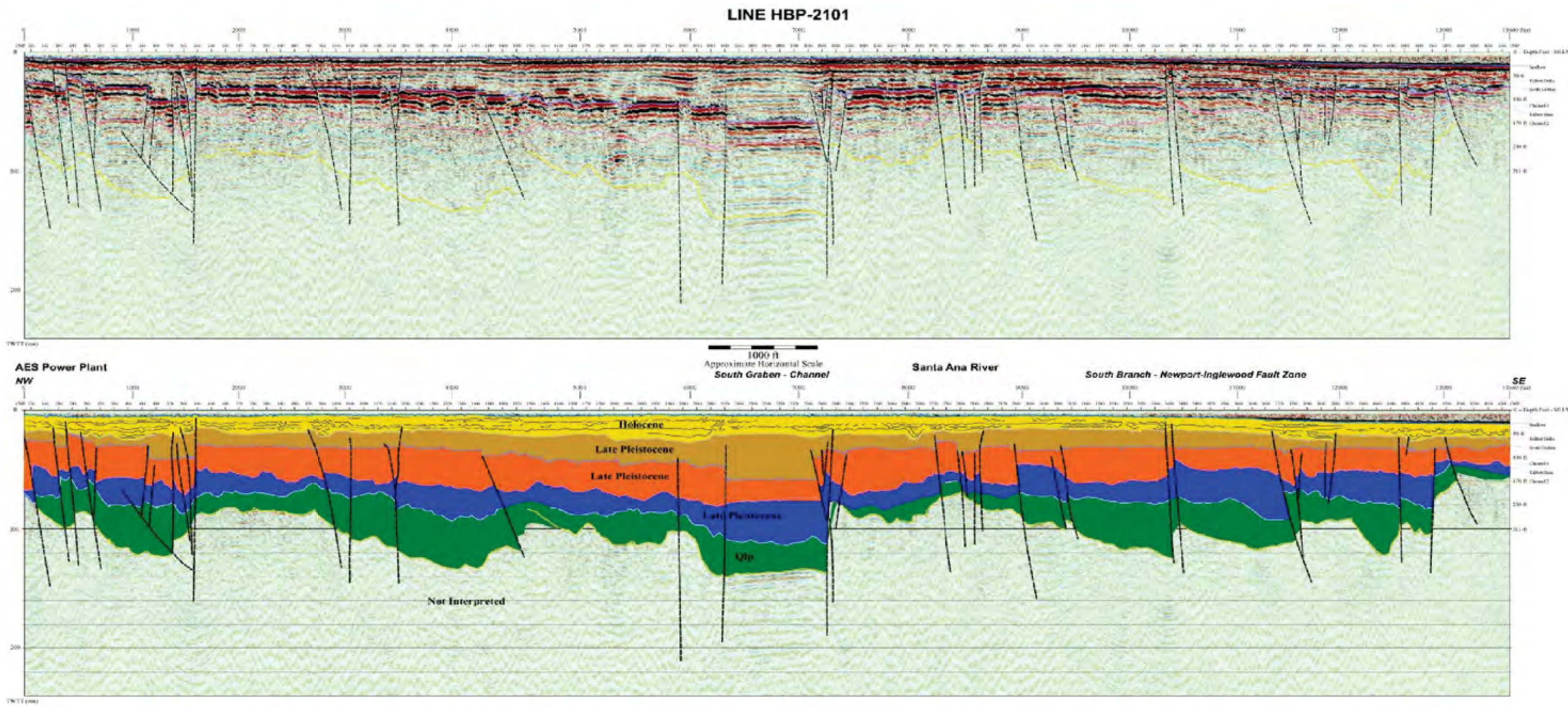
base image: Google Earth 4-2-2018

Previous Subsurface Investigations

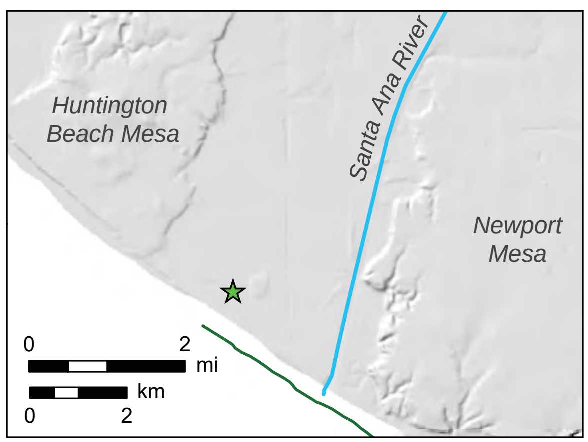
OCCK ASSESS SOUTH BRANCH NIFZ

Lettis Consultants International, Inc. | Figure **11**

File path: I:\Projects\1966.000 OCCK Assess South Branch NIFZ\0700 GIS\9 - Previous Explorations.mxd; Date: 04/23/2020; User: hemphill, LCI; Rev.1



Yellow	Holocene - Sand, silt, silty sand, some clay in interchannel areas, gravel in channels
Gold	Late Pleistocene - Layered sand, silt, silty sand, some clay in interchannel areas, gravel in channels (Talbert Delta)
Orange	Late Pleistocene - Talbert gravels, highly reflective seismic sequence with obscure reflectors below (South Graben)
Blue	Late Pleistocene - Layered sand, silt, silty sand, some clay in interchannel areas, gravel lag deposit at base (Channel1)
Green	Late Pleistocene - Layered sand, silt, silty sand, some clay in interchannel areas, gravel lag deposit at base (Channel2)



EMA (2015)

Seismic Profile HBP-2101 from EMA (2015)

OCCK ASSESS SOUTH BRANCH NIFZ

Lettis Consultants International, Inc.

Figure **12**

January 21, 2022

Tom Luster, Senior Environmental Scientist
California Coastal Commission
455 Market Street, Suite 300
San Francisco, CA 94105

Sent via email: Tom.Luster@coastal.ca.gov

Re: Expert Reports– Energy Use and Emissions at the Poseidon – Huntington Beach Desalination Plant

Dear Mr. Luster,

On behalf of the environmental coalition, we appreciate your consideration of the attached expert reports and the State Lands Commission (SLC) 2017 hearing transcript and their inclusion into the administrative record. Poseidon has submitted application materials asserting that energy use and emissions from the Poseidon plant are negligible and will be fully mitigated. The expert reports enclosed within are evidence to be considered as part of the administrative record and demonstrate that Poseidon will use a large amount of energy and that their proposed greenhouse gas mitigation plan is grossly inadequate.

The enclosed expert reports offer a third-party independent analysis of the legal, economic, and technical accuracy of Poseidon's application materials.

- **Bill Powers: Assessment of Energy Intensity and Greenhouse Emissions of Proposed Poseidon Huntington Beach Desalination Plant – 2022 Update Report.** This report is a major update to the 2016 analysis and reviews: 1) the energy intensity and greenhouse gas (GHG) emissions associated with the grid power demand of the proposed Poseidon Huntington Beach desalination plant and water supply alternatives, including the purification of recycled water and conservation, to assure local water reliability, 2) the electric "grid reliability" impacts of the desalination plant are assessed in the context of electricity supply limitations in the Los Angeles Basin, and, 3) the effectiveness of Poseidon's proposed 'carbon neutral' strategy. Finally, recommendations are provided for an alternative mitigation approach that would rely on local solar power and battery storage to fully address the local grid reliability and GHG impacts of the desalination plant.

  Major findings of this report are:

  - Water demand in Orange County Water District service territory has declined 20 percent, about 100,000 acre-feet per year, since 1998 when Poseidon first proposed a desalination plant for Huntington Beach and 2020. This is about two times the 56,000 acre-feet per year potable water production of the proposed desalination plant.

  - OCWD's production of purified recycled water to recharge the groundwater basin, via the Groundwater Replenishment System indirect potable reuse project, has increased from zero in 1998 to 112,000 acre feet per year (100 million gallons per day) in 2015.

  - OCWD anticipates expanding production of purified recycle water to 145,000 acre-feet per year (130 million gallons per day) in 2023.

  - The energy intensity of ocean water desalination is more than four times greater than that of purified recycled water.

- As a result, the carbon footprint of ocean water desalination is more than four times greater than that of purified recycled water.

- The proposed desalination plant will emit about 68,745 metric tons per year (75,620 tons per year) of carbon dioxide in the first year of operation.

- The approach Poseidon has proposed to achieve carbon neutrality, the purchase of offset credits, will not address the local grid reliability impacts of adding the continuous 30.34 MW of load of the desalination plant in the Los Angeles Basin.

- The cost of carbon credits is likely to be substantially higher than the $10 metric ton price that is assumed by Poseidon as an economically reasonable offset cost ceiling. By way of comparison, the California Air Resources Board cap-and-trade allowance cost ceiling for 2022 is $72.29 per metric ton.

- Battery storage is now a primary grid reliability resource in California. Southern California Edison, the utility serving Huntington Beach, projects that it will have at least 2,800 MW of battery storage under contract by 2023.

- 30 MW of battery storage should be developed by Poseidon in Huntington Beach to offset the grid reliability impacts of the desalination plant.

- 150 MW of local solar power should be developed by Poseidon in Huntington Beach on commercial and industrial rooftops and parking lots to fully mitigate the carbon footprint of desalination plant operations.

- The annualized cost of 30 MW of battery storage and 150 MW of rooftop and parking lot solar in Huntington Beach will be less than 3 percent of Poseidon's projected gross annual income of about $160 million per year.

➢ **The Future of California's Water-Energy- Climate Nexus by the Pacific Institute.** In this analysis, the report authors evaluated the combined impact of emerging trends on California's water (including population growth, climate change, and policies to promote water efficiency and alternative water supplies) and electricity (including generation decarbonization) on the state's water-related energy and GHG footprints from 2015 to 2035. The latest available (2015) water demand and supply data from water suppliers and state water agencies were used to develop various scenarios of future water resources and to estimate associated energy and GHG emissions out to 2035. This updated Pacific Institute report shows that long term demand reduction, decoupled from population growth, has positive impacts on GHG emissions - the opposite of the proposed ocean desalination project.

➢ **State Lands Commission Transcript References on GHG Plan.** In October 2017, the State Lands Commission heard the Poseidon Huntington Beach Project as part of their lease amendment. Included in that hearing was a discussion of the Poseidon Desalination Plant GHG Minimization Plan. During that hearing, Controller Yee, supported by then Lt. Governor Gavin Newson, expressed both concerns with the GHG plan and her insistence that it be truly carbon neutral. As the Commissioners and staff worked to craft a motion, Yee pointed out that she was concerned that by the time the plant was built that it would be out of date with the State's Climate goals. Given this, she pointed to ongoing discussions between Edison, Poseidon and others, called on Poseidon to go further by developing either a new technology or other tools to help them meet their obligation to be 100 percent GHG emission free and indicated that she was waiting for an update on that progression. Controller Yee stated that she believed there were additional options out there to strengthen the plan and that she wanted to see "movement" from Poseidon in this arena. She was very clear that she did not want Poseidon to just write a check to fulfill their obligations. (The full discussion on the GHG plan can be found starting on page 316 line 15 of the Transcript.)

It has been over four years since the SLC hearing and the only thing that has changed in Poseidon's GHG plan is the title which Poseidon is now calling the Climate Change Action Plan. Instead of revising the plan as Yee instructed, Poseidon submitted the same plan to the Santa Ana Regional Water Quality Control Board in 2019 and to the Coastal Commission in July of 2021. As demonstrated by the expert reports above, this plan is outdated and insufficient to meet California's climate goals and must be revised and strengthened.

We respectfully request these expert reports and the State Lands Commission 2017 Hearing Transcript be considered by the Coastal Commission as part of the administrative record. These submitted reports show both the lack of need for the project as well as the real and local GHG mitigation that would have to be required to make the project truly carbon neutral.

Sincerely,

Raymond Hiemstra
Associate Director of Programs
Orange County Coastkeeper

Assessment of Energy Intensity and Greenhouse Emissions of Proposed Poseidon Huntington Beach Desalination Plant and Water Supply Alternatives

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Table of Contents

1.0 Executive Summary

This report reviews the energy intensity and greenhouse gas emissions associated with the grid power demand of the proposed Poseidon Huntington Beach desalination plant and alternatives, including the purification of recycled water and conservation, to assure local water reliability. The electric “grid reliability” impacts of the desalination plant are assessed in the context of electricity supply limitations of the Los Angeles Basin. Finally, the effectiveness of Poseidon’s proposed carbon neutral strategy is examined. Recommendations are provided for alternative approaches that would fully address the local grid reliability impacts of the desalination plant while concurrently offsetting all carbon emissions associated with the grid power used to operate the plant. Major findings of this report are:

- Water demand in Orange County Water District service territory has declined 30 percent, about 150,000 acre-feet per year since Poseidon first proposed a desalination plant for Huntington Beach in 1999. This is about three times the 56,000 acre-feet per year potable water production of the proposed desalination plant.
- OCWD’s production of purified recycled water to recharge the groundwater basin, via the Groundwater Replenishment System indirect potable reuse project, has increased from zero in 1999 to 103,000 acre feet per year in 2015.
- OCWD anticipates expanding production of purified recycle water to 128,000 acre-feet per year in 2022.
- The energy intensity of ocean water desalination is more than four times greater than that of purified recycled water.
- As a result, the carbon footprint of ocean water desalination is more than four times greater than that of purified recycled water.
- The proposed desalination plant will emit about 96,000 tons per year of carbon dioxide in the first year of operation.
- The approach Poseidon has proposed to achieve carbon neutrality, the purchase of offset credits, will not address the local grid reliability impacts of adding the 30.34 MW of load in the LA Basin.
- The cost of carbon credits is likely to be substantially higher than the $10 metric ton assumed as an economically reasonable offset cost ceiling by Poseidon.
- SCE is under regulatory mandate to have at least another 300 MW of energy storage under contract by 2020.
- At least 30 MW of battery storage at the Huntington Beach Generating Station site is necessary to offset the grid reliability impacts of the desalination plant.
- The contract price of power purchase agreements for solar projects in California has dropped well below the utility wholesale power cost.
- Local solar power should be developed by Poseidon in sufficient quantity to fully offset the carbon footprint of desalination plant operations and support local grid reliability.

2.0 Introduction

Orange County Coastkeeper contracted Powers Engineering to provide a technical assessment of the energy intensity, in terms of kilowatt-hours per acre-foot of water (kWh/AF), and associated greenhouse gas (GHG) emissions with a range of actual and potential water supply options for Orange County. These water supply options evaluated include:

- Conservation
- Potable reuse
- Desalination
- Colorado River water transfers
- State Water Project water transfers

State Water Project and Colorado River Aqueduct water imports are used as the baseline for comparison purposes in this analysis. The overwhelming majority of the potable water utilized in Orange County Water District (OCWD) service territory is supplied from groundwater sources, replenished through natural processes and purified recycled water, with most of the remainder consisting of imported water provided by the Metropolitan Water District. In contrast, the majority of potable water consumed in Southern California as a whole is imported water. For this reason, the energy intensity and carbon dioxide (CO_2) emissions associated with water imports are used as baseline values in this report.[1]

3.0 Description of Proposed Desalination Project

Poseidon proposes to build and operate a 50 million gallons per day (mgd) desalination plant on the property of the Huntington Beach Generating Station (HBGS) in Huntington Beach, California. There are two operational steam boilers on the property, Units 1 and 2, with a combined capacity of 430 MW. Units 1 and 2 use seawater in a once-through cooling (OTC) configuration for power plant cooling. These units are currently operated infrequently and are currently scheduled to comply with the state's once-through cooling phase-out policy by December 2020.[2] If a replacement power project is built at the site it will not utilize an OTC cooling system.[3,4]

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[1] Greenhouse gases, carbon emissions, and CO_2 are used as interchangeable synonyms in this report.

[2] California Energy Commission , *Tracking Progress: Once-Through Cooling Phase-Out*, February 9, 2016, Table 1, p. 3. 2015 capacity factors of Huntington Beach Units 1 and 2 (through September 2015): Unit 1 = 20.7%; Unit 2 = 17.7%.

[3] SCE Application A.14-11-012, *Southern California Edison Company's (U 338-E) Application for Approval of the Results of Its 2013 Local Capacity Requirements Request For Offers for the Western Los Angeles Basin*, November 21, 2014. A 644 MW air-cooled combined cycle project is proposed for the Huntington Beach Generating Station site, with an online date of 2020. The project application was approved by the CPUC in November 2015. The approval is the subject of a legal appeal and the CPUC approval is not yet definitive as of September 26, 2016.

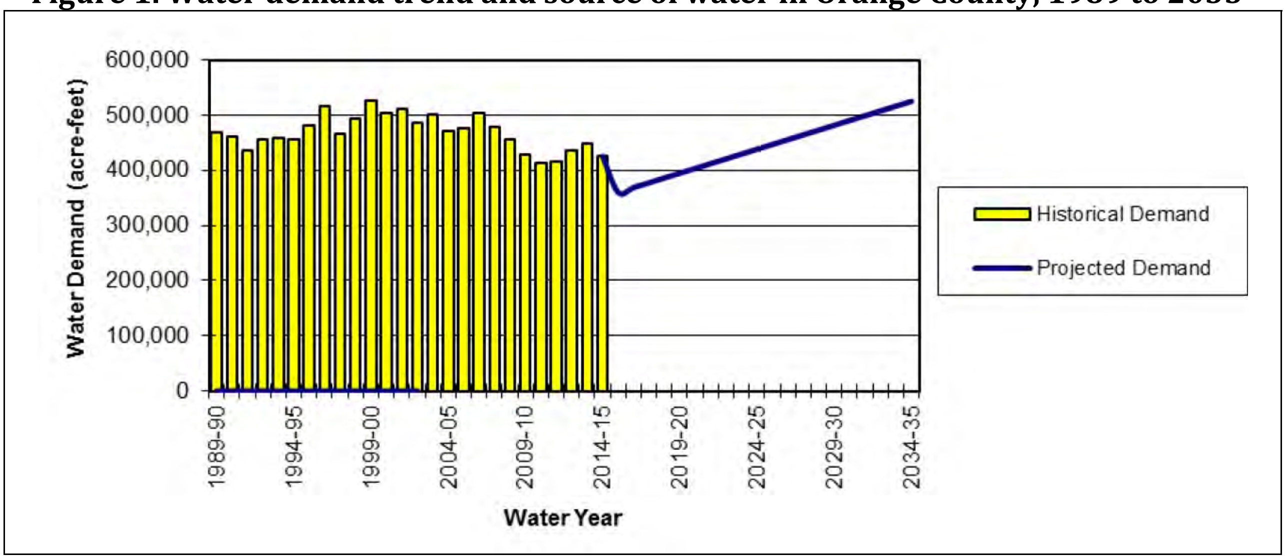
[4] The CEC Application for Certification (AFC) for the Huntington Beach Energy Project describes a 939 MW project, not the 644 MW project approved by the CPUC: http://www.energy.ca.gov/sitingcases/huntington_beach_energy/index.html.

Poseidon has pursued the development of the HBGS site as a seawater desalination facility since 1999. The City of Huntington Beach prepared and circulated the initial Final Environmental Impact Report (FEIR) for the project in 2002. The City Council certified the Recirculated EIR (2005 REIR) in September 2005. The City of Huntington Beach approved the project's conditional use permit and coastal development permit in February 2006. Changes in operational assumptions primarily related to seawater intake occurred after the certification of the REIR. As a result, in May 2010, a Subsequent EIR was prepared to address seawater intake effects based on a "standalone" condition, where the desalination facility would be responsible for direct intake of seawater.[5] Additional changes to the intake and discharge system are expected but have not yet been analyzed in an EIR or approved by the relevant regulatory agencies.

3.1 Orange County Water Demand Trends

Water demand in Orange County has declined about 150,000 acre-feet per year (AF-year), or about 30 percent, since Poseidon first proposed the project in 1999. See Figure 1. In addition, OCWD has added 103,000 AF-year of potable recycled water to its supply through the Groundwater Replenishment System (GWRS), which began operation in 2008 and was expanded in 2015.[6] The GWRS is expected to expand further to 128,000 AF-year of production by 2022,[7], allowing even greater reliance on groundwater to meet demand.

Figure 1. Water demand trend and source of water in Orange County, 1989 to 2035[8]



[5] City of Huntington Beach, *Draft Subsequent Environmental Impact Report –Desalination Project at Huntington Beach*, May 2010, p. 1-2 and p. 1-3.
[6] See OCWD Groundwater Replenishment System, frequently asked questions webpage, September 28, 2016: http://www.ocwd.com/gwrs/frequently-asked-questions/.
[7] Orange County Water District, *Orange County Water District Groundwater Replenishment System Final Expansion Project, Addendum No. 6: Final Program Environmental Impact Report/Environmental Impact Statement & CEQA-PLUS Federal Consultation Review*, August 2016, p. E-1, p. 2-11.
[8] OCWD, *2014-2015 Engineer's Report on the Groundwater Conditions, Water Supply and Basin Utilization in the Orange County Water District*, February 2016, Figure 5, p. 24.

Further, Los Angeles County and Metropolitan Water District are proposing a similar groundwater replenishment project that would deliver approximately 65,000 AF-year to replenish OCWD's groundwater supply by 2027.[9,10] The additional supply could either: 1) offset the need for the Poseidon desalination project, or 2) allow OCWD member agencies to forego fully treated imported water.

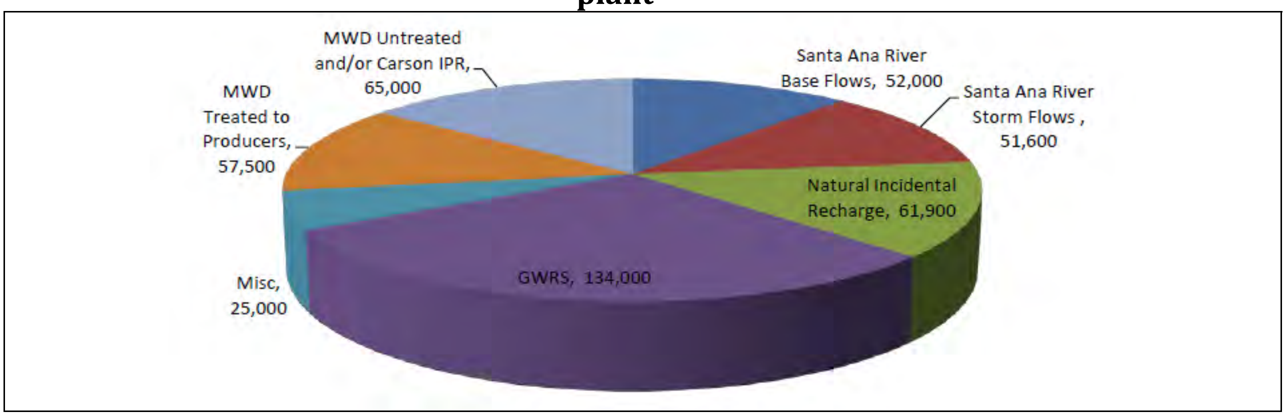
The source of the OCWD water supply is primarily groundwater supplemented with supply from Metropolitan Water District (MWD). The specific source and quantities of OCWD supply for the 2015-2016 fiscal year are shown in Table 1.

Table 1. Specific source and quantities of OCWD supply, 2015-2016[11]

2015-2016 supply source	Quantity (AF)
Groundwater, including potable reuse (GWRS supply)	281,750
Imported water - MWD	44,750
Santiago Creek native water	2,500
Recycled water, non-potable	21,000
Total:	350,000

OCWD is prepared to meet future water needs without the Huntington Beach desalination plant. Figure 2 is OCWD's water supply mix for meeting a projected 2040 demand of 447,000 AF-year without the desalination plant.

Figure 2. OCWD 2040 water supply mix without Huntington Beach desalination plant[12,13]



[9] OCWD Board of Directors Meeting, *Agenda Item - Metropolitan Water District Los Angeles County City of Carson Indirect Potable Reuse Project*, September 7, 2016, p. 1.
[10] OCWD Board of Directors Meeting, *Potential Regional Recycled Water Program* (PowerPoint presentation), September 7, 2016.
[11] Ibid, Table 5, p. 24.
[12] OCWD Board of Directors Meeting, *Agenda Item - Metropolitan Water District Los Angeles County City of Carson Indirect Potable Reuse Project*, September 7, 2016, p. 2. [graphic of water supply mix without Poseidon]
[13] Municipal Water District of Orange County, *Final Draft 2015 Urban Water Management Plan*, May 2016, p. 2-5. Planning horizon identified as 2040.

3.2 Proposed Desalination Plant

The proposed 50 Mgd seawater desalination project at HBGS would convert seawater drawn into the existing HBGS intake structure (with some modifications) into drinking water using a reverse osmosis (RO) desalination process. The desalination plant would draw approximately 100 Mgd from the intake structure and produce 50 Mgd of potable drinking water. The remaining 50 Mgd would be seawater with an elevated salt concentration, as the salts in the 50 Mgd of potable water would be concentrated in this 50 Mgd discharge stream. The 50 Mgd of concentrated discharge from the RO process would be discharged through the existing HBGS OTC discharge pipe.

The proposed desalination project would consist of a seawater intake system, pretreatment facilities, a seawater desalination facility utilizing reverse osmosis technology, post-treatment facilities, product water storage, on- and off-site landscaping, chemical storage, on- and off-site booster pump stations, and 42- to 48-inch diameter product water transmission pipelines up to 10 miles in length.[14] Figure 3 shows the location of the structures and parcels proposed for the 50 Mgd desalination plant at HBGS.

Recent proposed modifications to the HBGS cooling system to adapt it for use in the desalination process would include fine-mesh screens on the intake pipe and pressurized diffusers on the existing discharge pipe. These modifications have not been analyzed by Powers Engineering to determine the additional energy demand they represent.

The pre-treatment process requires energy to remove larger particles from the feedwater prior to the RO filtration system. Studies show that withdrawing seawater from sub-surface intakes can reduce or eliminate the need for pre-filtration, and consequently the energy demand and cost of constructing and maintaining the pre-filtration system. However, the current proposal does not call for the use of sub-surface intakes and this report does not analyze those energy savings.

The RO process would be a single-pass design using high rejection seawater membranes. The system would be made up of 13 process trains (12 operational and one standby). Each RO train would have a capacity of approximately 4 Mgd. High pressure electric feed pumps would convey water from the intake filters to the RO membranes. The pumps will provide feed pressures of 800 to 1,000 pounds per square inch. The actual feed water pressure depends on several factors including the temperature of the intake water, salinity of the intake water, and the age of the membranes.[15]

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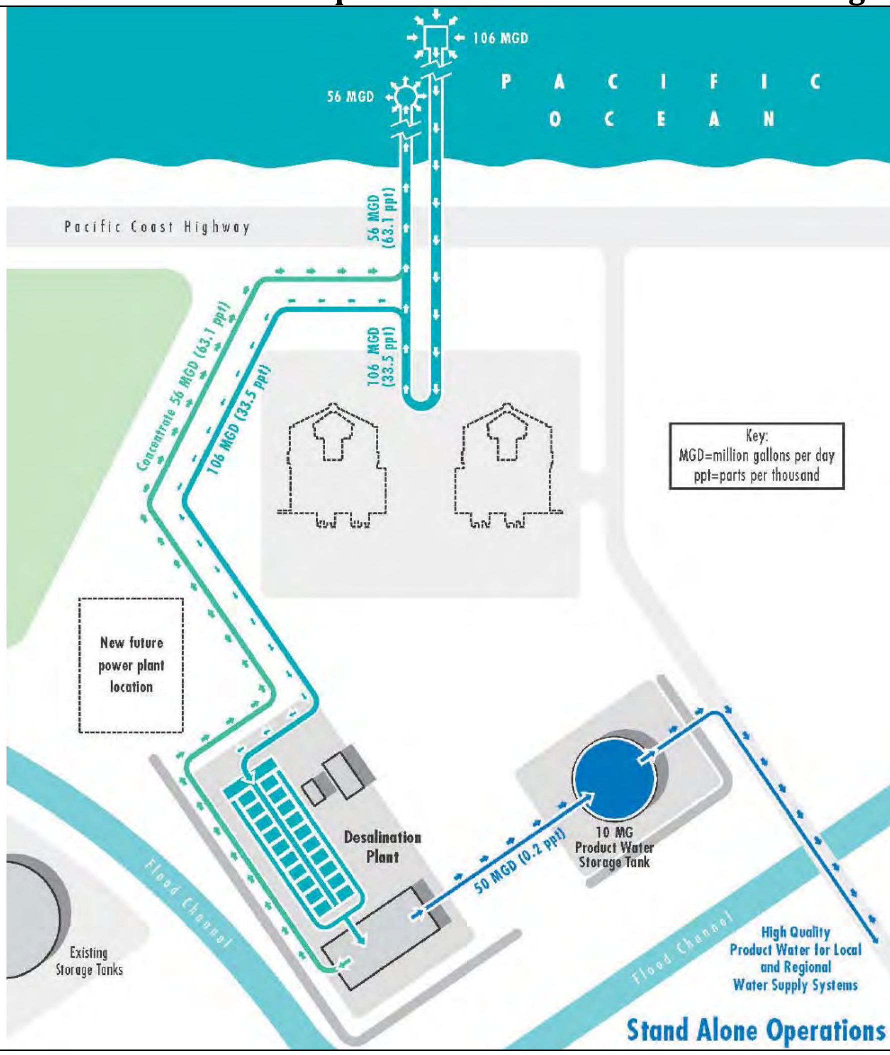
[14] City of Huntington Beach, *Draft Recirculated Environmental Impact Report –Desalination Project at Huntington Beach*, April 5, 2005, p. 3-2.

[15] Additional energy savings may result from the use of warmer water supplied from the HBGS OTC discharge. The desalination process was originally designed, in 2005, to operate at both ambient and elevated seawater temperature. Warmer water increases the efficiency of the RO membranes (Draft REIR, p. 3-25). However, the cooling water system, including use of the intake structure and the warm water discharge, will discontinue operation to meet new State requirements to minimize the intake and mortality of marine life.

Figure 3. Location of desalination plant and ocean intake and discharge structures[16]

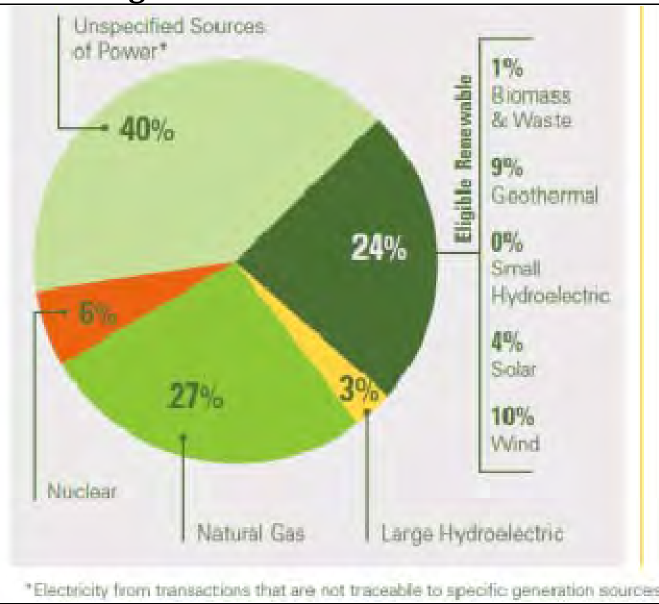


4.0 Greenhouse Gas Emission Rate of Purchased Utility Power

The Huntington Beach desalination project would purchase all of its electricity for the local investor-owned utility, Southern California Edison (SCE). The 2014 power mix of SCE, meaning the mix of power generation sources and the quantity of power generated by those sources is shown in Figure 4. An accurate accounting of the power mix allows precise calculation of the composite CO_2 emission rate of SCE grid power.

[16] Alden Research Laboratory, Inc., *Huntington Beach Desalination Plant Intake/Discharge Feasibility Assessment*, March 14, 2016, Figure 2, p. 15.

Figure 4. SCE 2014 Power Mix[17]



There are two sources of CO_2 emissions in the 2014 SCE power mix: 1) natural gas, 2) unspecified sources of power. Unspecified sources of power means wholesale power generated in the western U.S. The most recently available CEC analysis (2008) of unspecified sources of power indicates this power is 41.9 percent natural gas and 33.7 percent coal.[18] This analysis of the composition of unspecified sources of power remains reasonably accurate, as coal-fired power generation in the western U.S. declined less than 5 percent over the 2007-2015 time period.[19] All other sources of unspecified sources of power besides natural gas and coal are carbon-free, and include large hydro, renewables, and nuclear.

To corroborate the carbon footprint of 2014 SCE power mix, it is necessary to have accurate information on: 1) CO_2 emission factor for natural gas combustion, 2) CO_2 emission factor for coal combustion, and 3) the percentages of natural and coal-fired power in the "unspecified sources of power" that comprised 40 percent of SCE's power sales in 2014.

4.1 CO_2 Emission Factors for Natural Gas, Coal, and Unspecified Sources of Power

4.1.1 Natural Gas

Composite California 2013 natural gas-fired combustion heat rate = 8,537 Btu/kWh.[20]

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[17] SCE, *2014 Corporate Responsibility Report*, October 19, 2015, p. 29.
[18] CEC, *2008 Net System Power Report*, July 2009, Table 1, p. 3. The CEC discontinued analysis of the composition of undisclosed sources of power, also known as net system power, with this July 2009 report.
[19] EIA, *Power sector coal demand has fallen in nearly every state since 2007*, April 28, 2016.
[20] CEC, *Thermal Efficiency of Gas-Fired Generation in California: 2014 Update*, September 2014,Table 1, p. 1.

Natural gas CO_2 emission factor = 117 lb/MMBtu.

Therefore, 8,537 Btu/kWh × 1000 kW/MW × 117 lb $CO_2/10^6$ Btu = 999 lb/MWh.

The composite California 2013 natural gas-fired combustion CO_2 emission factor = 999 lb/MWh.

4.1.2 Coal

Sub-bituminous coal CO_2 emission factor = 2,160 lb/MWh.[21]

4.1.3 Unspecified sources of power

The CO_2 emission factor for unspecified sources of power is sum of the natural gas (41.9 percent) and coal (33.7 percent) combustion components of the unspecified power mix:

(0.419 × 999 lb/MWh) + (0.337 × 2,160 lb/MWh) = 1,147 lb/MWh.

4.2 SCE CO_2 Power Generation Emission Factor

The SCE CO_2 power generation emission factor is the weighted average of the CO_2 emission factors for natural gas, unspecified sources of power, and clean energy resources that produce no CO_2 emissions. The SCE CO2 emission factor is calculated below for 2014 and for 2030, assuming SCE reaches a 50 percent renewable portfolio standard (RPS) by 2030.

4.2.1 2014

As shown in Figure 1, the two sources of CO_2 emissions in the SCE generation mix are natural gas (27 percent) and unspecified sources of power (40 percent). Therefore, the CO_2 emission rate for the 2014 SCE power mix is:

2030 SCE CO_2 EF = (0.27 × 999 lb/MWh) + (0.40 × 1,147 lb/MWh) = 729 lb/MWh

The CO_2 emission factor identified by SCE in its 2014 Corporate Responsibility Report of 0.26 metric ton/MWh is low when accurate assumptions are used to characterize the carbon footprint of the "unspecified sources of power."[22] 0.26 metric ton/MWh equals approximately 570 lb/MWh.[23] This is the CO_2 emission rate identified by Poseidon for SCE

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[21] EIA, *Frequently Asked Questions - How much carbon dioxide is produced per kilowatthour when generating electricity with fossil fuels?*, February 29, 2016. Powers Engineering assumes the predominant form of coal burned in Western coal plants is sub-bituminous coal mined in Wyoming and Montana.
[22] SCE, *2014 SCE Corporate Responsibility Report*, p. 28.
[23] 0.26 metric ton/MWh × (1.1 ton/metric ton) × 2,000 lb/ton = 572 lb/MWh.

grid power in the company's GHG reduction plan.[24] The actual 2014 SCE CO_2 emission factor is approximately 28 percent higher, at 729 lb/MWh, than the reported 570 lb/MWh.

4.2.2 2030

SCE is under a legal mandate to achieve a 50 percent RPS by 2030.[25] In 2014, 24 percent of SCE's power came from renewable energy sources.[26] Assuming the additional renewable energy displaces in equal parts the natural gas and unspecified components of SCE's 2014 electricity supply, in 2030 natural gas will supply 14 percent and unspecified power 27 percent of the SCE power mix. The 2030 SCE CO_2 emission factor will be:

2030 SCE CO_2 EF = (0.14 × 999 lb/MWh) + (0.27 × 1,147 lb/MWh) = 450 lb/MWh

5.0 Energy Intensity of Water Supply Alternatives

5.1. Energy Intensity of Poseidon Huntington Beach Desalination Plant

Poseidon estimates a continuous electricity demand of 30.34 MW to produce 50 mgd of potable water.[27] This represents an energy intensity of 4,748 kWh/AF.[28]

This is an electricity consumption rate equivalent to the GHG emissions associated with electricity demand of about 39,410 California homes, as shown in the following calculations:

2014 Energy Information Administration (EIA) data for California, annual average residential customer load = 6,744 kWh-yr (562 kWh-month).[29]

Poseidon annual electricity demand = 30,340 kW × 8,760 hr/yr = 265,778,400 kWh-yr.

Poseidon electric demand, converted to number of homes = 265,778,400 kWh-yr ÷ 6,744 kWh-yr/home = 39,410 homes.

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[24] Poseidon, *Huntington Beach Desalination Plant - Energy Minimization and Greenhouse Gas Reduction Plan*, November 6, 2015, p. 7.
[25] Los Angeles Times, *Gov. Brown signs climate change bill to spur renewable energy, efficiency standards*, October 7, 2015: http://www.latimes.com/politics/la-pol-sac-jerry-brown-climate-change-renewable-energy-20151007-story.html.
[26] See Figure 1.
[27] Poseidon, *Huntington Beach Desalination Plant – Energy Minimization and Greenhouse Gas Reduction Plan*, November 6, 2015, p. 7.
[28] (30,340 kW × 24 hr/day) ÷ [(50,000,000 gallon/day)(1 AF/326,000 gallon)] = 4,748 kWh/AF.
[29] U.S. EIA, 2014 Average Monthly Bill – Residential (Data from forms EIA-861- schedules 4A-D, EIA-861S and EIA-861U), Table 5A.

5.2 Energy Intensity of Potable Reuse

The energy intensity of recycling treated wastewater to potable quality, 1,055 kWh/AF, is based on 2015 data for the Groundwater Replenishment System (GWRS) operated by the Orange County Water District.[30]

Operational since January 2008, the GWRS originally produced 70 mgd of purified water. The project was expanded in 2015 to produce 100 mgd (103,000 AF-year). Ultimate capacity for the GWRS is projected at 130 mgd (128,000 AF-year) after infrastructure is built to increase wastewater flows from Orange County Sanitation District to the GWRS.[31]

The GWRS uses less than half the energy required to transport water, on average, from Northern California to Southern California.[32]

Purifying wastewater in the GWRS is about one-third the cost of ocean desalination because there are far fewer dissolved solids (salts) to remove from wastewater, about 1,000 ppm as compared to 35,000 ppm in ocean water. Removing that high concentration of salts in ocean water requires three times more energy, additional membranes, and shortens reverse osmosis membrane life-span.[33]

5.3 Comparison of Energy Intensities of Potable Water Alternatives

Table 2 compares the energy intensity and annual CO_2 emission rates for five potable water supply alternatives: 1) conservation, 2) potable reuse based on the Orange County Water District Groundwater Replenishment System (GWRS), 3) Colorado River water transfers, and 4) State Water Project water transfers, and 5) Poseidon Huntington Beach desalination plant.

Table 2. Comparison of energy intensity of water supply alternatives

Alternative	Energy intensity (kWh per AF)
Conservation[34]	0
Potable reuse[35]	1,055
Colorado River water transfers[36]	2,223
State Water Project West water transfers[37]	2,817
Poseidon Huntington Beach desalination plant	4,748

[30] J. Kennedy – Executive Director of Engineering and Water Resources, Orange County Water District, e-mail to J. Geever detailing calculation of GWRS energy intensity in kWh/AF for calendar year 2015, September 19, 2016.
[31] 2016 GWRS technical brochure, p. 4: http://www.ocwd.com/media/4267/gwrs-technical-brochure-r.pdf.
[32] Ibid.
[33] Ibid.
[34] Conservation strategies include, for example: smart irrigation and landscaping, water efficient appliances. See OCWD webpage on water conservation strategies: http://www.ocwd.com/learning-center/water-use-efficiency/conservation-strategies/.
[35] J. Kennedy – Executive Director of Engineering and Water Resources, Orange County Water District, e-mail to J. Geever detailing calculation of GWRS energy intensity in kWh/AF for calendar year 2015, September 19, 2016.
[36] H. Blanco – USC Center for Sustainable Cities, *Water Supply Scarcity in Southern California: Assessing Water District Level Strategies, Chapter 9*, November 2012, Appendix 3, p. 251.
[37] Ibid.

6.0 Greenhouse Gas Emissions of Water Supply Alternatives

6.1 Annual CO_2 emissions from Huntington Beach desalination plant

Poseidon estimates a continuous power demand of 30.34 MW for the desalination plant, an annual electricity consumption of 265,888 MWh per year.[38] The expected annual CO_2 emission associated with this level of power consumption would be:

The Poseidon Huntington Beach indirect CO_2 emissions from electricity generation, based on the actual 2014 SCE CO_2 emission rate, would be:

729 lb/MWh × 265,888 MWh/yr × 1 ton/2,000 lb = 96,916 ton/yr

An annual CO_2 emissions rate of 96,916 tons/yr is more than 20,000 tons/yr higher than the 75,620 tons/yr estimated by Poseidon that are associated with the generation of power to be used by the facility.[39]

By 2030, the annual CO_2 emission rate of the Huntington Beach desalination plant would decline to 59,825 ton/yr if SCE reaches the 50 percent RPS target.[40]

6.2 Comparison of CO_2 Emission Rates of Potable Water Alternatives

Table 3 compares the energy intensity and annual CO_2 emission rates for five potable water supply alternatives: 1) conservation, 2) potable reuse based on the Orange County Water District Groundwater Replenishment System (GWRS), 3) Colorado River water transfers, and 4) State Water Project water transfers, and 5) Poseidon Huntington Beach desalination plant. The annual CO_2 emission rate calculation is assumes a production rate of 50 million gallons per day (mgd). 50 mgd is equivalent to 56,000 AF-yr of potable water.[41]

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[38] Ibid, p. 7.
[39] Ibid, p. 8. (68,745 metric ton/yr) × (1.1 ton/1 metric ton) = 75,620 ton/yr.
[40] 450 lb/MWh × 265,888 MWh/yr × 1 ton/2000 lb = 59,825 ton/yr.
[41] (50,000,000 gallon/day)(1 AF/326,000 gallon)(365 day/yr) = 55,982 AF-yr.

Table 3. Comparison of energy intensity and annual GHG emissions of water supply alternatives

Alternative	Energy intensity (kWh per AF)	GHG emissions for 56,000 AF-yr production, using 2014 SCE CO_2 emission factor (tons CO_2 per year)
Conservation	0	0
Potable reuse[42]	1,055	21,535
Colorado River water transfers[43]	2,223	45,376
State Water Project West water transfers[44]	2,817	57,501
Poseidon Huntington Beach desalination plant	4,748	96,619

7.0 Impact of Proposed Huntington Beach Desalination Plant Electric Load on LA Basin Grid Reliability

The 30.34 MW Huntington Beach desalination plant load is equivalent to adding the electric load of 39,410 homes to the LA Basin grid.[45] The LA Basin is classified as a local reliability area that must maintain a minimum amount of local generation to assure supply reliability in the event that major transmission lines are unavailable at times of peak demand. According to SCE, available generation may not be sufficient to meet peak summer demand within a few years. In that context, SCE recently received authorization from the California Public Utilities Commission (CPUC) to add supply resources in the LA Basin to address forecast grid reliability issues in 2022.[46]

7.1 Impact of Loss of Aliso Canyon Natural Gas Storage Field on LA Basin Grid Reliability

The SoCalGas Aliso Canyon natural gas storage facility suffered a catastrophic well blowout in October 2015 that resulted in the emergency closure of the storage field. This is the largest storage field in the SoCalGas system. As a result of the emergency

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[42] 1.055 MWh/AF × 56,000 AF/yr × 729 lb/MWh × (1 ton/2000 lb) = 21,535 ton/yr.

[43] H. Blanco – USC Center for Sustainable Cities, *Water Supply Scarcity in Southern California: Assessing Water District Level Strategies, Chapter 9*, November 2012, Appendix 3, p. 251.

[44] Ibid.

[45] 265,778,400 kWh-yr ÷ 6,744 kWh-yr/home = 39,410 homes

[46] CPUC, Decision 15-11-041, *Decision Approving, in Part, Results of Southern California Edison Company Local Capacity Requirements Request for Offers for the Western LA Basin Pursuant to Decisions, 13-02-015 and 14-03-004*, November 19, 2015.

closure of Aliso Canyon, the grid operator may now impose limits on natural gas usage in electric generators under certain peak demand conditions.[47] A map of the affected electric generators in the Aliso Canyon delivery area is shown in Figure 5.[48] HBGS is in the delivery area.

Figure 5. LA Basin electric generators served by the Aliso Canyon storage field

7.2 Grid Reliability Alternatives for Poseidon Huntington Beach Electric Load

The possible addition of a continuous 30.34 MW load in an area where state authorities have implemented fast-track mitigation measures to address a potential grid reliability deficit points to the need for the Poseidon GHG offsets to be generated by real projects in the LA Basin grid reliability area, and not by offset credits associated with projects that are likely to be outside of the LA Basin.

One element employed to address grid reliability and effective storage of renewable energy is battery storage. As a result of California Public Utilities Commission decisions D.13-10-040, SCE is required to have 580 MW energy storage capacity

[47] Aliso Canyon Winter Action Plan, August 22, 2016: http://www.energy.ca.gov/2016_energypolicy/documents/index.html#08262016.
[48] Aliso Canyon Summer Action Plan, April 5, 2016, Figure 2, p. 11: http://www.energy.ca.gov/2016_energypolicy/documents/#04082016.

under contract by 2020.[49] To date SCE has approval for installation of 264 MW of energy storage resources in its service territory.[50] This means SCE has an obligation to have over 300 MW of additional energy storage resources under contract by 2020. At a minimum 30 MW of battery storage, with sufficient capacity[51] to produce 30 MW for several hours to address peak demand events, can and should be located at the HBGS site to offset the additional load the Poseidon desalination plant will impose on the LA Basin grid.

Energy storage projects are being fast-tracked to address, in part, the unavailability of Aliso Canyon to supply natural gas to electric generation plants during periods of peak demand. Tesla announced on September 15, 2016 that it would complete a 20 MW battery storage project at SCE's Mira Loma substation by the end of 2016.[52] This project is part of a suite of battery storage projects initiated to address the loss of the Aliso Canyon Aliso Canyon. A 100 MW battery installation was also approved by the CPUC for the AES Alamitos Generating Station in Long Beach in November 2015.[53] AES has a proposal to expand the Alamitos battery project to 300 MW in the future.[54]

Further, a project composed of battery storage to help resolve water reliability and the "water-energy nexus" is proposed for the Irvine Ranch Water District, a member agency of OCWD. The project will be the largest of its kind at a public water agency in the U.S. The 7 MW and 34 megawatt-hour (MWh) storage system will utilize Tesla batteries to store power at eleven of Irving Ranch Water District's most energy-intensive points in its operations, including three water treatment plants, six pumping stations, a deep water aquifer treatment plant and a groundwater de-salter facility.[55]

Local solar can also be deployed to offset the 30.34 MW electric load the Huntington Beach desalination plant would impose on the LA Basin. The maximum output of solar panels occurs in the middle of the day, while summer peak demand generally occurs around 4 pm to 5 pm. As a result, substantially more solar capacity than 30.34 MW is needed to assure 30.34 MW is actually being delivered to the grid at the peak hour.

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[49] See D.13-10-040, October 17, 2013, Table 2, p. 15: http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M079/K533/79533378.PDF.

[50] See CPUC Decision D.15-11-041, November 19, 2015, p. 5.

[51] Measured in megawatt-hours, or MWh. Sufficient capacity was defined as the ability to operate for 4 hours at rated MW capacity on three consecutive days in SCE's November 21, 2014 Application A.14-11-012 to the CPUC in which SCE proposed battery projects capable of providing 4 hours of output at rated MW capacity on three consecutive days.

[52] Los Angeles Times, September 15, 2016: http://www.latimes.com/business/la-fi-tesla-edison-20160915-snap-story.html.

[53] See CPUC Decision D.15-11-041, November 19, 2015, p. 5.

[54] Utility Dive, *AES to partially replace California gas plant with 300 MW of battery storage*, July 25, 2016: http://www.utilitydive.com/news/aes-to-partially-replace-california-gas-plant-with-300-mw-of-battery-storag/423171/.

[55] See: http://www.irwd.com/liquid-news/ams-and-irwd-partner-on-energy-storage-project.

Solar power purchase agreement contracts for solar projects of 26 MW are now being signed for well under $40 per megawatt-hour (MWh) in California.[56] The benchmark 2015 wholesale power price in Southern California in 2015 is $55 per MWh.[57] Poseidon should work with SCE to encounter a contractual framework to offset its annual power consumption with solar power, preferentially local solar power in the LA Basin. This alternative to GHG offsets would turn an expense to Poseidon into a net economic benefit by lowering the energy cost to Poseidon to operate the desalination plant while completely offsetting GHG emissions.

8.0 Poseidon Carbon Neutral Proposal Will Not Assure Offsetting of GHG Emissions

Poseidon indicates that it will develop an amount of rooftop solar equivalent to the roof area of its desalination plant buildings, and use GHG credits of one form or another to offset all GHG emissions from the proposed Huntington Beach desalination plant.[58] However, ultimately Poseidon makes clear in its carbon neutral plan that $10 per metric ton of CO_2 emissions is a reasonable cost ceiling for offsets and that it will pay the City of Huntington Beach $10 per metric ton of CO_2 if offsets cannot be found at that price. .[59]

The basis for the $10 per metric ton of CO_2 value appears to be the California cap-and-trade auction floor value for the initial 2012 and 2013 cap-and-trade auctions.[60] The exemption level for the California cap-and-trade auction program is 25,000 metric tons per year. The program is limited to specific source types and does not specifically include desalination plants.[61] However, source types other than those currently included in the program may participate.[62] Poseidon states in its Greenhouse Gas Reduction Plan that it will purchase carbon offsets to achieve carbon neutrality.[63]

[56] Utility Dive, *Cheapest power in the US? Palo Alto muni eyes solar at under $37/MWh*, February 23, 2016: http://www.utilitydive.com/news/cheapest-power-in-the-us-palo-alto-muni-eyes-solar-at-under-37mwh/414372/.
[57] SDG&E Application A.15-04-014, *Approval of 2016 Electric Procurement Revenue Requirement Forecasts, Prepared Direct Testimony of Yvonne M. Le Mieux*, April 15, 2015, p. 9.
[58] Poseidon Resources, *Huntington Beach Desalination Plant - Energy Minimization and Greenhouse Gas Reduction Plan*, November 6, 2015, p. 11 and pp. 15-18.
[59] Ibid, p. 18.
[60] California Air Resources Board, *Cap-and-Trade Regulation Instructional Guidance, Chapter 5: How Do I Buy, Sell, and Trade Compliance Instruments?*, December 2012, p. 9: https://www.arb.ca.gov/cc/capandtrade/guidance/chapter5.pdf#page=2.
[61] Summary of California GHG cap-and-trade program, Subarticle 3 - Applicability: http://www.c2es.org/us-states-regions/action/california/cap-trade-regulation#sub3.
[62] Ibid.
[63] Poseidon Resources, *Huntington Beach Desalination Plant - Energy Minimization and Greenhouse Gas Reduction Plan*, November 6, 2015, pp. 15-16. "Poseidon will purchase carbon offset

The actual cap-and-trade auction clearing price may be much higher than the $10 per metric ton floor value. The cap-and-trade program also has offset credits, known as allowances from the Allowance Price Containment Reserve that can be directly purchased at a cost of $40 to $50 per metric ton. These costs rise at 5 percent per year after 2013.[64] By 2020, as a rate of increase of 5 percent per year, the cost to directly purchase offset credits will rise to $56 to $70 per metric ton.[65] The cap-and-trade auction cost may be lower than the direct purchase cost of emission credits. However, these costs are uncertain. The certain cost for the direct purchase of cap-and-trade emission credits in 2020 will be $56 to $70 per metric ton, assuming no inflation.

The cap-and-trade auction floor price and the Allowance Price Containment Reserve allowances increase by regulation at a rate of 5 percent per year, without even considering the impact on the availability of cap-and-trade allowances under of the 50 percent RPS requirement.[66] This means that a first tier Allowance Price Containment Reserve allowance that cost $50 per metric ton in 2013 would cost $115 per metric ton in 2030 before accounting for inflation.[67] In its November 6, 2015 GHG compliance submittal, Poseidon has proposed an unsupportable default GHG offset protocol that assures that Poseidon will pay no more than $10 per metric ton of CO_2 emissions.[68]

Poseidon estimates its first-year CO_2 emissions at 65,278 metric tons per year. Therefore, at $10 per metric ton, Poseidon would pay $652,780 to assert the desalination plant is carbon neutral, with the expectation that this cost would be recovered to a limited degree over time as the SCE CO_2 emission factor declines as it adds more renewable energy resources. In fact, the cost of cap-and-trade allowances will be as high as $70 per metric ton in 2020 and $115 per metric ton in 2030, unadjusted for inflation. At a firm cap-and-trade allowance cost of $70 per metric ton in 2020, Poseidon could be paying closer to $7 million for GHG offsets compared to less than $700,000 that it would pay assuming a cost of $10 per metric ton for offsets.

The most effective mechanism available to Poseidon to assure the GHG emissions generated by the operation of the desalination plant are directly offset in the LA Basin is to expand the scope of its small solar proposal to completely offset the GHG

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projects, except for RECs, through/from TCR, CAR, CARB, or California APCDs/AQMDs." and "Adherence will ensure that the offset projects acquired by Poseidon are real, permanent, quantifiable, verifiable, enforceable, and additional consistent with the principles of AB 32."

[64] California Air Resources Board, *Cap-and-Trade Regulation Instructional Guidance, Chapter 5: How Do I Buy, Sell, and Trade Compliance Instruments?*, December 2012, Table 5.2, p. 23.

[65] $40/metric ton × $(1.05)^7$ = $56/metric ton; $50/metric ton × $(1.05)^7$ = $70/metric ton.

[66] Any inflation must be added to the stipulated 5 percent per year rate increase.

[67] $50/metric ton × $(1.05)^{17}$ = $115/metric ton.

[68] Poseidon Resources, *Huntington Beach Desalination Plant - Energy Minimization and Greenhouse Gas Reduction Plan*, November 6, 2015, p. 18.

emissions from the operation of the desalination plant. This would require approximately 150 MW of installed solar capacity, battery storage and/or some combination of energy efficiency investments in Huntington Beach area combined with solar power to fully offset the GHG emissions from the plant. By way of comparison, the installation rate of net-metered solar power on homes and businesses in SCE territory is approximately 40 MW per month.[69] At a rooftop solar installation rate of 40 MW per month, it would take less than four months to install 150 MW of capacity.

Solar can be developed for less than the wholesale cost of power in SCE territory. Poseidon can effectively offset its entire GHG emissions burden, and potentially generate additional income, by building 150 MW of local solar in the LA Basin on rooftops and parking lots.

9.0 Conclusions

Water demand in OCWD service territory has declined substantially since the Huntington Beach desalination project was first proposed in 1999. Demand has declined from approximately 500,000 AF-year to 350,000 AF-year, a 30 percent reduction. On the supply side, the GWRS began producing purified recycled water in 2008 and currently produces 103,000 AF-year. GWRS production is expected to increase to 128,000 AF-year in 2022.

The energy intensity of ocean water desalination is more than four times greater than that of purified recycled water. As a result, the carbon footprint of ocean water desalination is more than four times greater than that of purified recycled water.

Poseidon proposes to purchase carbon emission offsets to achieve carbon neutrality for the desalination plant. This approach to carbon neutrality will not address the grid reliability impacts of adding a continuous load of 30.34 MW in the LA Basin. SCE is under regulatory mandate to have at least another 300 MW of energy storage under contract by 2020. At least 30 MW of battery storage at the HBGS site is necessary to offset the grid reliability impacts of the desalination plant.

Poseidon can also facilitate the installation of sufficient local solar power to achieve carbon neutrality for the desalination plant due to the favorable economics of solar power to wholesale energy cost of grid power. The contract price of power purchase agreements for solar projects in California has dropped well below the utility wholesale power cost. Given the favorable economics of solar power relative to the utility's wholesale cost of energy, local solar should be developed by Poseidon in sufficient quantity to fully offset the carbon footprint of desalination plant operations and support local grid reliability.

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[69] SCE monthly net-metered solar installation rate data, August 2016: https://www.sce.com/wps/wcm/connect/21db29a7-7291-408a-a86e-fdf658067696/Aug+NEM+Monthly+Growth_3.pdf?MOD=AJPERES.

Assessment of Energy Intensity and Greenhouse Emission Mitigation of Proposed Poseidon Huntington Beach Desalination Plant

January 2022 Update

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Table of Contents

1.0 Executive Summary

This updated report reviews the energy intensity and greenhouse gas (GHG) emissions associated with the grid power demand of the proposed Poseidon Huntington Beach desalination plant and examines an alternative GHG mitigation strategy that does not rely on carbon offset credits. The electric "grid reliability" impacts of the desalination plant are assessed in the context of the electricity supply limitations of the Los Angeles Basin. Recommendations are provided for an alternative GHG mitigation approach that would fully address the local grid reliability impacts of the desalination plant. Local solar power on commercial and industrial rooftops and parking lots, combined with local battery storage, should be used to mitigate all GHG emissions associated with the grid power needed to operate the desalination plant.

Water demand in Orange County Water District (OCWD) service territory has declined about 20 percent, from approximately 500,000 acre-feet per year (AFY) in 1998 when Poseidon first proposed a desalination plant in Huntington Beach, to 400,000 AFY in 2020. This 100,000 AFY decline is substantially greater than the 56,000 AFY potable water production capacity of the proposed Huntington Beach desalination plant.

Over this same time period the production capacity of OCWD purified recycled water used to recharge the groundwater basin, via the Groundwater Replenishment System (GWRS) indirect potable reuse project, has increased from zero in 1998 to 112,000 AFY, equivalent to 100 million gallons per day (MGD), in 2015. Production of GRWS purified recycled water will expand to 145,000 AFY (130 MGD) in 2023.

Los Angeles County and the Metropolitan Water District (MWD) are also in the initial development stages of a similar groundwater replenishment project, the "Regional Recycled Water Program," that will deliver approximately 65,000 AFY to OCWD to replenish groundwater by 2032.

The energy intensity of ocean water desalination is more than four times greater than that of purified recycled water. As a result, the carbon footprint of ocean water desalination is more than four times greater than that of purified recycled water.

Poseidon's GHG mitigation strategy for the proposed Huntington Beach desalination plant, as stated in its most recent 2017 GHG mitigation plan, is to make a one-time upfront payment to obtain GHG offset credits for the 50-year operating lifetime of the project. The desalination plant electricity demand will be indirectly responsible for 68,745 metric tons per year of carbon dioxide (CO_2) emissions. Poseidon proposes to mitigate these emissions with GHG offset credits.

According to Poseidon, these offset credits can be generated a variety of ways, by producing electricity with renewable sources such as solar or wind, or reforestation or preserving forests in other countries. One source of credits identified by Poseidon is the California Air Resources Board (CARB) cap-and-trade program. Use of carbon credits for compliance is controversial. They have been used in the past to give the impression holders of these credits are greener than they may in fact be. Meeting the Huntington Beach desalination plant electricity need with new local clean energy sources would remove doubt about the validity of the approach used by Poseidon to assert the desalination plant is carbon neutral.

Poseidon has set a de facto "economically feasible" cost ceiling for carbon credits of $10 per metric ton. Based on this carbon credit price ceiling, Poseidon would expect to pay a maximum of about $700,000 per year for the credits, or up to about $35 million up-front for fifty years of operation. In contrast, the cost of fifty years of CARB cap-and-trade allowances, at the 2022 cost ceiling price of $72.29 per metric ton, would be approximately $250 million.

The capital cost of the Huntington Beach desalination plant is currently estimated at about $1.4 billion.[1] In the Poseidon GHG offset scenario, with a $10 per metric ton cost cap, the company would pay less than 3 percent of the capital cost of the desalination plant for GHG offsets. However, in a "CARB offsets at the 2022 ceiling price" scenario, the company would pay about 18 percent of the capital cost of the desalination plant for offsets.

The negative marine impacts of the Huntington Beach desalination plant will be primarily local. The negative impacts of the desalination plant's demand on the Los Angeles Basin grid during tight supply conditions will also be local. Given this framework, the positive mitigation of the desalination plant's GHG emissions should also be local. Local mitigation is not a novel concept. Local GHG impact mitigation is proposed for another major Los Angeles area development project – Tejon Ranch – with projected GHG emissions on a comparable scale to those of the Huntington Beach desalination plant.

Solar and battery storage costs have declined steadily since Poseidon first developed its GHG mitigation plan. Sufficient local solar and battery storage – deployed in Huntington Beach and potentially in surrounding cities – to meet the annual energy and peak demand of the desalination plant can be constructed by Poseidon at reasonable cost relative to the capital cost of the desalination plant and the revenue it will generate when operational.

About 150 megawatts (MW_{AC}) of local solar on commercial and industrial rooftops and parking lots would meet the annual energy demand of the desalination plant. To put this amount of solar power in context, about 375 MW_{AC} of customer-owned solar is installed on rooftops and parking lots in Southern California Edison (SCE) territory every year. Separately, SCE has built a large-scale utility-owned urban solar project,[2] aggregating numerous warehouse rooftops in the Inland Empire,[3] that is approximately 100 MW_{AC} in total capacity.

For the specific purpose of offsetting the grid reliability impacts of the continuous 30 MW demand of the Huntington Beach desalination plant, four hours of battery storage (120 megawatt-hours) is also needed to assure the desalination plant imposes no burden on the local electric grid during times of peak demand. Four hours of storage at rated capacity is the standard

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[1] Los Angeles Times, *Controversial Poseidon desalination plant in Huntington Beach set for hearings this week*, July 28, 2020: https://www.latimes.com/socal/daily-pilot/news/story/2020-07-28/controversial-poseidon-desalinationination-plant-in-huntington-beach-set-for-hearings-this-week.

[2] See **Attachment A,** California Public Utilities Commission press release, *CPUC Approves Edison Solar Roof Program*, June 18, 2009, for overview of this SCE rooftop project.

[3] The Inland Empire is centered around the cities of Riverside and San Bernardino.

"peaker plant equivalent" battery storage duration for battery storage projects authorized by the California Public Utilities Commission (CPUC) in SCE service territory.

The capital cost of this local solar and battery storage mitigation strategy would be approximately $220 million in 2024 dollars, or about 15 percent of the project's estimated $1.4 billion capital cost. The annual cost of this solar and battery storage GHG mitigation scenario, $4.4 million per year over the 50-year project lifetime, would be in the range of 3 percent of the estimated $160 million per year in annual gross revenue of the Huntington Beach desalination plant. Under this local GHG mitigation scenario, Poseidon would pay for the construction of these solar and battery storage assets and then transfer ownership to Huntington Beach.

Mitigating the desalination plant electricity demand with local solar and battery storage resources is the most appropriate GHG mitigation strategy for the Huntington Beach desalination plant.

2.0 Introduction

Orange County Coastkeeper contracted Powers Engineering to provide a technical assessment of: 1) the energy intensity, in terms of kilowatt-hours per acre-foot of water (kWh/AF), and the associated GHG emissions of a range of actual and potential water supply options for Orange County, and 2) an alternative GHG mitigation strategy to achieve carbon neutrality with local clean energy resources.

The water supply options evaluated include:

- Conservation
- Potable reuse
- Desalination
- Colorado River water transfers
- State Water Project water transfers

State Water Project and Colorado River Aqueduct water imports are used as the baseline for comparison purposes in this analysis.

The overwhelming majority of the potable water utilized in OCWD service territory is supplied from groundwater sources, replenished through natural processes and with purified recycled water, with most of the remaining supply being imported water provided by the MWD. In contrast, the majority of potable water consumed in Southern California as a whole is imported water. For this reason, the energy intensity and CO_2 emissions associated with water imports are used as baseline values in this report.[4]

[4] Greenhouse gases, carbon emissions, and CO_2 are used as interchangeable synonyms in this report.

3.0 Description of Proposed Desalination Project

Poseidon proposes to build and operate a 50 MGD (56,000 AFY) desalination plant on the property of the Huntington Beach Generating Station (HBGS) in Huntington Beach, California. There is one operational steam boiler power unit on the property, HBGS Unit 2, with a capacity of 215 MW. Unit 2 uses seawater in a once-through cooling (OTC) configuration for power plant cooling. The proposed Huntington Beach desalination plant will utilize the existing OTC seawater intake and outfall pipelines currently serving Unit 2.

Unit 2 is operated infrequently. The CPUC has authorized the extension of the operational lifetime of this unit until December 2023.[5] A new power project has also been built at the site, the 644 MW Huntington Beach Energy Project combined-cycle power plant, that does not utilize an OTC cooling system.[6] This new 644 MW power plant became operational in 2021.[7]

Poseidon has pursued the development of the HBGS site as a seawater desalination facility since 1998. The City of Huntington Beach prepared and circulated the initial Final Environmental Impact Report (FEIR) for the project in 2002. The City Council certified the Recirculated EIR (2005 REIR) in September 2005. The City of Huntington Beach approved the project's conditional use permit and coastal development permit in February 2006.

The Coastal Development Permit (CDP) issued for the project expired in 2010. Changes to the desalination plant operational assumptions, primarily related to the seawater intake, also occurred after the certification of the REIR. As a result, in May 2010, along with the approval of a second CDP, a Subsequent EIR was prepared to address seawater intake effects based on a standalone condition. "Standalone" means the desalination facility would be responsible for direct intake of seawater.[8] The most recent document, the Final Supplemental EIR, was issued in October 2017.[9] Poseidon issued its most recent GHG mitigation plan for the Huntington Beach desalination plant in February 2017.[10]

3.1 Orange County Water Demand Trends

Water demand in Orange County has declined about 100,000 AFY, or about 20 percent, since Poseidon first proposed the project in 1998, as shown in Figure 1. In addition, OCWD has added

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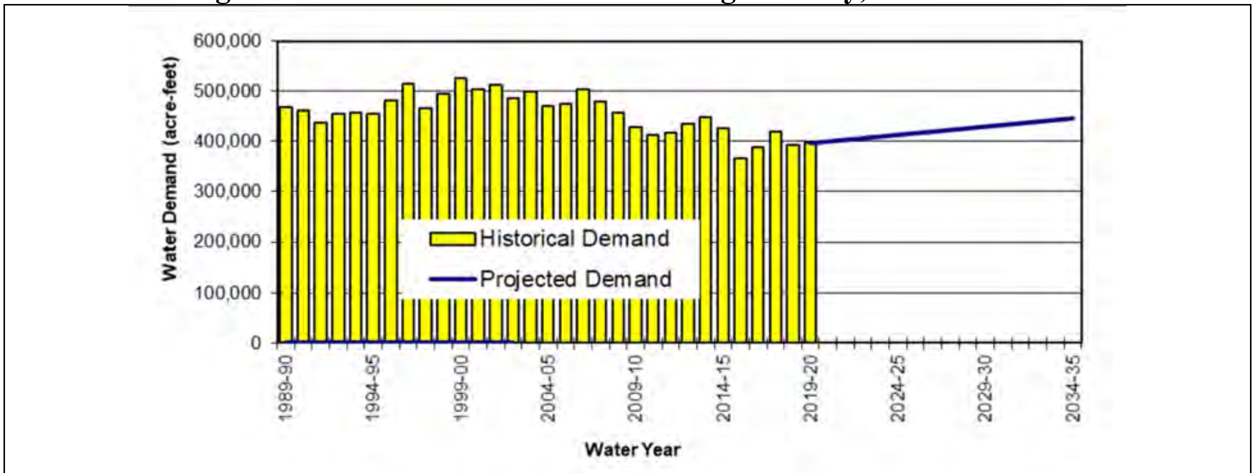
[5] CPUC Decision D.21-12-015, December 2, 2021.
[6] SCE Application A.14-11-012, *Southern California Edison Company's (U 338-E) Application for Approval of the Results of Its 2013 Local Capacity Requirements Request For Offers for the Western Los Angeles Basin*, November 21, 2014. A 644 MW air-cooled combined cycle project is proposed for the Huntington Beach Generating Station site, with an online date of 2020.
[7] California Energy Commission, Huntington Beach Energy Project, webpage accessed January 5, 2022: https://www.energy.ca.gov/powerplant/combined-cycle/huntington-beach-energy-project.
[8] City of Huntington Beach, *Draft Subsequent Environmental Impact Report –Desalination Project at Huntington Beach*, May 2010, p. 1-2 and p. 1-3.
[9] State Lands Commission, *Final Supplemental Environmental Impact Report, Seawater Desalination Project At Huntington Beach: Outfall/Intake Modifications & General Lease – Industrial Use (PRC 1980.1) Amendment*, October 2017.
[10] Poseidon Resources, *Huntington Beach Desalination Plant - Energy Minimization and Greenhouse Gas Reduction Plan*, February 27, 2017.

112,000 AFY (100 MGD) of potable recycled water to its supply through the GWRS, which began operation in 2008 and was expanded in 2015.[11] The GWRS will be expanded further to 145,000 AFY (130 MGD) of production by 2023,[12] increasing reliance on groundwater to meet demand.

Figure 1. Water demand trend in Orange County, 1989 to 2035[13]



Los Angeles County and MWD are also proposing a groundwater replenishment project similar to GWRS, the "Regional Recycled Water Program," that would deliver approximately 65,000 AF-year to OCWD to replenish groundwater supply by 2032.[14,15] The additional supply could either: 1) offset any need for water from the Huntington Beach desalination plant, or 2) allow OCWD member agencies to forego fully treated imported water.

The source of the OCWD water supply is primarily groundwater, supplemented with supply from MWD. The specific source and quantities of OCWD supply for the 2019-2020 fiscal year are shown in Table 1.

Table 1. Specific source and quantities of OCWD supply, 2019-2020[16]

2019-2020 supply source	Quantity (AFY)
Groundwater including potable reuse (GWRS supply)	286,498
Imported water - MWD	87,652
Santiago Creek native water	2,546

[11] See OCWD Groundwater Replenishment System, "Frequently Asked Questions" webpage, January 16, 2022: http://www.ocwd.com/gwrs/frequently-asked-questions/.
[12] Ibid.
[13] OCWD, *2019-2020 Engineer's Report on the Groundwater Conditions, Water Supply and Basin Utilization in the Orange County Water District*, February 2021, Figure 5, p. 21.
[14] OCWD Board of Directors Meeting, *Agenda Item - Metropolitan Water District Los Angeles County City of Carson Indirect Potable Reuse Project*, September 7, 2016, p. 1.
[15] Metropolitan Water District, *Regional Recycled Water Program – Engineering and Technical Studies* (PowerPoint presentation), June 7, 2021, p. 10: https://www.mwdh2o.com/planning-for-tomorrow/building-local-supplies/regional-recycled-water-program/.
[16] OCWD, *2019-2020 Engineer's Report on the Groundwater Conditions, Water Supply and Basin Utilization in the Orange County Water District*, February 2021, Figure 5, p. 20.

Recycled water, non-potable	20,723
Total:	397,419

The most recent 2020 Urban Water Management Plan (UWMP) prepared by Municipal Water District of Orange County (MWDOC), which includes planning for delivery of imported water to OCWD, found that projected water supplies will be sufficient to meet forecast demand through 2045 without the addition of desalinated water from the Huntington Beach desalination plant.[17] Table 2 is OCWD's projected water supply mix for meeting a forecast 2045 demand of 445,777 AFY without the desalination plant.[18]

Table 2. Forecast OCWD 2045 water sources and quantities[19]

2045 supply source	Quantity (AFY)
OCWD Basin groundwater	236,274
Non-OCWD groundwater	24,890
Imported water - MWD	122,819
Surface water	4,700
Recycled water	57,094
Total:	445,777

3.2 Proposed Desalination Plant

The proposed 50 MGD seawater desalination project at HBGS would convert seawater drawn into the existing HBGS intake structure (with some modifications) into drinking water using a reverse osmosis (RO) desalination process. The desalination plant would draw approximately 100 MGD from the intake structure and produce 50 MGD of potable drinking water. The remaining 50 MGD would be seawater with an elevated salt concentration, as the salts in the 50 MGD of potable water would be concentrated in this 50 MGD discharge stream. The 50 MGD of concentrated discharge from the RO process would be discharged through the existing HBGS OTC discharge pipe.

Recent proposed modifications to the HBGS cooling system to adapt it for use in the desalination process would include fine-mesh screens on the intake pipe and pressurized diffusers on the existing discharge pipe. These modifications have not been analyzed by Powers Engineering to determine the additional energy demand they represent. Graphics of the intake screens and the discharge diffusers are shown in Figure 2.

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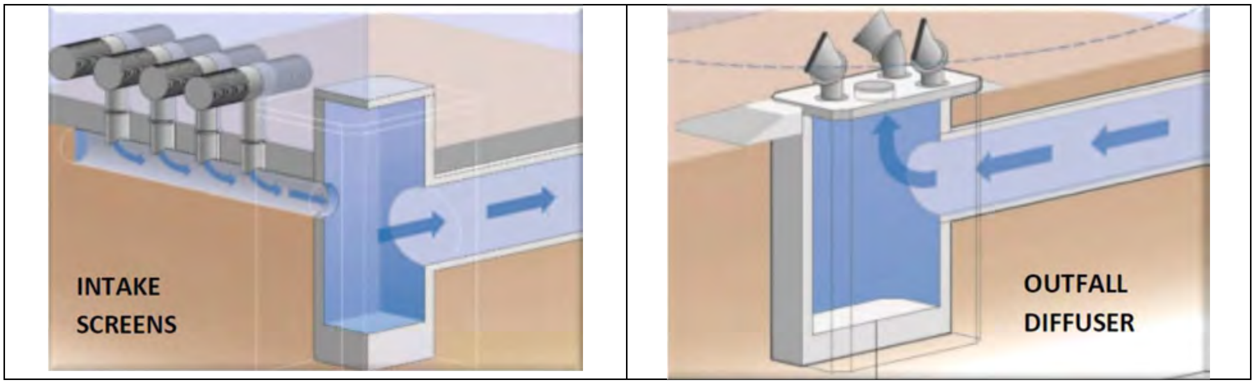
[17] Municipal Water District of Orange County, *2020 Urban Water Management Plan*, June 2021, Table 4-1: MWDOC's Service Area Existing and Future Water Use by Source, p. 4-3.
[18] Ibid, p. 21.
[19] Municipal Water District of Orange County, *2020 Urban Water Management Plan*, June 2021, Table 4-1, p. 4-3.

Figure 2. Proposed Huntington Beach Desalination Plant intake screens and discharge diffusers[20]



The proposed desalination project would consist of a seawater intake and discharge pipes, pretreatment facilities, a seawater desalination facility utilizing reverse osmosis (RO) technology, post-treatment facilities, product water storage, on- and off-site landscaping, chemical storage, on- and off-site booster pump stations, and 42- to 48-inch diameter product water transmission pipelines up to 10 miles in length.[21] The layout of the desalination plant, and the locations of the intake and discharge structures, are shown in Figure 3.

The desalination process includes pre-treatment and RO. The pre-treatment process requires energy to remove larger particles from the feedwater prior to the RO filtration system. Studies show that withdrawing seawater from sub-surface intakes can reduce or eliminate the need for pre-filtration, and consequently the energy demand and cost of constructing and maintaining the pre-filtration system. However, the current proposal does not call for the use of sub-surface intakes and this report does not analyze those energy savings.

The RO process would be a single-pass design using high rejection seawater membranes. The system would be made up of 13 process trains (12 operational and one standby). Each RO train would have a capacity of approximately 4 MGD. High pressure electric feed pumps would convey water from the intake filters to the RO membranes. The pumps will provide feed pressures of 800 to 1,000 pounds per square inch. The actual feed water pressure depends on several factors including the temperature of the intake water, salinity of the intake water, and the age of the membranes.[22]

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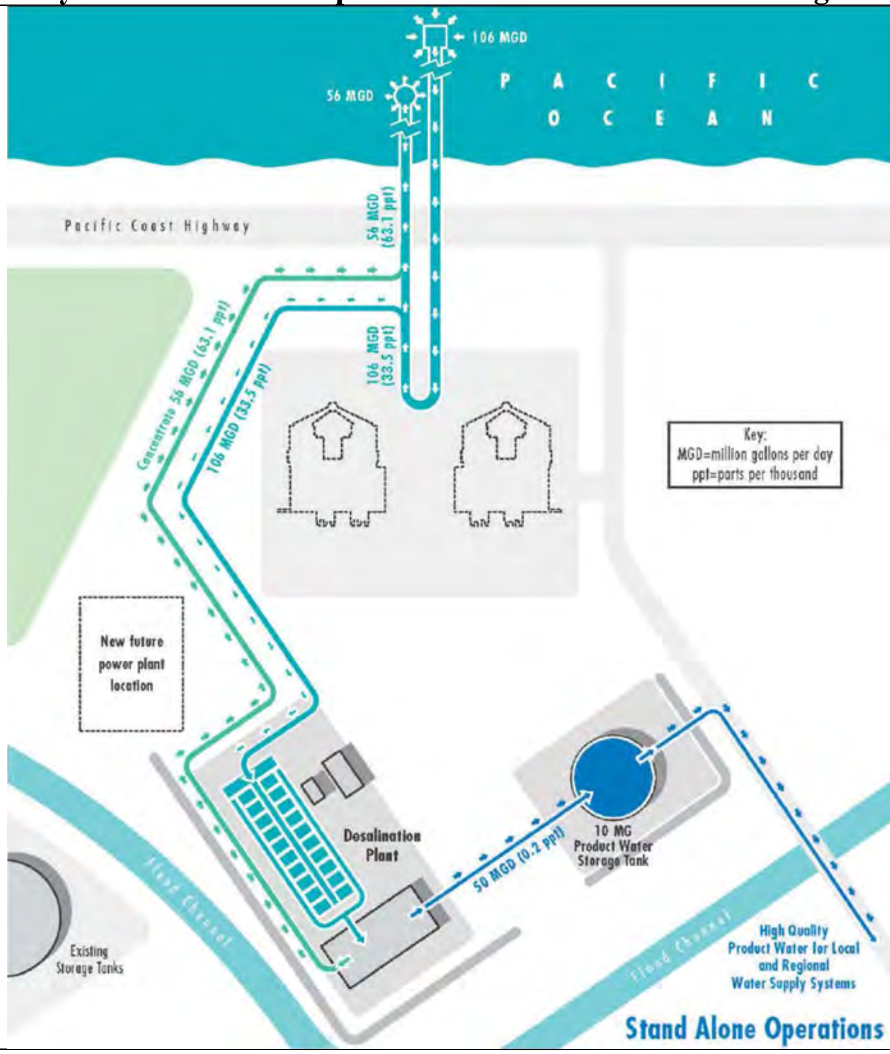
[20] Poseidon Resources, *Huntington Beach Desalination Plant - Energy Minimization and Greenhouse Gas Reduction Plan*, February 27, 2017 (cover graphics).

[21] City of Huntington Beach, *Draft Recirculated Environmental Impact Report –Desalination Project at Huntington Beach*, April 5, 2005, p. 3-2.

[22] Additional energy savings would result from the use of warmer water supplied from the HBGS OTC discharge. The desalination process was originally designed, in 2005, to operate at both ambient and elevated seawater temperature. Warmer water increases the efficiency of the RO membranes (Draft REIR, p. 3-25). However, the cooling water system, including use of the intake structure and the warm water discharge, will discontinue operation at the end of 2023 to meet State requirements to minimize the intake and mortality of marine life.

Figure 3. Layout of desalination plant and ocean intake and discharge structures[23]



5.0 Energy Intensity of Water Supply Alternatives

5.1. Energy Intensity of Poseidon Huntington Beach Desalination Plant

Poseidon estimates a continuous electricity demand of 30.34 MW to produce 50 MGD of potable water at the Huntington Beach desalination plant.[24] This represents an energy intensity of 4,748 kWh/AF.[25]

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[23] Alden Research Laboratory, Inc., *Huntington Beach Desalination Plant Intake/Discharge Feasibility Assessment*, March 14, 2016, Figure 2, p. 15.
[24] Poseidon, *Huntington Beach Desalination Plant – Energy Minimization and Greenhouse Gas Reduction Plan*, February 27, 2017, p. 7.
[25] Ibid, p. 7. (30,340 kW × 24 hr/day) ÷ [(50,000,000 gallon/day)(1 AF/326,000 gallon)] = 4,748 kWh/AF.

This is an electricity consumption rate equivalent to the GHG emissions associated with electricity demand of about 38,732 California homes, as shown in the following calculations:

> 2020 Energy Information Administration (EIA) data for California, annual average residential customer load = 6,862 kilowatt-hour per year (kWh-yr) per customer (572 kWh-month).[26]
>
> Poseidon annual electricity demand = 30,340 kW × 8,760 hr/yr = 265,778,400 kWh-yr.
>
> Poseidon electric demand, converted to number of homes = 265,778,400 kWh-yr ÷ 6,862 kWh-yr/home = 38,732 homes.

5.2 Energy Intensity of Potable Reuse

The energy intensity of recycling treated wastewater to potable quality, 1,055 kWh/AF, is based on operational data for the GWRS operated by the OCWD.[27]

Operational since January 2008, the GWRS originally produced 70 MGD of purified water. The project was expanded in 2015 to produce 100 MGD (112,000 AFY). Ultimate capacity for the GWRS is projected at 130 MGD (145,000 AFY) in 2023 after completion of an infrastructure build-out to increase wastewater flows from Orange County Sanitation District to the GWRS.[28]

The GWRS uses about half the energy per AF required to transport water, on average, from Northern California to Southern California.[29]

Purifying wastewater in the GWRS requires less than one-quarter the energy of ocean water desalination because there are far fewer dissolved solids (salts) to remove from wastewater (see Table 3). Conversely, the energy intensity of ocean water desalination is more than four times greater than that of purified recycled water. Wastewater contains about 1,000 ppm of salts compared to 35,000 ppm in ocean water. Removing the high concentration of salts in ocean water requires more energy, additional membranes, and shortens RO membrane life-span.

5.3 Comparison of Energy Intensities of Potable Water Alternatives

Table 3 compares the energy intensity and annual CO_2 emission rates for five potable water supply alternatives: 1) conservation, 2) potable reuse based on the OCWD GWRS, 3) Colorado River water transfers, and 4) State Water Project water transfers, and 5) Poseidon Huntington Beach desalination plant.

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[26] U.S. EIA, *California Electricity Profile 2020*, November 4, 2021, Table 8. Sales to ultimate customers, revenue, and average price by sector, 1990 through 2020. 2020 residential demand = 94,934,563 megawatt-hours (MWh); residential customers = 13,834,719; average demand per customer = 94,934,563,000 kWh-yr ÷ 13,834,719 customers = 6,862 kWh-yr/customer.

[27] J. Kennedy – Executive Director of Engineering and Water Resources, Orange County Water District, e-mail to J. Geever detailing calculation of GWRS energy intensity in kWh/AF for calendar year 2015, September 19, 2016.

[28] 2021 GWRS technical brochure, p. 5: https://www.ocwd.com/media/10297/gwrs-technical-brochure-2021.pdf.

[29] Ibid, p. 21.

Table 3. Comparison of energy intensity of water supply alternatives

Alternative	Energy intensity (kWh/AF)
Conservation[30]	0
Potable reuse[31]	1,055
Colorado River water transfers[32]	2,223
State Water Project West water transfers[33]	2,817
Poseidon Huntington Beach desalination plant	4,748

[30] Conservation strategies include, for example: smart irrigation and landscaping, water efficient appliances. See OCWD webpage on water conservation strategies: https://www.ocwd.com/learning-center/water-use-efficiency/.
[31] J. Kennedy – Executive Director of Engineering and Water Resources, Orange County Water District, e-mail to J. Geever detailing calculation of GWRS energy intensity in kWh/AF for calendar year 2015, September 19, 2016.
[32] H. Blanco – USC Center for Sustainable Cities, *Water Supply Scarcity in Southern California: Assessing Water District Level Strategies, Chapter 9*, November 2012, Appendix 3, p. 251.
[33] Ibid.

6.0 GHG Emissions of Water Supply Alternatives

6.1 Annual CO_2 emissions from Huntington Beach desalination plant

Poseidon estimates a continuous power demand of 30.34 MW for the desalination plant, equivalent to an annual electricity consumption of 265,888 MWh per year.[34] Poseidon estimates 68,745 metric tons per year (75,620 tons/yr) of GHG emissions associated with the annual power demand at the facility.[35]

6.2 Comparison of CO_2 Emission Rates of Potable Water Alternatives

Table 4 compares the energy intensity and annual CO_2 emission rates for five potable water supply alternatives: 1) conservation, 2) potable reuse based on the OCWD GWRS, 3) Colorado River water transfers, and 4) State Water Project water transfers, and 5) Poseidon Huntington Beach desalination plant. The annual CO_2 emission rate calculation assumes a production rate of 50 MGD. 50 MGD is equivalent to approximately 56,000 AFY of potable water.[36]

Table 4. Comparison of energy intensity and annual GHG emissions of water supply alternatives

Alternative	Energy intensity (kWh per AF)	GHG emissions for 56,000 AFY production [2020 SCE CO_2 emission factor = 464 lb/MWh][37] (tons CO_2 per year)
Conservation	0	0
Potable reuse[38]	1,055	13,707
Colorado River water transfers[39]	2,223	28,881
State Water Project West water transfers[40]	2,817	36,598
Poseidon Huntington Beach desalination plant	4,748	75,620 (Poseidon estimate)

[34] Ibid, p. 7.
[35] Ibid, p. 8. (68,745 metric ton/yr) × (1.1 ton/1 metric ton) = 75,620 ton/yr.
[36] (50,000,000 gallon/day)(1 AF/326,000 gallon)(365 day/yr) = 55,982 AFY.
[37] EEI, *Electric Company ESG/Sustainability Quantitative Information – Southern California Edison*, p. 3, line 5.4 (2020 year), November 10, 2021: https://www.edison.com/content/dam/eix/documents/sustainability/eix-esg-pilot-quantitative-section-sce.pdf. CO_2 emission factor = 0.211 metric tons CO_2 per megawatt-hour (MWh). Therefore, SCE CO_2 emission rate = (0.211 metric tons CO_2 per MWh) × 1.1 ton/metric ton × 2,000 lb/ton = 464 lb CO_2/MWh.
[38] 1.055 MWh/AF × 56,000 AF/yr × 464 lb/MW-hr × (1 ton/2000 lb) = 12,992 ton/yr.
[39] H. Blanco – USC Center for Sustainable Cities, *Water Supply Scarcity in Southern California: Assessing Water District Level Strategies, Chapter 9*, November 2012, Appendix 3, p. 251.
[40] Ibid.

7.0 Mitigation of Proposed Huntington Beach Desalination Plant Electric Load on Los Angeles Basin Grid Reliability

The continuous 30.34 MW Huntington Beach desalination plant load is equivalent to adding the electric load of 38,732 homes to the Los Angeles Basin grid.[41] The Los Angeles Basin is classified as a local reliability area that must maintain a minimum amount of local generation to assure supply reliability in the event that major transmission lines are unavailable at times of peak demand. According to the CPUC, available SCE electricity supply may not be sufficient to meet peak summer demand. In that context, SCE has received authorization from the CPUC to add supply resources in the Los Angeles Basin to address potential grid reliability issues in 2022 and 2023.[42]

The addition of a continuous 30.34 MW load in an area where state authorities have implemented fast-track mitigation measures to address the potential for grid reliability deficits underscores the need for the Poseidon GHG mitigation to be local clean energy projects. GHG offset credits associated with projects that are may be outside of the Los Angeles Basin and potentially outside of the country will not address this local grid reliability concern.

Three events in the last decade have put the focus on Orange County as a potential grid reliability weak point. These events are: 1) the unexpected permanent shutdown of the 2,250 MW San Onofre Nuclear Generating Station (SONGS) in 2012, 2) the well blowout at the SoCalGas Aliso Canyon gas storage facility in 2015 that led to the state's plan to permanently close Aliso Canyon by 2027, and 3) rolling statewide blackouts in August 2020 caused by tight electricity supplies under peak demand conditions.[43]

The SoCalGas Aliso Canyon natural gas storage facility suffered a catastrophic well blowout in October 2015 that resulted in the emergency closure of the storage field. This is the largest natural gas storage field in the SoCalGas system. As a result of the emergency closure of Aliso Canyon, the grid operator may now impose limits on natural gas consumption used in Los Angeles Basin electric generators under certain peak demand conditions.[44] A map of the affected electric generators in the Aliso Canyon delivery area is shown in Figure 4.[45] HBGS is in the Aliso Canyon delivery area.

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[41] 265,778,400 kWh-yr ÷ 6,862 kWh-yr/home = 38,732 homes.

[42] CPUC, Decision 21-12-015, *Phase 2 Decision Directing Pacific Gas and Electric Company, Southern California Edison Company, and San Diego Gas & Electric Company to Take Actions to Prepare for Potential Extreme Weather in the Summers of 2022 and 2023*, December 2, 2021.

[43] CAISO/CPUC/CEC, *Final Root Cause Analysis – Mid-August 2020 Extreme Heat Wave*, January 13, 2021.

[44] CAISO/CPUC/CEC/LADWP, *Aliso Canyon Winter Action Plan*, August 22, 2016.

[45] CAISO/CPUC/CEC/LADWP, *Aliso Canyon Action Plan to Preserve Gas and Electric Reliability for the Los Angeles Basin*, April 5, 2016, Figure 2, p. 11: https://www.cpuc.ca.gov/-/media/cpuc-website/files/uploadedfiles/cpuc_public_website/content/news_room/news_and_updates/aliso-canyon-action-plan-04-4-16-final-clean.pdf.

Figure 4. Los Angeles Basin electric generators served by Aliso Canyon storage field

At a minimum 30 MW of battery storage, with sufficient capacity to produce 30 MW for four hours, is needed to fully address the Huntington Beach desalination plant load during peak demand events.[46] This battery capacity can be placed locally in and around Huntington Beach to mitigate the additional load the Huntington Beach desalination plant will impose on the Los Angeles Basin grid.

Battery storage is now a primary grid reliability resource in California, with 1,000s of MW of battery storage capacity online or planned. As a result of CPUC's original battery storage decision in October 2013, SCE was required to have 580 MW energy storage capacity under contract by 2020.[47] Subsequent CPUC decisions have increased the amount of projected battery storage capacity in SCE territory to 2,810 MW by 2023.[48]

Battery storage is in use at the Irvine Ranch Water District, a member agency of OCWD. The 6.3 MW and 35.7 megawatt-hour (MWh) storage system utilizes Tesla batteries to store power at eleven of the Irving Ranch Water District's most energy-intensive points,

[46] Measured in MWh. Sufficient capacity was defined as the ability to operate for 4 hours at rated MW capacity on three consecutive days in SCE's November 21, 2014 Application A.14-11-012 to the CPUC in which SCE proposed battery projects capable of providing 4 hours of output at rated MW capacity on three consecutive days.
[47] See D.13-10-040, October 17, 2013, Table 2, p. 15: http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M079/K533/79533378.PDF.
[48] SCE press release, *SCE to Add 535 Megawatts of Energy Storage to Improve Grid Reliability -Resources Are Expected for Summer 2022*, October 21, 2021: https://newsroom.edison.com/releases/sce-to-add-535-megawatts-of-energy-storage-to-improve-grid-reliability-resources-are-expected-for-summer-2022.

including three water treatment plants, six pumping stations, a deep-water aquifer treatment plant and a groundwater de-salter facility.[49]

8.0 Poseidon Carbon Neutral Proposal Will Not Assure Offsetting of GHG Emissions

Poseidon plans to use GHG credits of one form or another to offset the overwhelming majority of GHG emissions associated with the proposed Huntington Beach desalination plant.[50] However, Poseidon states in its GHG reduction plan that $10 per metric ton of CO_2 emissions is its cost ceiling for GHG offsets. Poseidon will pay the City of Huntington Beach $10 per metric ton of CO_2 to fulfill its carbon neutrality commitment if carbon offsets cannot be found at that price or less.[51]

The basis for the $10 per metric ton of CO_2 value appears to be the California Air Resources Board (CARB) cap-and-trade auction floor value for the initial 2012 and 2013 cap-and-trade auctions.[52]

The CARB cap-and-trade allowance program is limited to specific source types and does not include desalination plants.[53] However, source types other than those currently included in the program may participate.[54] Poseidon states in its GHG reduction plan that it will purchase carbon offsets, potentially from CARB, to achieve carbon neutrality.[55]

The actual CARB cap-and-trade auction clearing price may be much higher than the $10 per metric ton ceiling defined by Poseidon. The allowance settlement price in the most recent cap-and-trade quarterly auction, in November 2021, was $28.26 per metric ton.[56] The cap-and-trade program also maintains a two-tier Allowance Price Containment

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[49] Irvine Ranch Water District press release, *IRWD and Macquarie Capital Announce Completion of the Largest Behind-the-Meter Energy Storage Project in the U.S.*, June 25, 2018:

[50] Poseidon Resources, *Huntington Beach Desalination Plant - Energy Minimization and Greenhouse Gas Reduction Plan*, February 27, 2017, pp. 14-21. Poseidon indicates that it is also "exploring the installation" of rooftop solar (606 kilowatts) on its desalination plant buildings (p. 11).

[51] Ibid, p. 18.

[52] CARB, *Cap-and-Trade Regulation Instructional Guidance, Chapter 5: How Do I Buy, Sell, and Trade Compliance Instruments?*, December 2012, p. 9: https://www.arb.ca.gov/cc/capandtrade/guidance/chapter5.pdf#page=2.

[53] CARB, *Regulation for the California Cap on Greenhouse Gas Emissions and Market-Based Compliance Mechanisms*, April 2019: http://www.c2es.org/us-states-regions/action/california/cap-trade-regulation#sub3.

[54] Ibid.

[55] Poseidon Resources, *Huntington Beach Desalination Plant - Energy Minimization and Greenhouse Gas Reduction Plan*, February 27, 2017, pp. 15-16. "Poseidon will purchase carbon offset projects, except for RECs, through/from TCR, CAR, CARB, or California APCDs/AQMDs." and "the Plan is designed to assure that selected offset projects will mitigate GHG emissions as effectively as on-site or direct GHG reductions."

[56] CARB, *Summary of Auction Settlement Prices and Results*, November 2021 (accessed January 16, 2022): https://ww2.arb.ca.gov/sites/default/files/2020-08/results_summary.pdf.

Reserve where allowances can be directly purchased at a set price, in 2022, of $46.05 and $59.17 per metric ton.[57] Both tier prices increase by 5 percent plus inflation each year.[58]

In the event that no allowances remain in the Reserve and an entity like Poseidon Huntington Beach does not have sufficient allowances in its compliance accounts, CARB has the authority to offer an annual price ceiling sale to cover the gap. CARB has set the price of the 2022 price ceiling sale at $72.29 per metric ton. The price ceiling also increases by 5 percent plus inflation each year.[59]

In its February 27, 2017 GHG compliance submittal, Poseidon has proposed a default GHG offset protocol that assures that Poseidon will pay no more than $10 per metric ton of CO_2 emissions.[60] As noted, Poseidon projects that it will emit 68,745 metric tons per year of CO_2, and intends to purchase 50 years of allowances/offset credits via a one-time upfront payment. At $10 per metric ton, Poseidon would pay $687,450 per year to assert the desalination plant is carbon neutral.

The GHG offset compliance cost would be much higher for the Huntington Beach desalination plant using CARB cap-and-trade allowances. Table 5 is a comparison of the lifetime, 50-year upfront payment for: 1) carbon offsets at $10 metric ton, 2) the November 2021 CARB cap-and-trade allowance settlement price, 3) the lower-tier 2022 reserve price, 4) the upper-tier 2022 reserve price, and 5) the 2022 ceiling price.

Table 5. Comparison of proposed Poseidon carbon offset ceiling price to CARB cap-and-trade (C&T) allowance prices

Carbon offset price type	Value ($/metric ton)	Quantity (metric ton/yr)	Annual cost ($/yr)	50-year carbon offset cost ($)
Poseidon self-selected carbon offset price cap	10	68,745	687,745	34,387,250
C&T Nov 2021 settlement price	28.26	68,745	1,942,734	97,136,700
C&T 2022 reserve price (lower tier)	46.05	68,745	3,165,707	158,285,350
C&T 2022 reserve price (upper tier)	59.17	68,745	4,067,642	203,382,100
C&T 2022 ceiling price	72.29	68,745	4,969,576	248,478,802

[57] CARB, *Cap-and-Trade Program, Cost Containment Information*, webpage accessed January 16, 2022: https://ww2.arb.ca.gov/our-work/programs/cap-and-trade-program/cost-containment-information. "From 2021 - 2030, allowances in the Reserve will be offered at two tier prices. Those levels were set at USD 41.40 and USD 53.20 in 2021. Both tier prices increase by 5% plus inflation each year. The tier prices in 2022 are USD 46.05 and USD 59.17. Price Ceiling Sale: CARB may offer an annual price ceiling sale to covered and opt-in entities to purchase what they need to meet their compliance obligation due that November. . . The price of the 2022 price ceiling sale is USD 72.29."

[58] Ibid.

[59] Ibid.

[60] Poseidon Resources, *Huntington Beach Desalination Plant - Energy Minimization and Greenhouse Gas Reduction Plan*, November 6, 2015, p. 18.

A realistic upper-bound ceiling for the one-time upfront 50-year lifetime cost of GHG mitigation for the Huntington Beach desalination plant, based on the 2022 CARB cap-and-trade allowance price ceiling, would be approximately $250 million. This is a much greater cost than the $34.4 million projected by Poseidon at a self-determined GHG mitigation cost ceiling of $10 metric ton of CO_2.

Legitimacy of carbon offsets: The legitimacy of carbon offsets has been questioned due to the difficulty in corroborating the validity of claims that the offsets represent bona fide permanent GHG reductions. This problem was addressed in a December 2021 Los Angeles Times article on the development of Tejon Ranch north of Los Angeles, where a recent court settlement would allow development of nearly 20,000 new homes:[61]

> Researchers have documented many flaws in these (carbon offset) programs, including wildfires burning down forests that are supposed to be protected, overestimates of how much carbon is stored in certain landscapes, and the inclusion of trees that were already protected and were never going to be chopped down.
>
> Responding to that criticism, Climate Resolve's Lindblad said the settlement will push Tejon Ranch to invest specifically in "new projects that reduce emissions." It also requires Tejon Ranch to use offsets only as a "last resort" when it's unable to reduce emissions onsite - and only then with the approval of a monitoring group formed by Climate Resolve and the developer.

The skepticism of carbon offsets is widespread in the electricity supply arena. California is rapidly transitioning from a historic investor-owned utility (IOU) model of "bundled" supply and delivery service, to supply by public Community Choice Energy (CCE) providers and delivery over the transmission and distribution system owned by the incumbent IOU. In the case of Huntington Beach, the CCE provider is Orange County Power Authority (OCPA),[62] and the IOU is SCE.

A number of CCEs are not using carbon credits to claim GHG reductions for their electricity supply portfolio, primarily due to customer concerns about the validity of the

[61] Los Angeles Times, *Can a far-flung suburb be net zero?*, December 27, 2021:
[62] See: https://www.ocpower.org/. OCPA will begin serving commercial customers in April 2022 and residential customers in October 2022.

claimed reductions. CCEs such as Peninsula Clean Energy and Marin Clean Energy have rejected the use of carbon offsets to reach GHG reduction targets.[63,64]

9.0 Local GHG Reductions Are Necessary to Address the Local Impacts of the Desalination Plant

The most effective mechanism available to Poseidon to assure the GHG emissions generated by the operation of the Huntington Beach desalination plant are directly offset in the Los Angeles Basin is to completely offset the GHG emissions from the operation of the desalination plant with local solar and battery power. This would require approximately 150 MW_{AC} of installed solar capacity,[65] along with 120 MW-hr of battery storage in the Huntington Beach area, to fully offset the GHG emissions and grid reliability impacts of the desalination plant.

Rooftop solar is being installed in the Los Angeles Basin and nearby areas at a large scale. The installation rate of net-metered rooftop solar[66] on homes and businesses in SCE territory is approximately 375 MW_{AC} per year.[67] To put this solar installation rate in context, at the current rooftop solar installation rate of about 30 MW_{AC} per month,[68] it would take five months to install the 150 MW_{AC} of solar capacity necessary to fully address the electricity demand of the proposed Huntington Beach desalination plant.

Poseidon can effectively offset its entire GHG emissions burden by building 150 MW_{AC} of local solar on commercial and industrial rooftops and parking lots. The model for this project is the SCE warehouse rooftop solar project, involving the aggregation of many warehouse rooftops in the framework of a single large project, in the Inland Empire.[69]

The cost of commercial rooftop solar is reasonable. Figure 5 shows the estimated installed unit benchmark cost of residential and commercial rooftop solar, and utility-

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63 December 2017, *Peninsula Clean Energy 2018 Integrated Resource Plan*, p. 11. "PCE has made a commitment not to procure unbundled RECs to meet either its RPS requirements or its additional requirements to provide customers with 50% or 100% renewable energy. Members of PCE's Board, Executive Committee, and Citizens Advisory Committee expressed concerns about how unbundled RECs have been used and misused to give the impression that polluters are more "green" and "clean" than they actually are. Although each unbundled REC is created because 1 MWh of renewable energy has been generated to create that REC, the use of unbundled RECs has created confusion in the market."

64 Marin Clean Energy webpage, accessed January 5, 2022: https://www.mcecleanenergy.org/energy-suppliers/. "Starting in 2019, MCE's energy portfolio includes zero unbundled renewable energy certificates (RECs)."

65 The capacity factor of rooftop solar in Orange County would on average be in the range of about 0.20. Poseidon would have a continuous electricity demand of about 30 MW on a continuous basis. For the Poseidon annual electricity demand to be completely met by local solar power would require: 30 MW ÷ 0.20 = 150 MW of solar capacity.

66 Net-metered rooftop solar is solar capacity installed on the customer side of the electric meter.

67 California Distributed Generation Statistics, "Statistics and Charts" and "SCE", accessed January 5, 2022: https://www.californiadgstats.ca.gov/charts/. The five-year 2016-2020 installation average rate for SCE territory is approximately 375 MW per year.

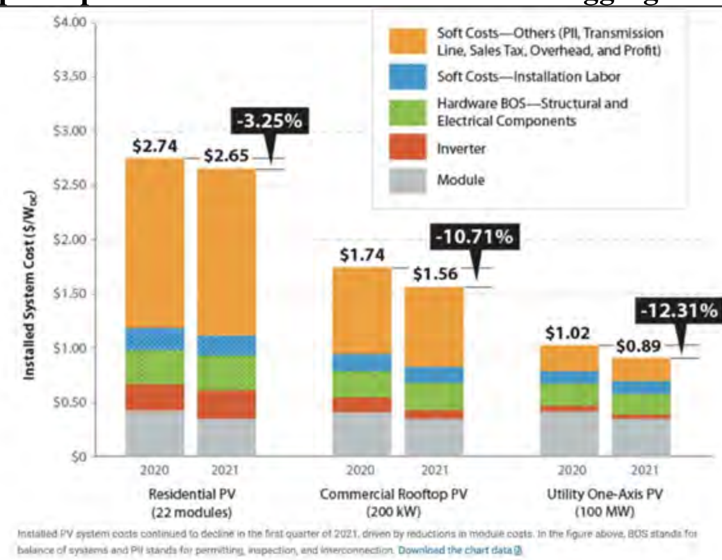
68 375 MW_{AC}/year ÷12 months/year = 31.25 MW_{AC}/month.

69 See **Attachment A**.

scale remote solar capacity, in the first quarter of 2021. The benchmark installed cost of commercial rooftop solar in the first quarter of 2021 was $\$1.56/W_{DC}$.[70,71] The cost decline rate for commercial rooftop solar installed cost between 2020 and 2021 was approximately 10 percent. [72]

<u>Recommended approach</u>: Poseidon would finance the installation of 150 MW_{AC} of solar on commercial and industrial rooftops and parking lots in Huntington Beach and (potentially) surrounding cities. Assuming a contract year of 2024 and a 10 percent per year decline rate in the installed cost of commercial rooftop solar, the installed cost of this solar capacity would be about $\$1.26/W_{AC}$.[73] Under this scenario, the cost to Poseidon of this solar capacity would be: $\$1.26/W_{AC} \times 10^6\ W_{AC}/MW_{AC} \times 150\ MW_{AC} = \$189$ million (2021 dollars).

Figure 5. 2021 installed cost of rooftop and utility-scale solar, \$ per watt, with principal elements of the installed cost disaggregated[74]



Battery storage, with four hours of duration at the rated 30 MW demand of Poseidon Huntington Beach, would be included at the commercial solar installations to assure the desalination plant imposes no net additional load on the grid during peak demand conditions. The total battery storage capacity would be 30 MW × 4 MWh/MW = 120 MWh.

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[70] NREL, *U.S. Solar Photovoltaic System and Energy Storage Cost Benchmark: Q1 2021,* November 2021: https://www.nrel.gov/news/program/2021/new-reports-from-nrel-document-continuing-pv-and-pv-plus-storage-cost-declines.html.

[71] The assumed direct current-to-alternating current ("dc-to-ac") conversion factor for commercial rooftop solar is 0.90. Therefore, the installed "ac" capacity installed capital cost of commercial rooftop solar is: $\$1.56/W_{DC} \div 0.90 = \$1.73/W_{AC}$. .

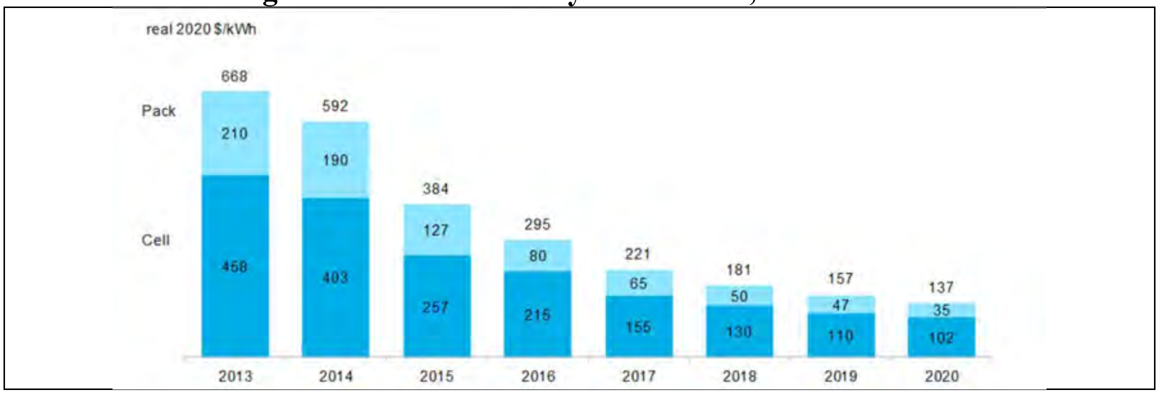
[72] NREL, 2021, p. vi. Figure ES-1. Comparison of Q1 2020 and Q1 2021 PV cost benchmarks.

[73] $\$1.73/W_{AC} \times (1 - 0.10)^3 = \$1.26/W_{AC}$.

[74] Ibid.

A survey of leading battery manufacturers indicates that battery equipment costs are steadily declining, as shown in Figure 6, with a benchmark equipment cost of $137/kWh in 2020.[75] Additionally, the National Renewable Energy Laboratory (NREL) forecasts that the installed cost of battery storage, which includes installation labor and all additional hardware - and soft costs like permitting - to make the battery storage fully operational, will be approximately $250/kWh in 2024-2025 timeframe.[76] Using the NREL estimate, Poseidon's cost to purchase and install this amount of battery storage capacity would be: 120 MWh × 10^3 kWh/MWh × $250/kWh = $30 million.

Figure 6. Lithium battery cost decline, 2013-2020[77]



Note: A battery pack and battery cells are the two elements of a functional lithium battery.

The total cost to Poseidon to fully address it energy needs with local solar power and assure grid reliability under peak demand conditions with sufficient battery storage would be: $189 million (solar) + $30 million (battery storage) = $219 million.

This $219 million solar + battery capital expenditure, averaged over the 50-year operating lifetime of the Huntington Beach desalination plant, would amount to $4.4 million per year. The San Diego County Water Authority calculated a $2,866/AF cost for desalination water from Poseidon's Carlsbad desalination plant for 2019-2020.[78] The annual gross revenue from the sale of 56,000 AF from the Huntington Beach desalination plant, at $2,866/AF, would be $160 million per year.

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[75] BloombergNEF, *Battery Pack Prices Cited Below $100/kWh for the First Time in 2020, While Market Average Sits at $137/kWh*, December 16, 2020: https://about.bnef.com/blog/battery-pack-prices-cited-below-100-kwh-for-the-first-time-in-2020-while-market-average-sits-at-137-kwh/. "BNEF's 2020 Battery Price Survey, which considers passenger EVs, e-buses, commercial EVs and stationary storage, predicts that by 2023 average pack prices will be $101/kWh."

[76] NREL, *Cost Projections for Utility-Scale Battery Storage: 2021 Update*, June 2021, Figure ES-2. Battery cost projections for 4-hour lithium ion systems, p. iv: https://www.nrel.gov/docs/fy21osti/79236.pdf.

[77] Ibid.

[78] San Diego County Water Authority, *Rates & Charges and Budget Update - Administrative and Finance Committee*, PowerPoint presentation, October 22, 2020, pdf p. 78: https://www.sdcwa.org/sites/default/files/2016-12/Board/2020_Presentations/2020_10_22BoardPresentations.pdf.

Therefore, the cost of GHG mitigation, at $4.4 million per year over 50 years, would represent less than 3 percent of the annual gross revenue of $160 million per year.[79]

Substantial work has already been done by the California Energy Commission (CEC) on the capacity of Huntington Beach to host rooftop commercial and industrial solar rooftop and parking lot installations.[80] The 2019 CEC study evaluated one neighborhood in Huntington Beach, the Oak View neighborhood. However, the study also characterized the solar hosting capacity of six Huntington Beach substations in the vicinity of Oak View, concluding these substations could collective absorb over 350 MW of additional distributed solar generation.[81]

The 2019 CEC study also reviewed a "utility scenario," where solar would be located only on commercial and industrial rooftops and parking lots, with the solar output on the utility side of the meter and delivered directly to the grid.[82]

The Oak View analysis is scalable to other areas of Huntington Beach, as noted in the CEC study. This tool should be utilized by Poseidon and the City of Huntington Beach to identify 150 MW_{AC} of solar capacity on commercial and industrial rooftops and parking lots in Huntington Beach. The battery storage capacity can be co-located at the sites with rooftop solar or located at the nearest utility substation(s). The CEC's scalable "utility scenario" is the right template to identify the local solar sites that will serve as GHG mitigation for the proposed Huntington Beach desalination plant.

10.0 Conclusions

Water demand in OCWD service territory has declined substantially since the Huntington Beach desalination project was first proposed in 1998. Demand has declined from approximately 500,000 AFY to 400,000 AFY, a 20 percent reduction. On the supply side, the GWRS began producing purified recycled water in 2008 and currently produces 112,000 AFY (100 MGD). GWRS production is expected to increase to 145,000 AFY (130 MGD) in 2023. OCWD forecasts it will meet water demand through 2045 without supply from the Huntington Beach desalination plant.

The energy intensity of ocean water desalination is more than four times greater than that of purified recycled water. As a result, the carbon footprint of ocean water desalination is more than four times greater than that of purified recycled water.

Poseidon proposes to purchase GHG offsets to achieve carbon neutrality for the desalination plant. This approach to carbon neutrality will not address the local grid reliability impacts of adding a continuous 30 MW load in the Los Angeles Basin.

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[79] $4.4 million per year ÷ $160 million per year = 0.0275 (2.75 percent)

[80] California Energy Commission, *Huntington Beach Advanced Energy Community Blueprint - A Scalable, Replicable, and Cost-Effective Model for the Future*, April 2019.

[81] **Attachment B** (excerpts of Huntington Beach report), Table 14: 66/12 kV Substations – Existing Generation, Projected Load, and Maximum Remaining Hosting Capacity (p. 81).

[82] Ibid, p. C-1, p. C-4, p. C-5.

150 MW_{AC} of local solar power, and 30 MW of local battery storage, should be developed by Poseidon in Huntington Beach to fully mitigate the carbon footprint of desalination plant operations and to assure the plant does not compromise local grid reliability. The annual cost of the solar and battery storage GHG mitigation scenario would be in the range of 3 percent of the annual gross revenue of the Huntington Beach desalination plant.

ATTACHMENT A

California Public Utilities Commission
505 Van Ness Ave., San Francisco

FOR IMMEDIATE RELEASE **PRESS RELEASE**
Media Contact: Terrie Prosper, 415.703.1366, news@cpuc.ca.gov Docket #: A.08-03-015

CPUC APPROVES EDISON SOLAR ROOF PROGRAM

SAN FRANCISCO, June 18, 2009 - The California Public Utilities Commission (CPUC), in its ongoing commitment to innovative programs and policies to advance the delivery of renewable energy, today approved a solar photovoltaic program for Southern California Edison.

The program will result in the deployment of 500 megawatts (MW) of solar photovoltaic (PV) on existing commercial rooftops in Edison's service territory. Edison will own, install, operate, and maintain 250 MW of solar PV projects, which will primarily consist of one to two MW rooftop systems. The remaining 250 MW will be installed, owned, and operated by independent, non-utility solar providers selected through a competitive process.

Prior to today's decision, utility solar programs in the one to two MW range had limited participation in the California Solar Initiative or Renewables Portfolio Standard (RPS) program. Edison's program creates a new avenue for developing such smaller sized solar projects.

"This program represents a valuable complement to the existing renewable procurement efforts we have underway, given the significant permitting challenges large scale renewables face, both in terms of transmission and the generating facilities themselves," said CPUC President Michael R. Peevey. "It represents an important hedging strategy by allowing for the deployment of distributed resources that, while somewhat more expensive than the large scale renewable projects that are the primary focus of the RPS program, offer a much higher level of certainty in terms of when they will come online."

Added Commissioner John A. Bohn, author of the decision, "This decision is a major step forward in diversifying the mix of renewable resources in California and spurring the development of a new market niche for large scale rooftop solar applications. Unlike other generation resources, these projects can get built quickly and without the need for expensive new transmission lines. And since they are built on existing structures, these projects are extremely benign from an environmental standpoint, with neither land use, water, or air emission impacts. By authorizing both utility-owned and private development of these projects we hope to get the best from both types of ownership structures, promoting competition as well as fostering the rapid development of this nascent market."

"This decision is good for California because it makes good use of all that sun and warehouse roofs in Southern California to produce clean energy right where we need it, both by Edison and independent generators," commented Commissioner Rachelle Chong. "I commend Edison for its foresight in bringing a focus on commercial solar PV projects that are 1-2 megawatts in size."

Commissioner Timothy Alan Simon said, "I support this decision because it strikes a balance between promoting utility-owned generation and competitive procurement for independent energy producers, as well as distributed generation and central station solar systems. Finally, it will bring much needed economic stimulus to the Inland Empire."

Because this is the first significant foray by a utility into ownership of renewable generation, the CPUC will carefully monitor the program's progress, examine ways in which the program can be improved, and fine tune the program when and where appropriate.

The energy generated from the project will be used to serve Edison's retail customers and the output from these facilities will be counted towards Edison's RPS goals. The output and capacity of the projects will not count towards the California Solar Initiative program goals.

The RPS program is one of the most ambitious renewable energy standards in the country. It requires investor-owned utilities to procure 20 percent of their electricity sales from renewable sources by 2010. Governor Schwarzenegger subsequently established an RPS target of 33 percent by 2020 for all retail sellers of electricity. The California Solar Initiative has a goal to install 3,000 MW of new customer solar projects by 2016, moving the state toward a cleaner energy future and helping lower the cost of solar systems for consumers.

###

ATTACHMENT B

Energy Research and Development Division

FINAL PROJECT REPORT

Huntington Beach Advanced Energy Community Blueprint

A Scalable, Replicable, and Cost-Effective Model for the future

California Energy Commission

Gavin Newsom, Governor

April 2019 | CEC-500-2019-047

EXECUTIVE SUMMARY

Introduction

California's Renewables Portfolio Standard requires that 33 percent of the state's electricity be powered using renewable resources by 2020, 50 percent by 2026, and 60 percent by 2030. In 2016, the Energy Commission released a solicitation titled, The EPIC Challenge, a two-phase competition to assist California's local governments in meeting these targets. The competition focuses on overcoming financial and regulatory challenges to more widely deploy advanced energy communities. This concept was created to represent the combination of technology types that can (1) reduce energy demand through energy conservation measures, (2) generate energy using renewable sources, and (3) manage community energy flows to optimize service and connection with the surrounding communities. The first phase of the competition is focused on the planning and design of a replicable advanced energy community, inclusive of a master community design, case study, and resources. Phase II will award funding to build-out the design developed under Phase I, and was released in the fall of 2018.

As a Phase I recipient, a team consisting of the Advanced Power and Energy Program at University of California, Irvine, the City of Huntington Beach, Altura Associates, the National Renewable Energy laboratory, Southern California Edison, and Southern California Gas was partnered together to develop tools to optimally design an advanced energy community for the disadvantaged Oak View community. The Huntington Beach Advanced Energy Community project's goal was to install various interworking clean energy technologies in way that could be successfully replicated in other communities.

Project Process

Tool development included the creation of the community-scale energy modeling platform URBANopt. This tool is able to capture the complex relationships between building and community energy use when considering different types of energy conservation measures. Since it is based on the EnergyPlus building energy simulation engine, URBANopt can be expanded to include numerous other energy conservation and renewable generation measures. The current version examines interior and exterior lighting efficiency, plug load efficiency, and structural improvements that can be used to reduce interior heating and cooling loads. Development also included a smart community energy management model that included the DERopt community solar energy and battery energy storage optimization model. Using this model, it is possible to optimally determine the best types and locations of renewable generation within the community, and ensure feasible operation. This model also can be used to evaluate the renewable fuel potential for a community.

During development of the tools, the team also participated in extensive community outreach, which is discussed in more detail, under the Knowledge Transfer section.

Table 12: Southern California Edison Time-of-Use Rates for Domestic Customers

Charge Type	TOU-D-A	Notes
Summer On-Peak ($/kWh)	0.48	Summer weekdays from 2pm -8pm
Summer Mid-Peak ($/kWh)	0.28	Summer weekdays from 8am - 2pm or 8pm - 10pm, or Summer Weekends from 8am - 10pm
Summer Off-Peak ($/kWh)	0.12	All other summer times
Winter On-Peak ($/kWh)	0.36	Winter weekdays from 2pm -8pm
Winter Mid-Peak ($/kWh)	0.27	Winter weekdays from 8am - 2pm or 8pm - 10pm, or Winter Weekends from 8am - 10pm
Winter Off-Peak ($/kWh)	0.13	All other winter times

Source: University of California, Irvine

Table 13: Southern California Edison Tiered Rates for Domestic Customers

Rate	SCE - D	SCE - D - Care	Notes
Summer T1	0.1746	0.11784	Summer usage up to 100% baseline
Summer T2	0.2462	0.16558	Summer usage between 101% and 400% baseline
Summer T3	0.3466	0.23308	Summer usage above 400%
Winter T1	0.1746	0.11784	Winter usage up to 100% baseline
Winter T2	0.2462	0.16558	Winter usage between 101% and 400% baseline
Winter T3	0.3466	0.23308	Winter usage above 400%

Source: University of California, Irvine

Existing Oak View Energy Infrastructure

As a first step towards modeling the existing electric distribution system, the team performed an initial characterization of the local distribution circuits and substations using SCE's DERiM (Distributed Energy Resources Interconnection Map) [16]. The DERiM ArcGIS© database provided not only the precise geographical location of substations, sub-transmission, and distribution circuits, but also information on the current and projected future load and generation and, most importantly, maximum distributed generation hosting capacity.

Ocean View 66/12 kV Substation

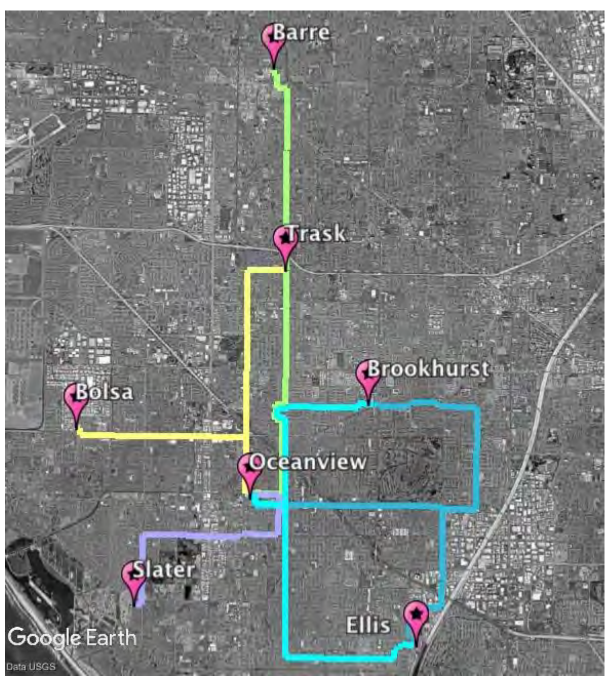
The Ocean View 66/12 kV substation is the B-substation that feeds the Oak View AEC. A B-substation steps-down voltage from the sub-transmission voltage level (typically 66 kV and 115 kV) to the distribution voltage level (typically 4 kV, 12 kV, and 16 kV), The Ocean View Substation is part of the Ellis-A System [16]. Ocean View's projected load for 2017 is 49.20 MW.

Ellis-66/12 kV currently hosts 3.95 MW of DG and still offers capacity for hosting an additional 40.85MW [16]. Figure 30 shows an aerial view of the Ocean View substation as found using *Google Earth Pro©* [41]. There are five 66 kV sub-transmission circuits (Figure 31) that create a network between six neighboring B-substations: Ellis, Bolsa, Barre, Trask, Brookhurst, and Slater.

Figure 30: View of Ocean View Substation

Source: Google Earth

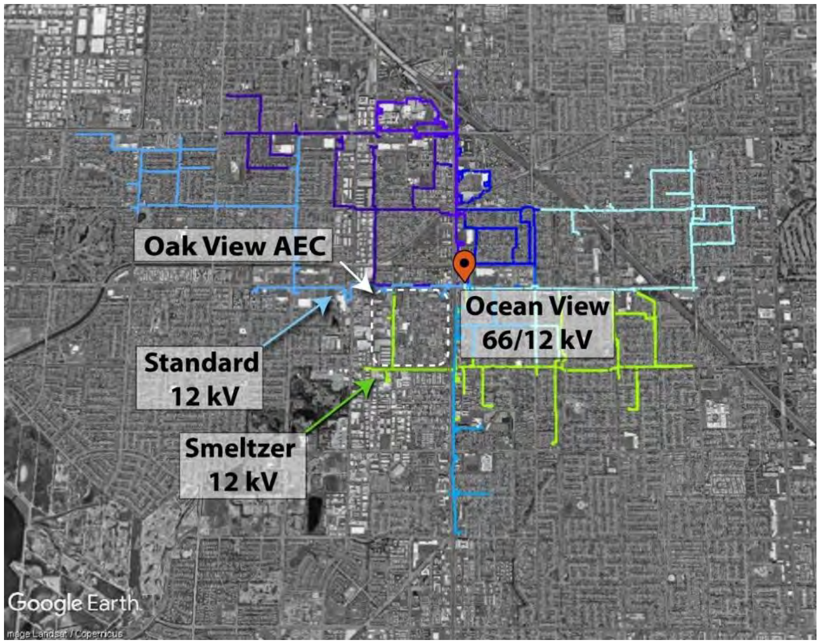
Figure 31: 66 kV Circuits from Ocean View substation.



Source: University of California, Irvine; DERiM circuits exported to Google Earth

Additionally, there are seven 12 kV circuits (Figure 32) that originate from Ocean View and deliver electricity to the Oak View AEC and surrounding area: Smeltzer, Bushard, Beach, Bishop, Heil, Standard, and Wintersburg. The Oak View AEC residential customers are mainly served by Smeltzer 12 kV, whereas the north-west commercial customers are mainly served by Standard 12 kV.

Figure 32: 12 kV Circuits from Ocean View Substation



Source: University of California, Irvine; DERiM circuits exported to Google Earth

Neighboring 66/12 kV Substations

Data gathered from DERiM [16] for existing generation, projected 2018 system load, and remaining generation hosting capacity on the primary 66 kV substations are summarized in Table 14. The Integration Capacity Analysis (ICA) method used to calculate the maximum capacity values (see [42]) defines the amount of distributed generation and aggregated loads the system that may be capable of supporting in its current configuration, that is, without any upgrades needed. The ICA takes into account four criteria with the ultimate goal to maintain system safety and reliability after DER placement:

1. Thermal rating: prevents thermal overloads of conductors, transformers, circuit breakers, and line devices.
2. Power quality/vVoltage: prevents operation outside of the allowable power quality or voltage limits defined by the California Rule 21 and Engineering Standards, which are drawn from American National Standard (ANSI) C84.1 - 2011 Range A. Steady-state voltage is limited to remain in the range between 0.95 p.u. and 1.05 p.u. or 114 to 126 on a 120 V base. Voltage fluctuation limits of 3 percent are used.
3. Protection: ensures existing protection schemes will still promptly detect and respond to abnormal system conditions

4. System flexibility: ensures line transfers and emergency restorations are still performed reliably.

Table 14: 66/12 kV Substations – Existing Generation, Projected Load, and Maximum Remaining Hosting Capacity

Substation	Total Existing Generation (MW)	Projected Load (MW)	Maximum Remaining Generation Integration Capacity (ICA) (MW)
Barre (66/12 kV)	3.35	75.50	108.65
Brookhurst	3.30	44.80	41.50
Bolsa	2.90	40.00	37.10
Ellis (66/12 kV)	3.95	42.50	40.85
Slater	4.42	50.50	51.57
Trask	5.58	86.10	95.22

Source: University of California, Irvine, [16]

The maximum remaining generation ICA values are defined as technology-agnostic, that is, they do not refer to a specific type of distributed generation resource. To calculate the ICA for a specific generation technology (like solar PV), the technology specific hourly per-unit production (the hourly output per MW installed) must be taken into account. Equation (1) is used to calculate the remaining solar PV hosting capacity for the AEC.

$$TS_{ICA}(t) = \frac{TA_{ICA}}{TS_{pu}(t)} \tag{1}$$

Where:

$TS_{ICA}(t)$ = Technology Specific ICA on time t

TA_{ICA} = Technology Agnostic ICA

$TS_{pu}(t)$ = Technology Specific per-unit output on time *t*.

66 kV Sub-Transmission Feeders

The lengths of the 66 kV sub-transmission feeders connecting the substations were measured using Google Earth's geospatial measuring tool and are shown in Figure 33.

12 kV Distribution Feeders

The current generation/load and the remaining generation/loading hosting capacity of the two primary 12 kV distribution feeders, Smeltzer and Standard, were also gathered from DERiM. According to SCE's methodology [42], the ICA values for 12 kV feeders were broken down into specific circuit segments (shown in Table 15 and Table 16). As a starting point for this study, the total ICA assumed is the sum of the ICA values of the individual segments that directly feed the AEC community. For the AEC, these segments 2 and 3 for the Smeltzer circuit (Figure 34), and segment 1 for the Standard circuit. The values assumed for feeder length account for the total circuit length, which was measured using the geospatial measuring tool in Google Earth.

capacity for the Oak View community. Under this method, the team considered realistic rooftop constraints, such as the existence of existing roof mounted equipment or exhaust flue ducting, building code at setback requirements, and other structural limitations observed during site visits and energy audits. The total area that can be covered is shown in the aerial image of the Oak View community in Figure 44.

Figure 44: Aerial Image of Maximum Solar Photovoltaic Capacity across Entire Oak View Community

Source: University of California, Irvine

The maximum solar PV capacity assuming a panel efficiency of 18 percent is shown in Table 28. If the maximum capacity were installed, the projected energy production would be approximately 16 GWh, less than the projected 17 GWh used annually after LED and plug load ECM implementation. This shortfall, however, is due to the mismatch between the solar PV capacity in the waste transfer sector and the electrical loads at that location. The maximum solar PV capacity at the waste transfer station is projected to produce 1.6 GWh, much less than

APPENDIX C: Solar Photovoltaic Scenarios

In addition to the maximum solar PV capacity scenario developed in the section on distributed energy resource potential in Chapter 8, three additional solar PV scenarios were developed using the heuristic solar PV design tool. These scenarios include the “grid constraint scenario” where solar PV is sized such that the solar PV system is capable of operating without storage, curtailment, or overloading the local utility grid, the “carport scenario”, where only carport solar PV is adopted, and the “utility scenario”, where only large solar PV systems are adopted to be placed on the utility side of the meter.

Under the grid constraint scenario, as shown in Figure C-1, each PV Zone in the community is given a limitation of the amount of PV can be deployed in that specific Zone. The determination is made based on the transformer rating such as power and voltage as well as the corresponding power flow. Those factors become the constraint for how much PV each zone could potentially have without causing the problem to the local power distribution system. Therefore, the PV installation potential has been dramatically reduced in the community. From maximum to grid constraint scenario, certain specific design criteria need to be considered to optimizing the system efficiency and maximizing energy output. After applying the methodology described in Chapter 1, the community’s total PV potential is reduced by almost 57 percent.

Figure C-1: Oak View Community Solar Photovoltaic System Overview under the Grid Constraint Scenario

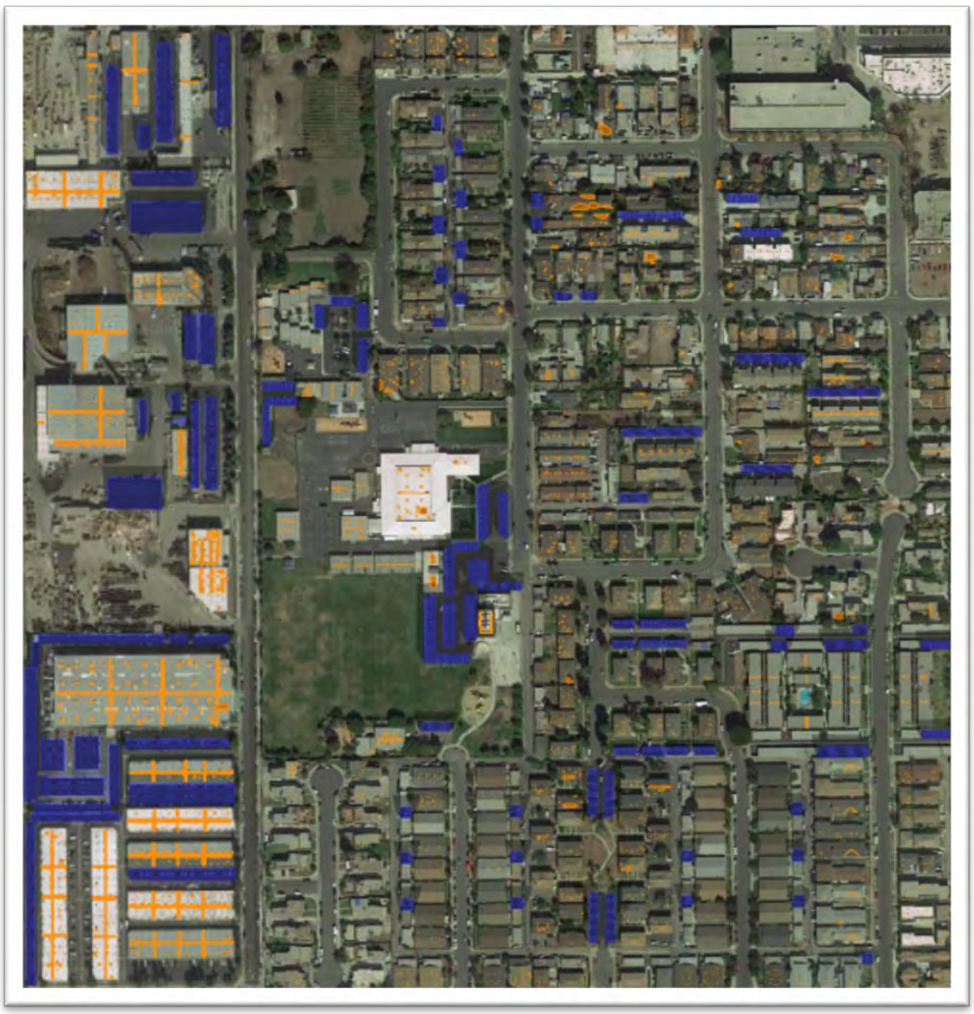
Source: University of California, Irvine

Table C-1: Constraint Scenario, Solar Photovoltaic Potential and Energy Production Broken Down into All Community Sectors

Oak View Community (Grid Constraint Scenario)	C&I Sector	School Sector	Residential Sector	Community Total
PV Capacity (MW)	3.62	0.66	1.74	6.02
Annual Production (GWh)	5.50	0.97	2.65	9.12
kWh/kW	1,521	1,463	1,525	1,515
System Performance (%)	79.5%	79.3%	78.4%	79.2%

Under this scenario, as shown in Figure C-2, remove all the rooftop PV arrays, and only count for carport PV which is designed based on the empty parking lot in the community. This scenario is supposed to estimate how much public carport PV structure cloud potentially exist without considering any carport PV design regulations and requirements (such as carport PV structure needs to be 20 feet away from permanent buildings). Those will be considered and included in the utility scenario. In the carport PV scenario, most carport PV array will be concentrated in the C&I and the School sector. There are several available carport PV potential locations in the Residential sector which could provide shade for public vehicles. The carport PV array in the residential sectors is usually small systems and likely to be scatted around, which could be a challenge for power local distribution compared with those large, concentrated, and continuous arrays in commercial sectors.

Figure C-2: Oak View Community Solar Photovoltaic System Overview under the Carport Photovoltaic Scenario



Source: University of California, Irvine

Table C-2: Carport Photovoltaic Scenario, Solar Photovoltaic Potential and Energy Production Broken Down into All Community Sectors

Oak View Community (Carport PV Scenario)	C&I Sector	School Sector	Residential Sector	Community Total
PV Capacity (MW)	2.64	0.48	0.99	4.11
Annual Production (GWh)	3.98	0.72	1.55	6.25
kWh/kW	1,509	1,504	1,567	1,521
System Performance (%)	81.8%	82.2%	82.2%	81.9%

In utility scenario, as shown in Figure C-3, most of the solar PV will be placed in C&I sector, with rest of the sectors with only carport PV system. Comparing with the carport PV scenario, all the carport PV in the community are designed based on regulations and rules. The PV capacity in each zone and sector are sized under the constraint from the grid. Comparing with the carport PV scenario, most of the small carport PV structure between car garages in South Residential and North Residential Sector cannot be built based on the design requirement that the canopy PV structure needs to be 20 feet from permanent buildings, which caused a dramatical reduction in solar PV capacity in the residential sector.

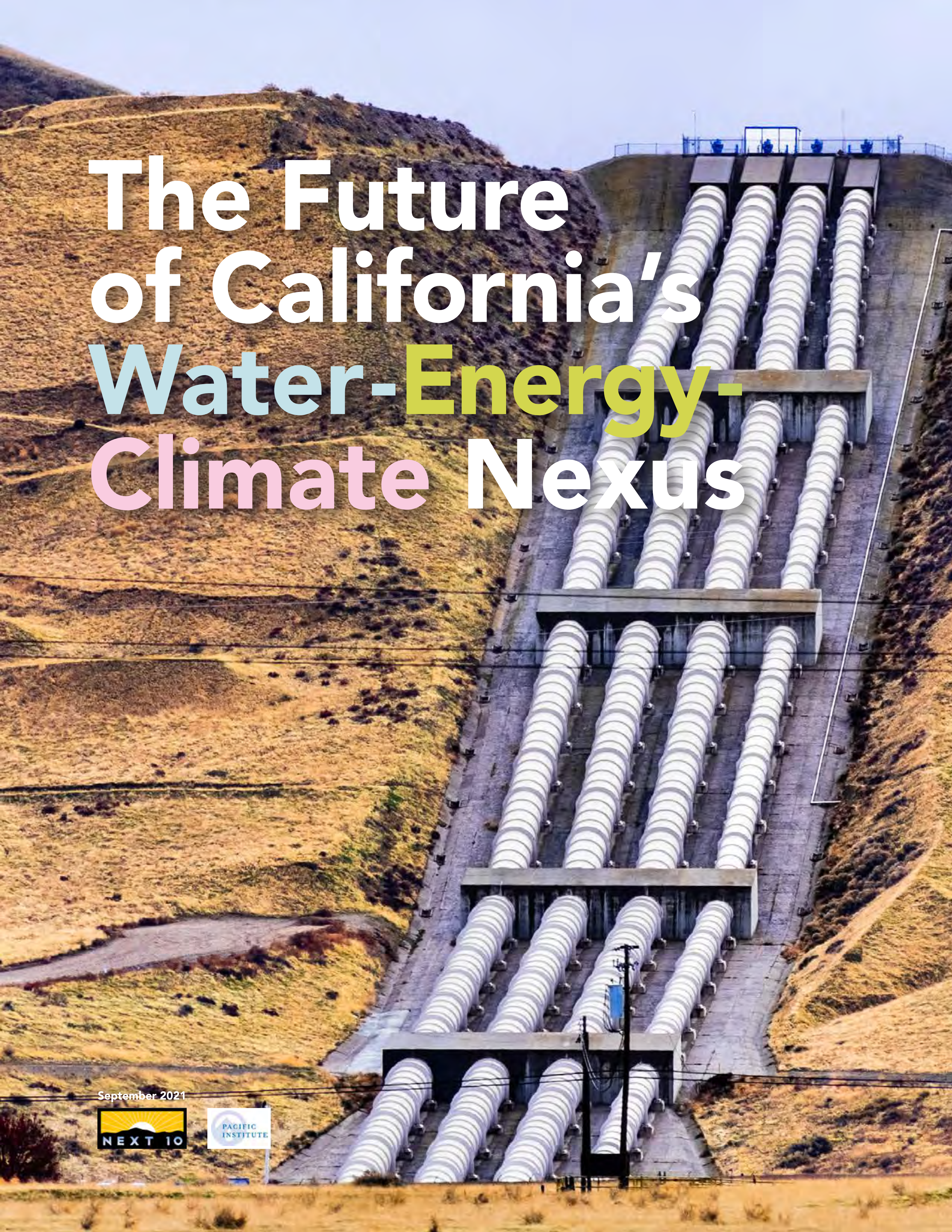
Figure C-3: Oak View Community Solar Photovoltaic System Overview under the Utility Scenario

Source: University of California, Irvine

Table C-3: Utility Scenario, Solar Photovoltaic Potential and Energy Production Broken Down into All Community Sectors

Oak View Community (Utility Scenario)	C&I Sector	School Sector	Residential Sector	Community Total
PV Capacity (MW)	4.27	0.40	0.33	5.00
Annual Production (GWh)	6.54	0.60	0.51	7.65
kWh/kW	1,533	1,512	1,552	1,530
System Performance (%)	81.4%	82.5%	82.6%	81.6%

The Future of California's Water-Energy-Climate Nexus



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NEXT 10

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Next 10 is focused on innovation and the intersection between the economy, the environment, and quality of life issues for all Californians. We provide critical data to help inform the state's efforts to grow the economy and reduce greenhouse gas emissions. Next 10 was founded in 2003 by businessman and philanthropist F. Noel Perry.

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1. EXECUTIVE SUMMARY

Water and energy are inextricably linked in California and, as one resource faces constraints or challenges, so does the other. With the state looking to both reach its climate change goals and decarbonize its economy through a transition to 100 percent clean energy, water will play an integral role. Water is a key input for energy production, and energy is integral to all aspects of water management and use in California—including collection, treatment, heating, and wastewater management. Prior studies have estimated that about 20 percent of California's total statewide electricity use, a third of non-power plant natural gas consumption, and 88 billion gallons of diesel consumption are related to water—from collection and treatment to use and wastewater management—with a large share associated with heating water. These interdependencies between water and energy supplies are commonly referred to as the water-energy nexus.

TABLE E.S.1 Estimated Urban Water-Related Energy and Greenhouse Gas (GHG) Impacts, 2015-2035

Change from 2015-2035	Declining Per-Capita Demand Scenario (Low-Case)	2015 Constant Per-Capita Demand Scenario (Mid-Case)	Water Supplier Projections Scenario (High-Case)
Urban Water Demand	-17%	+24%	+44%
Water-Related Electricity Use	-19%	+21%	+40%
Water-Related Natural Gas Use	-16%	+25%	+45%
GHG Emissions From Urban Water-Related Energy Use	-41%	-12%	+2%

Many factors affect California's water demand and supply portfolio, and the implications of multiple, ongoing changes to the state's water resources on future energy use are not well understood. California has experienced a dramatic decoupling between water use and growth over the last 40 years. Total urban demand has declined, particularly since 2005, despite continued population and economic growth due to end-use efficiency improvements and less water-intensive commercial and industrial activities. At the same time, urban water suppliers are pursuing local water supply options, many of which are more energy-intensive than traditional water sources but still less energy-intensive than imported water. Agricultural water use has remained relatively flat since the 1980s despite a significant increase in the economic value of crop production. Agriculture, however, is particularly dependent on unsustainable groundwater extraction, and pumping has become increasingly energy-intensive as groundwater levels have fallen around the state. Climate change, with impacts on water availability, quality, and demand, may accelerate these trends.

Water and energy trends in California also affect greenhouse gas (GHG) emissions for the state. In California, electricity generation—the main energy source for the provision and treatment of water—is undergoing structural reform to decarbonize and reduce its GHG intensity. There are also state programs and policies to incentivize switching to electric water heating, which is the most energy-intensive end-use of water and is still largely done using natural gas water heaters. While these policies and incentives help limit the energy- and carbon-intensity of the state's water sector, as droughts worsened by climate change continue to place constraints on both water supply and quality—both the energy- and carbon-intensity related to water are in danger of increasing. These complex interactions between changing water supply and demand trends, grid decarbonization, and electrification of water heaters will affect California's water-related GHG emissions.

In this analysis, the report authors evaluated the combined impact of emerging trends on California's water (including population growth, climate change, and policies to promote water efficiency and alternative water supplies) and electricity (including generation decarbonization) on the state's water-related energy and GHG footprints from 2015 to 2035. The latest available (2015) water demand and supply data from water suppliers and state water agencies were used to develop various scenarios of future water resources and to estimate associated energy and GHG emissions out to 2035. Key findings from the study, summarized in Tables ES.1 and ES.2, include:

Urban Findings:

- **If urban per-capita water demand is maintained at current (2015) levels, statewide urban water demand would increase 24 percent (1.3 million acre-feet, or MAF) between 2015 and 2035 with population growth.** This "mid-case" scenario would result in a 21 percent increase in annual water-related electricity use (from about 30,000 GWh to 36,000 GWh) and a 25 percent increase in annual natural gas use for water heating (from about 150,000,000 to 190,000,000 MMBtu).
- **If per-capita water demand increases to levels consistent with urban water suppliers' projections (a "high-case" scenario), urban water demand would increase by 44 percent (2.4 MAF) between 2015 and 2035,**

TABLE E.S.2 Estimated Central Valley Agricultural Water-Related Energy and Greenhouse Gas (GHG) Impacts, 2015-2035

Change from 2015-2035	Low Ag Water Use Scenario	Mid Ag Water Use Scenario	High Ag Water Use Scenario
Agricultural Water Supply Delivered	-3%	-2%	-5%
Water-Related Electricity Use	-5%	-4%	-6%
GHG Emissions From Agricultural Water-Related Energy Use	-62%	-62%	-62%

resulting in a 40 percent and 45 percent increase in related electricity and natural gas use, respectively. As the state replaces fossil fuel generators with more renewable resources, the GHG intensity (greenhouse gases emitted per unit of energy produced) of California's electricity is expected to decline, and consequently GHG emissions associated with urban water-related energy use (electricity and natural gas) are projected to decrease about 12 percent in the mid-case scenario. However, in the high-case scenario, GHG emissions increase two percent because growing natural gas use offsets some of the impact of decarbonization in the electricity sector.

- **The authors found that more comprehensive water conservation and efficiency efforts in urban California could reduce water-related electricity usage by 19 percent, natural gas use by 16 percent, and GHG emissions by 41 percent cumulatively between 2015 and 2035.** Because indoor residential water use is the most energy-intensive subsector (driven by high energy requirements for end-use, treatment, and wastewater treatment), water conservation and efficiency improvements for this subsector could dramatically decrease the energy use and GHG emissions that would result from the mid- and high-case scenarios.
- **While the total annual electricity use related to urban water use increases in the mid-case scenario, the average energy intensity of water—the total electricity used per unit of water used—decreases by two percent between 2015 and 2035.** This decrease is driven in part by a shift away from energy-intensive imported water toward alternative local water sources, including brackish desalination (+7,000% increase in supply between 2015 and 2035 from the current low levels), potable recycled water (+300% increase in supply between 2015 and 2035), and captured stormwater (+19,000% in supply between 2015 and 2035). The shares of these alternative sources among the statewide urban water supply portfolio remain relatively small in this scenario but have important implications for total energy use because they are less energy-intensive than imported water in most regions of California, especially in Southern California.

Agricultural Findings:

- **Central Valley agricultural water use under the mid-case scenario is projected to decline by two percent, or 0.3 MAF, between 2015 (23.4 MAF) and 2035 (23 MAF).** This decline is driven by the state's projection that urban population growth will encroach on agricultural lands. Under this scenario, the associated electricity use decreases four percent (from 14,200 to 13,600 GWh), and GHG emissions decrease about 60 percent.[1] The proportionally larger reduction in electricity usage compared to water use is due to expected reductions in supply from relatively energy-intensive water sources, such as imported water. Likewise, the proportionally larger reduction in GHG emissions is due to statewide efforts to decarbonize its electricity generation. Climate change is assumed to have minimal impacts on agricultural water use by 2035 across all of the scenarios; however, changes in temperature, precipitation, and evapotranspiration are likely to have a much larger effect on both supply availability and irrigation demand toward the end of century.

1 These GHG emissions are entirely from electricity because natural gas agricultural use was not calculated.

- **There are also large uncertainties in the future energy use of Central Valley agriculture because of its dependence on groundwater, which the state has mandated through the Sustainable Groundwater Management Act (SGMA) to reach sustainable levels by 2040.** If pumping volumes are maintained at current levels and groundwater depths drop to the proposed minimum thresholds (levels of groundwater beyond which any reduction would cause undesirable effects in the basin), the authors estimate agricultural water system energy intensity would increase by 20 percent and six percent for the San Joaquin and Tulare regions, respectively. This would increase overall energy use for agricultural water in the San Joaquin and Tulare regions by about 16 percent by 2035. Permitting groundwater levels to rise can reduce the magnitude of the increase, as can improvements in pump efficiency. Likewise, shifting the timing of energy usage to coincide with times of renewable electricity generation could reduce the impact on GHG emissions.

Cross-Cutting Findings:

- **Overall, urban water efficiency improvements have the largest beneficial effect on California's water-related energy use and GHG emissions because urban water is much more energy-intensive than agricultural water.** Even though Central Valley agricultural water use is projected to be almost three times that of the urban sector by 2035, agriculture's water-related electricity usage is about half, primarily because irrigation is less energy-intensive than water treatment and heating for urban end-uses. In the mid-case, the energy intensity and total GHG emissions related to urban water statewide are about 9 times that of Central Valley's agricultural water (5,400 kWh/AF and 14 million tons CO_2 for urban water, compared to 600 kWh/AF and 1.4 million tons CO_2 for agricultural water by 2035). GHG emissions from other aspects of the agricultural sector are not included in this assessment.
- **Water-related GHG emissions are driven by the pace of California's electricity decarbonization and end-use electrification.** The increasing share of renewables in the generation portfolio is estimated to effectively minimize the electricity component of these GHG emissions. Natural gas usage, mostly for heating water in residential and non-residential settings, is projected in the mid- and high-case scenarios to rise, which could cause GHG emissions from urban water use to increase overall. Therefore, there is an opportunity for water-energy partnerships to promote the electrification of water-end uses (water heaters) to reduce the state's GHG footprint.

Policy Recommendations:

The report authors identify specific water policies that could play an important role in helping the state meet energy and GHG goals:

- Expand urban water conservation and efficiency efforts;
- Accelerate water heater electrification;
- Maintain groundwater levels and expand flexible, high-efficiency groundwater pumps;
- Provide financial incentives and regulatory pathways for water suppliers to invest in less energy- and GHG-intensive water systems, including through existing financial incentives and programs for energy efficiency and GHG reduction;
- Expand and standardize water data reporting and energy usage tracking; and
- Formalize coordination between water and energy regulatory agencies about forecasted energy demand changes.

2. INTRODUCTION

2.1 Study Background and Motivation

California's energy and water systems are closely connected. Water is a key input for energy production, and energy is integral to all aspects of water management and use in California. About 18 percent of California's electricity generation has come from hydropower on average (from 1983 – 2013),[2] and water is also used to cool thermoelectric power plants. Prior studies have estimated that in California nearly 20 percent of annual statewide electricity use, a third of non-power plant natural gas consumption, and 88 billion gallons of diesel fuel consumption are related to water —from collection and treatment to use (such as water heating) and wastewater management.[3] The State Water Project—which pumps water from Northern California to communities across the state including over the Tehachapi Mountains to Southern California—is the single largest electricity user in the state.[4] These interdependencies are commonly referred to as the water-energy nexus.

2 Gleick, P.H. "Impacts of California's Five-Year (2012-2016) Drought on Hydroelectricity Generation." Pacific Institute. April 2017. Available at: https://pacinst.org/publication/impacts-of-californias-five-year-2012-2016-drought-on-hydroelectricity-generation-2/

3 Klein, G., Krebs, M., Hall, V., O'Brien, T., Blevins, B.B. "California's Water – Energy Relationship (No. CEC-700-2005-011-SF)." California Energy Commission. November 2005. Available at: http://large.stanford.edu/courses/2012/ph240/spearrin1/docs/CEC-700-2005-011-SF.PDF

4 Producing and Consuming Power. California Department of Water Resources. Available at: http://water.ca.gov/What-We-Do/Power

Many factors affect California's water demand and supply portfolio, and the implications of multiple, ongoing changes to the state's water resources on future energy use are not well understood. California's urban water demand has been declining significantly with time, decoupling water use from population growth and economic output in the state.[5] At the same time, ongoing water-scarcity concerns and continued population growth are prompting water planners to pursue alternative, local water-supply options,[6] many of which are more energy-intensive than traditional water sources, but still less energy-intensive than imported water.[7] Similarly, declining water quality and new contaminants are leading water suppliers to adopt more energy-intensive treatment options like UV purification, ozonation, and reverse osmosis. In the agricultural sector, water use has stayed relatively flat since the 1980s while the economic value of crop production has increased significantly.[8] However, groundwater pumping, heavily relied on by the agricultural sector, is increasingly energy-intensive as groundwater levels fall in many parts of the state.[9] Climate change, with impacts on water availability, quality, and demand, is likely to accelerate these trends.[10]

Water and energy trends in California also affect greenhouse gas (GHG) emissions for the state. Shifts in water supplies and demands affect energy usage related to water and the GHG emissions associated with that energy usage. In California, electricity generation, the main energy source for the provision and treatment of water, is undergoing structural reform to decarbonize. The state has committed to reach 100 percent carbon-free electricity by 2045, including intermediate requirements of 50 percent renewable generation by 2026 and 60 percent renewable generation by 2030.[11] However, water heating is the most energy-intensive end-use of water and is still largely done using natural gas water heaters. Therefore, energy programs in the state have begun to provide incentives for switching natural gas water heaters to more efficient and less GHG-intensive electric heat pump water heaters.[12] These complex interactions between changing water supply and demand trends, grid decarbonization, and electrification of water heaters will affect California's water-related GHG emissions.

There are several options for reducing the energy and GHG footprint related to California's water. These include reducing water demand, adopting water sources with low energy requirements, and using renewable energy sources. For example, the East Bay Municipal Utility District's (EBMUD) wastewater treatment plant produces more renewable energy onsite than is needed to run the facility, selling excess energy back to the electrical grid. Some local water-supply strategies, such as Los Angeles' plans to source an increased share of water supplies from recycled water, are energy-intensive, but may offset even more energy-intensive imported water supplies. In the agricultural sector, there is an opportunity for energy savings with higher efficiency groundwater pumps, especially in Central Valley regions where the energy intensity of groundwater pumping may increase from current levels, at the proposed minimum thresholds allowed by the 2014 Sustainable Groundwater Management Act (levels of groundwater beyond which any reduction would cause undesirable effects in the basin).[13]

5 Cooley, H. "Urban and Agricultural Water Use in California, 1960-2015." Pacific Institute. June 2020. Available at: https://pacinst.org/wp-content/uploads/2020/06/PI_Water_Use_Trends_June_2020.pdf

6 Luthy, R.G., Wolfand, J.M., Bradshaw, J.L. "Urban Water Revolution: Sustainable Water Futures for California Cities." J. Environ. Eng. 146, 04020065. May 2020. Available at: https://doi.org/10.1061/(ASCE)EE.1943-7870.0001715

7 Stokes-Draut, J., Taptich, M., Kavvada, O., Horvath, A. "Evaluating the electricity intensity of evolving water supply mixes: the case of California's water network." Environ. Res. Lett. 12, 114005. October 2017. Available at: https://doi.org/10.1088/1748-9326/aa8c86

8 Cooley, H. "Urban and Agricultural Water Use in California, 1960-2015." Pacific Institute. June 2020. Available at: https://pacinst.org/wp-content/uploads/2020/06/PI_Water_Use_Trends_June_2020.pdf

9 Moran, T., Choy, J., Sanchez, C. "The Hidden Costs of Groundwater Overdraft." Water in the West | Stanford Woods Institute for the Environment. December 2014. Available at: http://waterinthewest.stanford.edu/groundwater/

10 Anderson, J., Chung, F., Anderson, M. et al. Progress on incorporating climate change into management of California's water resources. Climatic Change 87, 91–108. March 2008. Available at: https://doi.org/10.1007/s10584-007-9353-1

11 De Leon, K., Skinner, N. SB-100 California Renewables Portfolio Standard Program: emissions of greenhouse gases. Chaptered September 2018. Available at: https://leginfo.legislature.ca.gov/faces/billHistoryClient.xhtml?bill_id=201720180SB100

12 Gerdes, J. "California Moves to Tackle Another Big Emissions Source: Fossil Fuel Use in Buildings." Greentech Media. February 4, 2020. Available at: https://www.greentechmedia.com/articles/read/california-moves-to-tackle-another-big-emissions-source-fossil-fuel-use-in-buildings

13 Sustainable Groundwater Management Act (SGMA). California Department of Water Resources. Available at: https://water.ca.gov/programs/groundwater-management/sgma-groundwater-management

2.2 Scope of This Study

There is a need to update prior estimates of the water-related energy and GHG footprint of the urban and agricultural sectors in California given the complex set of trends likely to affect water and energy systems in the coming decades. This study builds on previous studies to address this need.[14,15,16,17,18,19]

First, report authors developed a comprehensive assessment of the energy and GHG footprint related to water in California. Statewide and regional trends in water supply and demand for the urban and agricultural sectors were examined, and associated energy use and GHG emissions under various future water scenarios were calculated.

Second, case studies were developed highlighting risks and opportunities associated with water-related energy use and GHG emissions, such as the adoption of biogas recovery and other renewable energy strategies implemented at EBMUD's wastewater treatment facility.

Third, a set of policy recommendations for reducing California's water-related GHG and energy footprint are offered. These policy recommendations are drawn from the scenario analysis as well as the case studies in the report.

Section 3 of this report outlines the energy, GHG, and water data and analysis methodology. Section 4 presents results of the energy and GHG emissions associated with California's urban and agricultural water. Section 5 provides three case studies highlighting examples of technical and policy innovations related to California's water-energy-GHG nexus, and Sections 6 and 7 provide conclusions and recommendations.

14 GEI Consultants/Navigant Consulting. "Embedded Energy in Water Studies Study 1: Statewide and Regional Water-Energy Relationship." Prepared for California Public Utilities Commission. August 2010. Available at: https://waterenergyinnovations.com/wp-content/uploads/2020/03/Embedded-Energy-in-Water-Studies-Study-1-FINAL.pdf

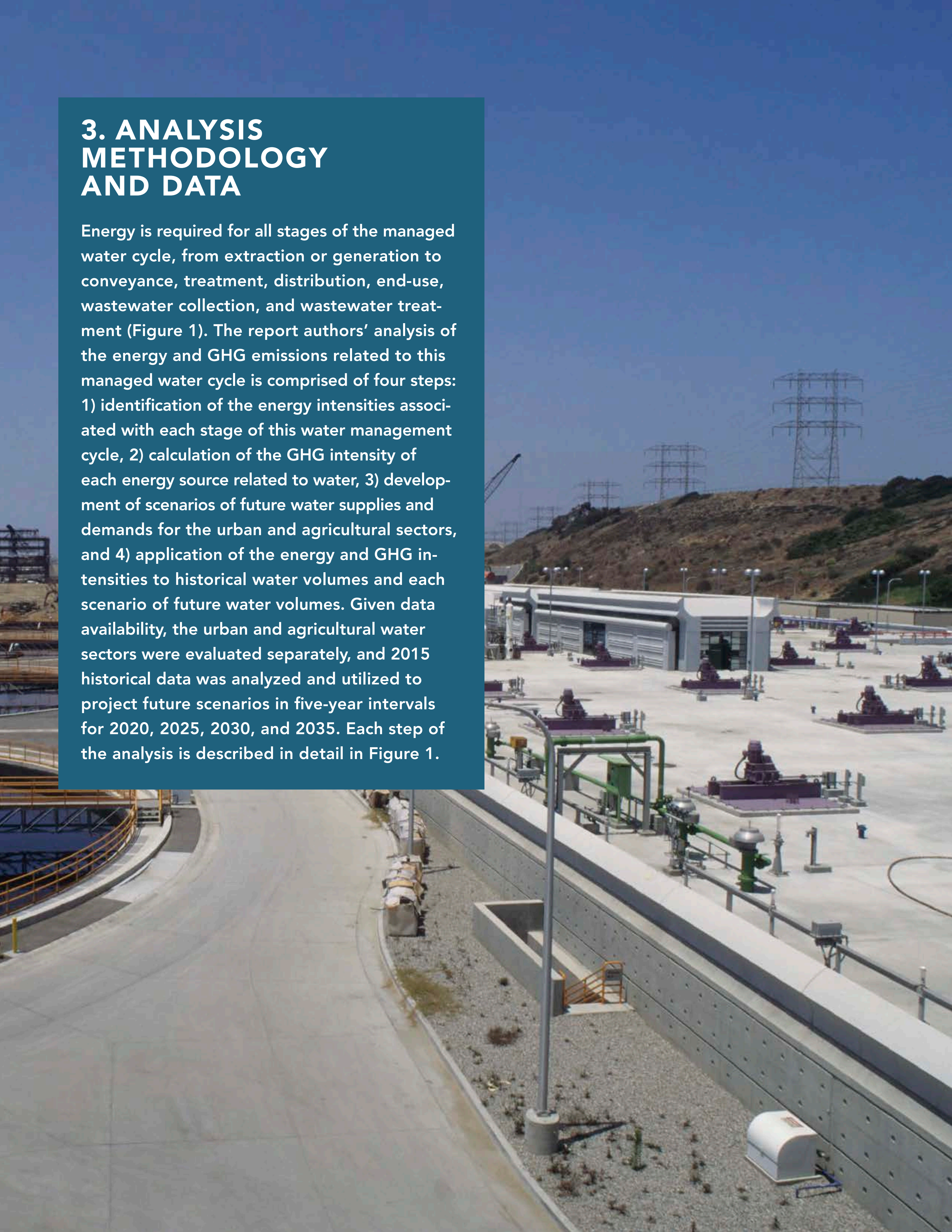
15 GEI Consultants/Navigant Consulting. "Embedded Energy in Water Studies Study 2: Water Agency and Function Component Study and Embedded Energy-Water Load Profiles." Prepared for California Public Utilities Commission. August 2010. Available at: https://waterenergyinnovations.com/wp-content/uploads/2020/03/Embedded-Energy-in-Water-Studies-Study-2-FINAL.pdf

16 Klein, G., Krebs, M., Hall, V., O'Brien, T., Blevins, B.B. "California's Water – Energy Relationship (No. CEC-700-2005-011-SF)." California Energy Commission. November 2005. Available at: http://large.stanford.edu/courses/2012/ph240/spearrin1/docs/CEC-700-2005-011-SF.PDF

17 Porse, E., Mika, K.B., Escriva-Bou, A., Fournier, E.D., Sanders, K.T., Spang, E., Stokes-Draut, J., Federico, F., Gold, M., Pincetl, S. "Energy use for urban water management by utilities and households in Los Angeles." Environ. Res. Commun. 2, 015003. January 10, 2020. Available at: https://doi.org/10.1088/2515-7620/ab5e20

18 Tidwell, V.C., Moreland, B., Zemlick, K. "Geographic Footprint of Electricity Use for Water Services in the Western U.S." Environ. Sci. Technol. 48, 8897–8904. June 25, 2014. Available at: https://doi.org/10.1021/es5016845

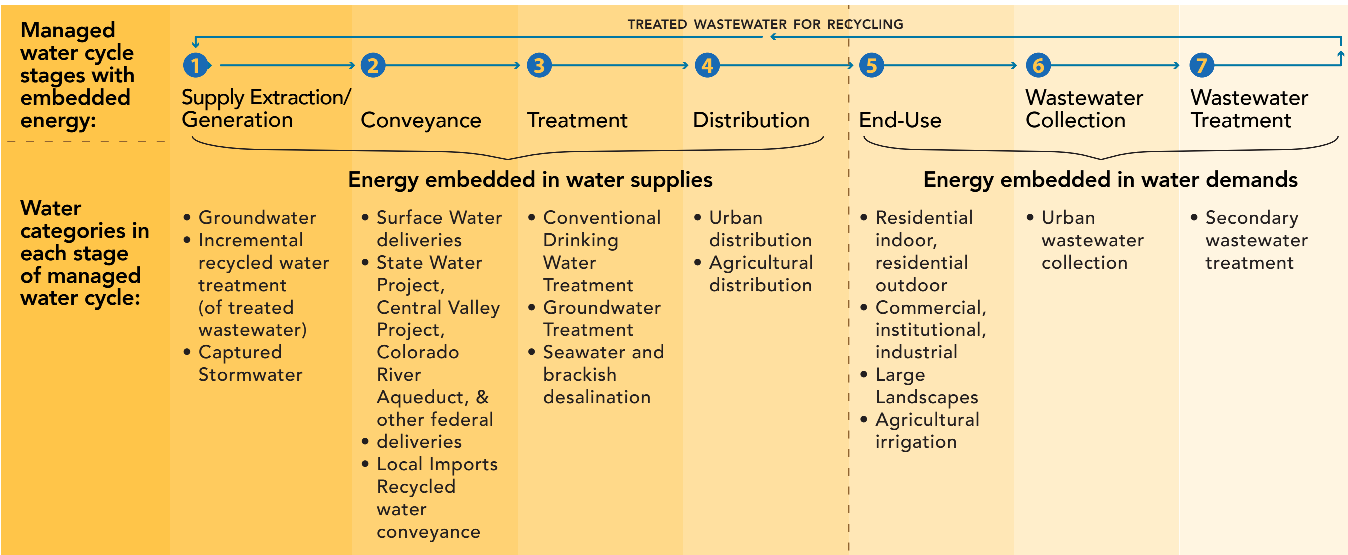
19 Zohrabian, A., Sanders, K.T. "The Energy Trade-Offs of Transitioning to a Locally Sourced Water Supply Portfolio in the City of Los Angeles." Energies 13, 5589. October 2020. Available at: https://doi.org/10.3390/en13215589



3. ANALYSIS METHODOLOGY AND DATA

Energy is required for all stages of the managed water cycle, from extraction or generation to conveyance, treatment, distribution, end-use, wastewater collection, and wastewater treatment (Figure 1). The report authors' analysis of the energy and GHG emissions related to this managed water cycle is comprised of four steps: 1) identification of the energy intensities associated with each stage of this water management cycle, 2) calculation of the GHG intensity of each energy source related to water, 3) development of scenarios of future water supplies and demands for the urban and agricultural sectors, and 4) application of the energy and GHG intensities to historical water volumes and each scenario of future water volumes. Given data availability, the urban and agricultural water sectors were evaluated separately, and 2015 historical data was analyzed and utilized to project future scenarios in five-year intervals for 2020, 2025, 2030, and 2035. Each step of the analysis is described in detail in Figure 1.

Figure 1 Stages of the Water Cycle with Embedded Energy



3.1 Energy Intensity of California's Water

Following a similar approach to Cooley et al. (2012)[20] and Diringer et al. (2019)[21] to track the total embedded energy of the managed water system (Figure 1), energy intensity values (energy use per unit volume of water in units of kWh/acre-foot (AF) for electricity and MMBtu/AF for natural gas) are assigned for the extraction, conveyance, and treatment of historical and projected water sources, and for the distribution, end-use, wastewater collection, and wastewater treatment based on end-use sector (urban and agriculture) for each of California's 10 hydrologic regions.[22] These energy intensities are summed to calculate the total embedded energy in a particular water source and water demand category and for the system as a whole. Data from Urban Water Management Plans (UWMP) and from the Department of Water Resources (DWR) were used to identify water source and demand categories for the urban and agricultural sectors, respectively (details in Section 3.3).[23]

3.1.1 Mapping Water Categories to Energy Use

First, the authors mapped the urban and agricultural water supply and demand data to the relevant stages of the managed water cycle (Figure 1), starting with categories of water sources (Table 1) and then water demands (Table 2). The water-related energy analysis focuses on electricity usage throughout each of the stages, and natural gas usage is only evaluated for water-heating—the largest natural gas user related to California water.[24] The energy intensity of recycled water, which does not fit easily in this framework, is detailed at the end of Section 3.1.1.

20 Cooley, Heather, et al. The Water-Energy Simulator (WESim): User Manual. WateReuse Foundation, Pacific Institute, UC Santa Barbara for California Energy Commission, 2012. Available at: https://pacinst.org/wp-content/uploads/2013/02/user_manual3.pdf.

21 Diringer, Sarah, et al. Moving Toward a Multi-Benefit Approach for Water Management. Pacific Institute and Bren School of Environmental Science and Management, University of California, Santa Barbara, Apr. 2019. Available at: https://pacinst.org/wp-content/uploads/2019/04/moving-toward-multi-benefit-approach.pdf.

22 The 10 hydrologic regions are North Coast, San Francisco, Central Coast, South Coast, North Lahontan, Sacramento River, San Joaquin Valley, Tulare Lake, South Lahontan, and Colorado River.

23 We are constrained by the "water supply" and "water demand" categories included in these urban and agricultural water datasets. In cases where supply categories cannot be attributed to a specific water source, we make assumptions as noted below.

24 Klein, G., Krebs, M., Hall, V., O'Brien, T., Blevins, B.B. "California's Water – Energy Relationship (No. CEC-700-2005-011-SF)." California Energy Commission. November 2005. Available at: http://large.stanford.edu/courses/2012/ph240/spearrin1/docs/CEC-700-2005-011-SF.PDF

TABLE 1 Energy Intensity Categories Applied to Water Sources

	WATER CYCLE STAGES RELATED TO WATER SOURCES		
	1. Extraction or Generation	**2. Conveyance**	**3. Treatment***
Water Sources			
Desalinated Water (Seawater)		Seawater Desalination Conveyance	Seawater Desalination Treatment
Desalinated Water (Brackish)	Groundwater pumping		Brackish Desalination Treatment
Exchanges		Local Imported Deliveries	Conventional Drinking Water Treatment
Groundwater	Groundwater pumping		Conventional Drinking Water Treatment
Other		Local Surface Water Deliveries	Conventional Drinking Water Treatment
Central Valley Project Deliveries		Central Valley Project Deliveries	Conventional Drinking Water Treatment
Colorado River Deliveries		Colorado River Deliveries	Conventional Drinking Water Treatment
Other Federal Deliveries		Local Imported Deliveries	Conventional Drinking Water Treatment
State Water Project Deliveries		State Water Project Deliveries	Conventional Drinking Water Treatment
Recycled Water (Indirect Potable Reuse)	Recycled Water (Potable) Treatment	Recycled Water Conveyance	Conventional Drinking Water Treatment
Recycled Water (Non- Potable)	Recycled Water (Non-potable) Treatment		
Captured Stormwater	Groundwater pumping		Conventional Drinking Water Treatment
Supply from Storage		Local Surface Water Deliveries	Conventional Drinking Water Treatment
Surface Water		Local Surface Water Deliveries	Conventional Drinking Water Treatment
Local Imports		Local Imported Deliveries	Conventional Drinking Water Treatment
Transfers		Local Imported Deliveries	Conventional Drinking Water Treatment

*Energy intensity values for treatment of water supplies to drinking water standards are only applied to water supplies for the urban sector. It is also assumed that water used in the agricultural sector does not receive potable treatment.

1. Water Extraction or Generation: Following the framework of Cooley et al. (2012),[25] water supply extraction includes the energy required to pump groundwater from its source to Earth's surface. Energy intensities depend on the depth of groundwater relative to the surface and on the pump efficiency. The energy intensity for groundwater pumping is also applied to captured stormwater because in some cities, such as Los Angeles, stormwater is used to recharge aquifers and requires pumping for extraction.[26] Groundwater energy intensities were also added for desalinated brackish water, which is typically pumped from aquifers before it is conveyed to a desalination treatment plant. Because of limited availability of detailed data, the authors assume that all groundwater pumps are electric. However, the researchers do note that this may slightly overestimate electricity use, and underestimate GHG emissions because a small portion of groundwater pumps in Cali-

25 Cooley, Heather, et al. The Water-Energy Simulator (WESim): User Manual. WateReuse Foundation, Pacific Institute, UC Santa Barbara for California Energy Commission, 2012. Available at: https://pacinst.org/wp-content/uploads/2013/02/user_manual3.pdf.

26 Geosyntec Consultants, Cordoba Corp, Council for Watershed Health, CWE, DakeLuna, EW Consulting, FlowScience, HDR, Kleinfelder, Kris Helm, MWH, Murakawa Communications, M2 Resource Consulting, Ron Gastelum, "Los Angeles Stormwater Capture Master Plan." Los Angeles Department of Water and Power. August 2015. Available at: https://www.ladwp.com/ladwp/faces/wcnav_externalId/a-w-stormwatercapturemp;jsessionid=ZqtygZTQqnmTxP2v1yrZBb6RfMWCcL9vCfKJFpYy6hDzmy2v-LKhv!-1647871916?_afrLoop=917808504540909&_afrWindowMode=0&_afrWindowId=null#%40%3F_afrWindowId%3Dnull%26_afrLoop%3D917808504540909%26_afrWindowMode%3D0%26_adf.ctrl-state%3D9wujqmer0_4

fornia use diesel or natural gas—which are both more GHG-intensive than California's current and projected electricity mix.[27,28]

This category also includes the energy to "generate" water supplies, namely the incremental treatment of wastewater to recycle it for either potable or non-potable reuse, which is described in more detail at the end of Section 3.1.1.

2. Water Conveyance: Energy for water conveyance includes the energy for pumping, lifting, and transporting raw or partially-treated water that is at the Earth's surface from its source to the drinking water treatment plant (for the urban sector) or directly to the distribution system (for the agricultural sector). The energy for water conveyance primarily depends on the lift (elevation) of the water pumped and on the pump efficiency. Conveyance energy is included for deliveries from the state's major inter-basin water transfers including the State Water Project (SWP), Central Valley Project (CVP), and Colorado River Aqueduct (CRA); local imports (water transferred by local water suppliers from other regions of California); and local surface water deliveries. For inter-basin conveyance projects (SWP, CVP, CRA) the energy intensity values for the furthest delivery point within a given hydrologic region are used. If there are multiple branches of a project within the same region, a volume-weighted average energy intensity is calculated across the delivery points in the region. In addition, average hydropower generation per unit of water volume on any conveyance project is subtracted from the energy intensity to represent a net value of energy required.[29,30] Supplies labeled as 'Other Federal Deliveries,' 'transfers' or 'exchanges' are assigned the same energy intensity as local imports, because the UWMP data do not typically include more detailed information about these categories. Supplies labeled as 'Other,' 'Supply from Storage,' or 'Return Flows' are similarly assigned the same energy intensity as local surface water. For potable recycled water, an energy-intensity for conveyance (pumping) from the wastewater treatment plant to the drinking water treatment plant is assigned[31] via an environmental buffer as detailed at the end of Section 3.1.1.[32] Finally, for desalinated seawater, the energy requirements for conveyance of ocean feedwater to the desalination plant are included.

3. Water Treatment: Water used in the urban sector is assumed to be treated to drinking water standards and is assigned a drinking water treatment energy. For all water sources (including deliveries from inter-basin water projects, local imports, and stormwater), an average energy intensity for conventional water treatment is assigned.[33]

Desalination of seawater and brackish water is included under the Treatment category. It is assumed that the desalination technology used is reverse osmosis, which is most common worldwide and for existing and proposed plants in California.[34] The energy requirements for desali-

27 The report authors believe the simplification is appropriate given that the 2018 Irrigation and Water Management Survey by the U.S. Department of Agriculture found that 90% of on-farm well pumps and other irrigation pumps are electric, and only 8% of on-farm well and other irrigation pumps are diesel in California. The remaining 2% of pumps are powered by natural gas or other fuels (*2018 Irrigation and Water Management Survey*. https://www.nass.usda.gov/Publications/AgCensus/2017/Online_Resources/Farm_and_Ranch_Irrigation_Survey/index.php. Accessed 3 May 2021.).

28 Burt, C., Howes, D., Wilson, G. "California Agricultural Water Electrical Energy Requirements (No. ITRC Report No. R 03-006)." Prepared by Irrigation Training and Research Center for the California Energy Commission. December 2003. Available at: https://digitalcommons.calpoly.edu/cgi/viewcontent.cgi?referer=www.google.com/&httpsredir=1&article=1056&context=bae_fac

29 GEI Consultants/Navigant Consulting. Embedded Energy in Water Studies Study 1: Statewide and Regional Water-Energy Relationship. Prepared for California Public Utilities Commission, 31 Aug. 2010. Available at: ftp://ftp.cpuc.ca.gov/gopher-data/energy%20efficiency/Water%20Studies%201/Study%201%20-%20FINAL.pdf.

30 Electricity generated from hydropower plants on SWP and CVP conveyance projects is also included in the calculation of the GHG intensity of California's total electricity generation, however, the contribution by conveyance project hydropower to statewide GHG intensity is nominal relative to the total emissions from all electricity in the state.

31 Sanders, K.T., Webber, M.E. "Evaluating the energy consumed for water use in the United States." Environ. Res. Lett. 7, 034034. September 2012. Available at: https://doi.org/10.1088/1748-9326/7/3/034034

32 We use a simplifying assumption of a uniform energy intensity for conveyance of treated potable water from the wastewater to the treatment plant across all hydrologic regions. However, the energy intensity may vary widely according to the terrain and decisions regarding buildout, which will affect the total energy requirements of recycled water.

33 This assumption may overestimate the water treatment for groundwater sources, which in some cases may use a lower level of treatment (typically just disinfection, such as with chlorine) (*Water & Sustainability (Volume 4): U.S. Electricity Consumption for Water Supply & Treatment - The Next Half Century*. 1006787, 2002, https://www.circleofblue.org/wp-content/uploads/2010/08/EPRI-Volume-4.pdf.).

34 Rao, P., Kostecki, R., Dale, L., Gadgil, A. "Technology and Engineering of the Water-Energy Nexus." Annu. Rev. Environ. Resour. 42, 407–437. September 2017. Available at: https://doi.org/10.1146/annurev-environ-102016-060959

TABLE 2 Energy Intensity Categories Applied to Water Demand Sectors

	Water Cycle Stages Related to Demand Sectors			
	4. Demand Distribution	5. Demand End-Use	6. Demand Wastewater Collection	7. Demand Wastewater Treatment
Demand Sectors				
Commercial	Urban Water Distribution	Urban Commercial Water Heating	Wastewater Collection	Wastewater Treatment (secondary)
Industrial	Urban Water Distribution	Urban Industrial Water Heating	Wastewater Collection	Wastewater Treatment (secondary)
Institutional/ Governmental	Urban Water Distribution	Urban Institutional Water Heating	Wastewater Collection	Wastewater Treatment (secondary)
Large Landscape	Urban Water Distribution			
Losses	Urban Water Distribution			
Other	Urban Water Distribution		Wastewater Collection	Wastewater Treatment (secondary)
Residential- Indoor	Urban Water Distribution	Urban Residential Indoor Water Heating	Wastewater Collection	Wastewater Treatment (secondary)
Residential- Outdoor	Urban Water Distribution			
Agricultural	Agricultural Water Distribution	Agricultural Irrigation		

nation to drinking water quality (<500 ppm salinity) are much higher with seawater (35,000 – 45,000 ppm salinity) than with brackish water (1,500 – 15,000). All desalted water in coastal hydrologic regions is assumed to come from seawater, and desalted water in inland hydrologic regions is assumed to come from brackish groundwater.

Supplies for the agricultural sector are assumed to not receive treatment to potable standards and therefore have no treatment energy intensities assigned.[35]

4. Distribution: Urban water demand volumes are assigned a distribution system energy intensity to represent the energy required to pump and pressurize the water for delivery from the treatment plant to the end-user. This value varies by the distance and steepness of the terrain over which water is pumped (hilly areas require more energy to pump water).[36]

Agricultural water is assigned an energy intensity for pumping and distributing raw water from the primary conveyance or groundwater source to on-farm end-users.

5. End-Use: Energy for water heating is modeled in the residential, commercial, institutional, and industrial sectors as the primary urban end-use, and for irrigation as the primary agricultural sector end-use.

Residential indoor water is assigned electric and natural gas energy intensities for water heating calculated (Section 3.1.2.1) based on the water temperatures used by different appliances and state average saturation of electric or gas water heaters.[37,38,39] Residential outdoor

35 Sanders, K.T., Webber, M.E. "Evaluating the energy consumed for water use in the United States." Environ. Res. Lett. 7, 034034. September 2012. Available at: https://doi.org/10.1088/1748-9326/7/3/034034

36 McDonald, C., Sathe, A., Zarumba, R., Landry, K., Porter, L., Merkt, E., White, L., Ramirez, I. "Water/Energy Cost-Effectiveness Analysis (No. Navigant Reference No.: 169145)." Prepared for California Public Utilities Commission. April 2015. Available at: https://www.cpuc.ca.gov/WorkArea/DownloadAsset.aspx?id=5356

37 Gleick, P.H., Haasz, D., Henges-Jeck, C., Srinivasan, V., Wolff, G., Cushing, K.K., Mann, A. "Waste Not, Want Not: The Potential for Urban Water Conservation in California." Pacific Institute. November 2003. Available at: https://pacinst.org/publication/waste-not-want-not/

38 KEMA, Inc. "2009 California Residential Appliance Saturation Study Volume 2 (No. CEC-200-2010-004)." California Energy Commission. 2010. Available at: https://www.energy.ca.gov/data-reports/surveys/2019-residental-appliance-saturation-study/2009-and-2003-residential-appliance

39 William B. DeOreo, Peter Mayer, Benedykt Dziegielewski, Jack Kiefer. "Residential End Uses of Water, Version 2 (No. PDF Report #4309b), Subject Area: Water Resources and Environmental Sustainability." Water Research Foundation. 2016. Available at: https://www.redwoodenergy.tech/wp-content/uploads/2017/07/4309B-June-16-2016.pdf

water use is not assigned an energy intensity for the end-use category. The estimated indoor share of commercial, institutional, and industrial (CII) water volumes are also assigned electric and natural gas energy intensities based on the estimated water temperatures of CII end-use processes. Landscape water is not assigned an energy intensity.

Agricultural end-uses are assigned an average energy intensity for irrigation, which often requires pumping and pressurization. The energy intensity is calculated (Section 3.1.2.2) based on the average share of applied water by crop, the typical energy intensity by irrigation technology, and the average irrigation technology for each crop type.

6. Wastewater Collection: Energy is required to collect and move untreated wastewater from end-users to the wastewater treatment plant.[40] As with water distribution, wastewater collection energy requirements depend on the terrain steepness and distance for pumping wastewater to the treatment facility. This energy intensity is assigned to all indoor residential, commercial, and industrial water volumes. Agricultural water is assumed to not require wastewater treatment, and therefore has no energy for wastewater collection.

7. Wastewater Treatment: Urban wastewater is assumed to be treated to secondary levels.[41] The energy intensity assigned is an average of requirements across wastewater treatment plant capacities, technologies, and efficiencies for secondary treatment. Wastewater treatment energy intensities are applied to all indoor residential, commercial, and industrial water volumes. Agricultural water is assumed to not require wastewater treatment.

Recycled Water: Recycled water does not fit neatly in the linear progression of the managed water cycle steps (Figure 1), because the "source" water for recycled water is treated wastewater. Therefore, the energy for incremental levels of treatment beyond standard, secondary wastewater treatment for recycled water for potable and non-potable reuse is included in the "extraction/generation" category.

Potable recycled water is assumed to be for indirect reuse, which is currently the only permitted form of potable recycled water in the state.[42] With indirect potable reuse, treated recycled water is stored temporarily in either a reservoir (surface water augmentation) or in a groundwater aquifer, which serves as an environmental buffer before the water is conveyed to a conventional drinking water treatment plant and distributed to the end-user.[43] For potable recycled water, a treatment train following the Orange County Water District Groundwater Replenishment System is assumed—i.e., after secondary treatment at a wastewater treatment plant, water is treated with microfiltration, reverse osmosis, and UV/Advanced Oxidation Processes (AOP). Therefore, for potable recycled water conveyance energy to represent water transport to the environmental buffer and to the drinking water treatment plant from the environmental buffer in the "conveyance" category is included, as well as conventional water treatment in the "treatment" category (Table 1).[44]

Non-potable recycled water is typically reused for irrigation of food crops, non-food crops, and parks or golf courses; cooling; and other industrial uses.[45] The treatment level for non-potable recycled water depends on the use. For example, irrigation of food crops that have an edible part in contact with the recycled water require at least disinfected tertiary treatment, whereas irrigation of food crops with the edible portion not in contact with the recycled water (or other uses such as freeway landscape, cemeteries, certain golf-courses) can use disinfected secondary treatment or undisinfected secondary treatment (including vineyards, orchards,

40 Cooley, H., Wilkinson, R. "Implications of Future Water Supply Sources on Energy Demands." WateReuse Foundation, Pacific Institute, UC Santa Barbara for California Energy Commission. July 2012. Available at: https://pacinst.org/publication/wesim/

41 This energy intensity of wastewater treatment may be an underestimate because there are some treatment plants in the state which use more energy-intensive tertiary treatment.

42 Direct potable reuse is explored further in the Los Angeles case study in Section 5.2.

43 Environmental Protection Agency and CDM Smith. "2017 Potable Reuse Compendium." Environmental Protection Agency. 2017. Available at: https://www.epa.gov/sites/production/files/2018-01/documents/potablereusecompendium_3.pdf

44 Note that the energy for pumping water from the groundwater environmental buffer to the surface is not captured in the calculation of the energy intensity of indirect potable recycled water.

45 State Water Resources Control Board Regulations Related to Recycled Water. *California Code of Regulations: Title 22*. October 1, 2018. Available at: https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/lawbook/RWregulations_20181001.pdf

not-fruit bearing trees).[46] For this analysis, non-potable recycled water is assumed to receive disinfected tertiary treatment, and the incremental energy requirements for tertiary treatment plus disinfection for its energy intensity value are aggregated. Distribution energy to pump the non-potable recycled water to the end-user is also included, using the same energy intensity as for potable water distribution.

3.1.2 Literature Review and Estimation of Energy Intensities of California Water Cycle

The report authors reviewed academic literature and technical reports related to the energy usage of California's water system[47] and collected the range of low-, mid-, and high-energy intensity values from each study for each process involved in the water cycle stages described in Section 3.1.1. Data for each hydrologic region are used, if available; otherwise, a statewide value was used. For all water cycle stages except for end-use, the energy intensity values across the studies for each hydrologic region and water cycle process are averaged. In this analysis, the averages of the "mid" energy intensity values are used. For both the urban and agricultural sectors, the energy intensity values for water end-uses are calculated as described below, because these data are not available directly from the literature. The final electricity and natural gas energy intensity values used in this analysis, based on the literature and report authors calculations, are summarized by hydrologic region and water cycle stage in Table 4.

3.1.2.1 Urban End-Use Energy Intensities

End-use energy intensity for water heating is calculated for residential indoor water use as the product of several parameters. First, the average fuel share of residential water heaters is estimated (approximately 32% electric, 64% natural gas based on Energy Information Administration surveys of the Pacific region.[48]) Next, the energy intensity for water heating is calculated based on the specific heat formula, which estimates the thermal energy required to heat a unit of water a certain number of degrees. The degrees of heating for each end-use is calculated as the difference between the average water heater inlet temperature (58 °F) across California cities from a prior analysis,[49] and outlet temperatures specific to each water end-use, listed in Appendix Table 29.[50]

46 ibid

47 California Water Plan Update 2013, Volume 3 - Resource Management Strategies. California Department of Water Resources. 2013. Available at: https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/California-Water-Plan/Water-Plan-Updates/Files/Update-2013/Water-Plan-Update-2013-Volume-3.pdf; Cooley, Heather, and Robert Wilkinson. Implications of Future Water Supply Sources on Energy Demands. WateReuse Foundation, Pacific Institute, UC Santa Barbara for California Energy Commission, 2012. Available at: https://pacinst.org/wp-content/uploads/2012/07/report19.pdf; EPRI. Water & Sustainability (Volume 4): U.S. Electricity Consumption for Water Supply & Treatment - The Next Half Century. 1006787, 2002. Available at: https://www.circleofblue.org/wp-content/uploads/2010/08/EPRI-Volume-4.pdf; GEI Consultants/Navigant Consulting. Embedded Energy in Water Studies Study 1: Statewide and Regional Water-Energy Relationship. Prepared for California Public Utilities Commission, 31 Aug. 2010. Available at: ftp://ftp.cpuc.ca.gov/gopher-data/energy%20efficiency/Water%20Studies%201/Study%201%20-%20FINAL.pdf; GEI Consultants/Navigant Consulting and GEI Consultants/Navigant Consulting. Embedded Energy in Water Studies Study 2: Water Agency and Function Component Study and Embedded Energy-Water Load Profiles. Prepared for California Public Utilities Commission, 31 Aug. 2010. Available at: ftp://ftp.cpuc.ca.gov/gopher-data/energy%20efficiency/Water%20Studies%202/Study%202%20-%20FINAL.pdf; Klein, Gary, et al. California's Water – Energy Relationship. CEC-700-2005-011-SF, California Energy Commission, Nov. 2005, http://large.stanford.edu/courses/2012/ph240/spearrin1/docs/CEC-700-2005-011-SF.PDF; Liu, Qinqin, et al. Connecting the Dots between Water, Energy, Food, and Ecosystems Issues for Integrated Water Management in a Changing Climate. Climate Change Program, California Department of Water Resources, Feb. 2017. Available at: https://cawaterlibrary.net/wp-content/uploads/2017/10/QLf2017FinalWhitePaper_jta_edits_fk_format_2.pdf; McDonald, Craig, et al. Water/Energy Cost-Effectiveness Analysis. Navigant Reference No.: 169145, Prepared for California Public Utilities Commission, Oct. 2014. Available at: https://www.cpuc.ca.gov/WorkArea/DownloadAsset.aspx?id=5360; Stokes-Draut, Jennifer, et al. "Evaluating the Electricity Intensity of Evolving Water Supply Mixes: The Case of California's Water Network." Environmental Research Letters, vol. 12, no. 11, Oct. 2017, p. 114005. Institute of Physics. Available at: https://doi.org/10.1088/1748-9326/aa8c86; Tarroja, Brian, et al. "Evaluating Options for Balancing the Water-Electricity Nexus in California: Part 1 – Securing Water Availability." Science of The Total Environment, vol. 497–498, Nov. 2014, pp. 697–710. ScienceDirect. Available at: https://doi.org/10.1016/j.scitotenv.2014.06.060; Tidwell, Vincent C., et al. "Geographic Footprint of Electricity Use for Water Services in the Western U.S." Environmental Science & Technology, vol. 48, no. 15, Aug. 2014, pp. 8897–904. ACS Publications, https://doi.org/10.1021/es5016845.

48 Residential Energy Consumption Survey (RECS). Table HC1.1 Fuels used and end uses in U.S. homes by housing unit type. Energy Inf. Adm. EIA. 2015. Available at: https://www.eia.gov/consumption/residential/data/2015/hc/php/hc8.8.php

49 WeCalc: Your Home Water-Energy-Climate Calculator. WeCalc Your Home Water-Energy-Clim. Calc. Available at: http://www.wecalc.org/

50 Cooley, H., Wilkinson, R. "Implications of Future Water Supply Sources on Energy Demands." WateReuse Foundation, Pacific Institute, UC Santa Barbara for California Energy Commission. July 2012. Available at: https://pacinst.org/publication/wesim/

For gas water heaters, a typical water heater efficiency of 63 percent is applied to the thermal energy required, and for electric water heaters an efficiency of 90 percent is applied to the thermal energy required.[51] Next, data on the average share of residential indoor water for each end-use, summarized in the Appendix Table 29.[52] Finally, the fuel share, energy intensity of the water heater for each end-use, and indoor water share for each end-use are multiplied to estimate a total weighted average energy intensity that is applied to total residential indoor water use (6,800 kWh/AF for electric and 67 MMBtu/AF for natural gas water heaters).[53] The same value is used for residential indoor water volumes in all hydrologic regions. Residential outdoor water use is not assigned an energy intensity for the end-use category.

The water end-uses within the CII sectors vary significantly. Here, the authors focus on the energy requirements for water heating on average across all CII water uses. An average share of total CII water use in California among different types of processes (i.e., landscaping, laundry, kitchen, industrial process, restroom, cooling, other) is assumed based on Gleick et al. (2003),[54] as shown in Table 3. Within each of these processes, the report authors estimate the average share of water to different end-uses based on Gleick et al. (2003) as shown in Appendix Table 30. Next, temperatures are assigned to each end-use in the various process categories (Appendix Table 30), and the specific heat formula is used to calculate the energy intensity of heating to that temperature from the California average inlet temperature (as described for residential heating). Fuel shares between electric and gas water heaters are used, based on the electric and gas proportions of total commercial floor space that uses heating.[55] Finally, the process shares, end-use shares within each process, energy intensity of water heating for each process, and the fuel ratios are multiplied. For electric water heaters, the same water heater efficiency value is used as for residential water heaters, and for natural gas water heaters, the energy requirements with higher efficiencies (68%) typical of average commercial water heaters were calculated.[56] The resulting average energy intensities used for CII water are about 5,200 kWh/AF for electric and 30 MMBtu/AF for natural gas water heating. The same value is used for CII indoor water volumes in all hydrologic regions.

TABLE 3 Estimated CII Water Use by Process

CII Sub-Sector	Percentage of CII Total Water Use
Landscaping	35%
Laundry	2%
Kitchen	6%
Process	17%
Other	9%
Cooling	15%
Restroom	16%

Source: Data from Gleick, et.al. Waste Not, Want Not: The Potential for Urban Conservation in California. Pacific Institute, 2003.

3.1.2.2 Agricultural End-Use Energy Intensities

Irrigation is the primary agricultural end-use requiring energy. The average energy intensity for irrigation is estimated for each hydrologic region based the regional crop mix and typical irrigation technology by crop. First, the weighted average energy intensity of irrigation for

51 The energy required to heat one 1 kg of water by 1 °C is calculated based on the specific heat formula: $Q=mc\Delta T$, where Q = thermal energy, m= mass of water, c = specific heat capacity of water (4200 Joules/kg/°C), ΔT = change in temperature, calculated as the difference between the California average inlet temperature (58 °F) and the typical temperature for each water end-use in degrees Celsius. The formula is multiplied by 1/efficiency of the water heater.

52 William B. DeOreo, Peter Mayer, Benedykt Dziegielewski, Jack Kiefer. "Residential End Uses of Water, Version 2 (No. PDF Report #4309b), Subject Area: Water Resources and Environmental Sustainability." Water Research Foundation. 2016. Available at: https://www.redwoodenergy.tech/wp-content/uploads/2017/07/4309B-June-16-2016.pdf

53 We note that the energy requirements for natural gas water heaters are in "primary energy" terms, and therefore not directly comparable to electric water heaters which use "secondary energy" that is generated from primary fuel sources and is subject to generation and transmission efficiency losses.

54 Gleick, P.H., Haasz, D., Henges-Jeck, C., Srinivasan, V., Wolff, G., Cushing, K.K., Mann, A., 2003. "Waste Not, Want Not: The Potential for Urban Water Conservation in California." Pacific Institute.

55 Itron, Inc. "California Commercial End-Use Survey (CEUS) (No. CEC-400-2006-005)." California Energy Commission. 2006. Available at: https://www.energy.ca.gov/data-reports/surveys/california-commercial-end-use-survey/2006-california-commercial-end-use-survey

56 Sanders, K.T., Webber, M.E. "Evaluating the energy consumed for water use in the United States." Environ. Res. Lett. 7, 034034. September 2012. Available at: https://doi.org/10.1088/1748-9326/7/3/034034

TABLE 4 California Electricity (kWh/AF) and Natural Gas (MMBtu/AF) Energy Intensities by Hydrologic Region, by Water Cycle Stage

	North Coast	San Francisco Bay	Central Coast	South Coast	Sacramento River	San Joaquin River	Tulare Lake	North Lahontan	South Lahontan	Colorado River
Electricity Energy Intensity (kWh/AF)										
1. Water Generation/Extraction										
Groundwater Pumping	343	453	479	647	350	365	450	320	433	494
Recycled (Indirect Potable) Treatment	1,218	1,218	1,218	1,218	1,218	1,218	1,218	1,218	1,218	1,218
Recycled (Non-potable) Treatment	543	543	543	419	508	508	508	508	508	508
2. Water Conveyance										
Local Surface Water Deliveries	110	110	118	128	118	118	118	110	118	128
Local Imported Deliveries	116	137	44	44	44	44	44	44	44	44
Central Valley Project Deliveries	225	650	726	225	225	334	196	NA	NA	NA
Colorado River Deliveries	NA	NA	NA	2,115	NA	NA	NA	NA	NA	225
State Water Project Deliveries	NA	1,031	2,043	3,280	238	501	2,158	NA	3,505	4,000
Seawater Desalination Conveyance	100	100	100	100	100	100	100	100	100	100
Recycled Water Conveyance	364	364	364	364	364	364	364	364	364	364
3. Water Treatment										
Conventional Drinking Water Treatment	237	237	237	227	235	235	235	235	235	235
Seawater Desalination Treatment	4,503	4,503	4,503	4,503	4,503	4,503	4,503	4,503	4,503	4,503
Brackish Desalination Treatment	1,593	1,593	1,593	1,593	1,707	1,707	1,707	1,593	1,593	1,593
4. Distribution										
Urban Water Distribution	501	977	501	501	54	54	54	54	501	54
Agricultural Water Distribution	144	144	144	488	19	19	389	144	389	488

TABLE 4 California Electricity (kWh/AF) and Natural Gas (MMBtu/AF) Energy Intensities by Hydrologic Region, by Water Cycle Stage, Continued

	North Coast	San Francisco Bay	Central Coast	South Coast	Sacramento River	San Joaquin River	Tulare Lake	North Lahontan	South Lahontan	Colorado River
5. End-Use										
Urban Residential Indoor Water Heating	6,830	6,830	6,830	6,830	6,830	6,830	6,830	6,830	6,830	6,830
Urban Commercial Water Heating	5,245	5,245	5,245	5,245	5,245	5,245	5,245	5,245	5,245	5,245
Urban Industrial Water Heating	5,245	5,245	5,245	5,245	5,245	5,245	5,245	5,245	5,245	5,245
Urban Institutional Water Heating	5,245	5,245	5,245	5,245	5,245	5,245	5,245	5,245	5,245	5,245
Agricultural Irrigation	98	154	175	181	78	116	121	84	91	98
6. Wastewater Collection										
Wastewater Collection	104	104	104	111	111	111	111	111	111	111
7. Wastewater Treatment										
Wastewater Treatment (Secondary)	716	716	716	687	697	697	697	697	697	697
Natural Gas Energy Intensity (MMBtu/AF)										
5. End-Use										
Urban Commercial Water Heating	30	30	30	30	30	30	30	30	30	30
Urban Industrial Water Heating	30	30	30	30	30	30	30	30	30	30
Urban Institutional Water Heating	30	30	30	30	30	30	30	30	30	30
Urban Residential Indoor Water Heating	67	67	67	67	67	67	67	67	67	67

each crop type is estimated, based on irrigation surveys about the typical irrigation technology used for each crop as shown in Appendix Table 31,[57] and the average energy intensity for each irrigation technology (15 kWh/AF for gravity or flood irrigation, 284 kWh/AF for standard sprinklers, and 206 kWh/AF for drip/micro-irrigation.[58] The authors find the average applied water for each hydrologic region to each crop type between 1998 and 2002 based on available data on applied crop water from DWR's Agricultural Land and Water Use Estimates.[59]

57 Statewide Irrigation Systems Methods Surveys. Available at: http://water.ca.gov/Programs/Water-Use-And-Efficiency/Land-And-Water-Use/Statewide-Irrigation-Systems-Methods-Surveys

58 Burt, C., Howes, D., Wilson, G. "California Agricultural Water Electrical Energy Requirements (No. ITRC Report No. R 03-006)." Prepared by Irrigation Training and Research Center for the California Energy Commission. December 2003. Available at: https://digitalcommons.calpoly.edu/cgi/viewcontent.cgi?referer=www.google.com/&httpsredir=1&article=1056&context=bae_fac

59 Agricultural Land & Water Use Estimates. Available at: http://water.ca.gov/Programs/Water-Use-And-Efficiency/Land-And-Water-Use/Agricultural-Land-And-Water-Use-Estimates

Finally, the weighted average energy intensity of irrigation by crop is multiplied with the average applied water volumes by crop for each region to estimate an average energy intensity of irrigation by hydrologic region.

3.2 GHG Intensity of California's Water Cycle

To calculate the total GHG emissions associated with California's water system, the authors first calculated the GHG intensity (emissions of carbon dioxide (CO_2) equivalent per unit of energy) of the energy sources powering the water system: electricity (metric tons CO_2 equivalent/MWh) and natural gas (metric tons CO_2 equivalent/MMBtu).

The GHG intensity of electricity depends primarily on the regional fuel mix of generation. Because of policy targets in California like the Renewable Portfolio Standard (RPS), which requires a certain percentage of electricity be generated from renewable sources like solar and wind, electricity generation in California has a relatively low GHG intensity compared to neighboring states. The state passed Senate Bill 100 (SB 100) in 2017, which accelerated existing RPS targets for electricity and now requires 60 percent of electricity generation from renewable sources by 2030, and 100 percent of electricity from zero-emissions sources by 2045.[60] California does import electricity from outside the state to meet demands, however, because future GHG intensity projections for imported electricity were not available, this analysis assumes that the electricity demand of California's water system is met entirely by in-state generation compliant with the SB 100 renewable targets.[61]

The GHG intensity of electricity also varies temporally. For example, during times of high electricity demand, electricity may be generated from "peaking" fossil generators that have high emissions, while for other times of day, electricity demand may be met primarily from renewable generators that produce no GHG emissions. For simplicity, the California annual average GHG intensity of electricity was calculated based on the total GHG emissions from in-state electric generators divided by the total annual electricity produced.

Because state policy would drive such substantial changes to the GHG emissions from electricity over the time horizon of this analysis, the historical and projected GHG intensities are tracked in the authors' calculations. Data from the California Air Resources Board on in-state emissions and annual electricity generation were used to calculate the historical annual average GHG intensity of electricity generation.[62] For future years, the GHG intensities projected in electricity system simulations prepared for policy discussions on pathways for California's 100 percent zero-emissions electricity by 2045 were utilized.[63] The GHG intensities for the intervening years between historical data and projections are linearly interpolated. The annual GHG intensity values used are summarized in Table 5, and decrease from 0.26 tons CO_2/MWh in 2015 to 0.10 tons CO_2/MWh by 2035. The GHG emissions from natural gas are assumed to be a constant 0.053 tons of CO_2/MMBtu.[64]

3.3 Historical and Future Scenarios of Water Supply and Demande

The third step of the analysis is to collect historical data and develop future scenarios of water supply and demand volumes for the urban and agricultural water sectors in California. The analysis is conducted separately for the urban and agricultural sectors.

3.3.1 Urban Water Sector

For this analysis, historical and projected water demand and supply data were obtained from Urban Water Management Plans (UWMPs) submitted by urban water suppliers. In California, water suppliers that provide more than 3,000 AF of water annually or serve more than 3,000 customers (referred to as urban water suppliers) are required to prepare a UWMP every five years and submit those plans to the California Department of Water Resources (DWR). Together, the population served

60 De Leon, K., Skinner, N. SB-100 California Renewables Portfolio Standard Program: emissions of greenhouse gases. Chaptered September 2018. Available at: https://leginfo.legislature.ca.gov/faces/billHistoryClient.xhtml?bill_id=201720180SB100

61 In-state generation includes utilities within the California Independent System Operator (CAISO) region, as well as other municipal and irrigation district utilities such as Los Angeles Department of Water and Power and the Imperial Irrigation District.

62 California Greenhouse Gas Inventory for 2000-2018 — by Sector and Activity. California Air Resources Board. 2020.

63 California Energy Commission, California Public Utilities Commission, California Air Resources Board. "Draft 2021 SB 100 Joint Agency Report." 2020. Available at: https://www.energy.ca.gov/sb100

64 Carbon Dioxide Emissions Coefficients. US Energy Inf. Adm. EIA. Available at: https://www.eia.gov/environment/emissions/co2_vol_mass.php

TABLE 5 GHG Intensity of California Electricity Generation 2015–2035 (Tons of CO_2 equivalent/MWh)

	Historical Observed					Interpolated					Projected From Simulations				
	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2030	2035
In-State Generation	0.26	0.21	0.18	0.20	0.19	0.19	0.19	0.19	0.18	0.18	0.18	0.17	0.17	0.13	0.10

The low GHG intensity value in 2017 was due to an overall increase renewable generation on the grid as well as to the large increase in hydro-electricity production that year, the wettest year on record.

by the UWMPs is about 90 percent of California's total population; the urban water demands not included in the UWMP data are not analyzed.[65] The first UWMPs were published in 1990, and the most recent plans as of 2020 are the 2015 UWMPs.[66] Actual and projected demand and supply and current population data were extracted from the 2015 UWMPs from DWR's public data portal, WUEdata.[67] Suppliers report their data in five-year increments. Therefore, this analysis is performed using actual data for 2015, and projected data for 2020, 2025, 2030, 2035.

UWMP data are available for a total of 401 water suppliers. Only data related to retail operations for all water suppliers are used. However, data for eight suppliers were removed—which account for 0.4 percent of the total population reported in the UWMPs—from the analysis as their reported numbers are outliers and appear to be reporting errors.[68] Data for demand, supply, and population were joined with another dataset[69] to match each supplier to its respective hydrologic region. Each of these compiled datasets is then grouped and aggregated by hydrologic region for further analysis.

3.3.1.1 Urban Water Demand Data

Water demand data were extracted from "Table 4-1 Retail: Demands for Potable and Raw Water – Actual" and "Table 4-2 Retail: Demands for Potable and Raw Water – Projected." Population data were extracted from "Table 3-1 Retail: Population - Current and Projected." These data were joined with another dataset[70] to assign each supplier to a hydrologic region. Population and each demand category were then respectively summed to give totals for each hydrologic region. The UWMP data categorize residential end-use as "multifamily" and "single family." The authors separated the residential categories into "indoor" and "outdoor" using a ratio for each hydrologic region based on a six-year (2011-2016) annual average on indoor and outdoor demand from DWR's Water Balances data.[71] This ratio was then applied to the UWMP data and the respective categories were summed to get total "indoor residential" and "outdoor residential" water demand for each hydrologic region. The final set of demand categories were residential indoor, residential outdoor, commercial, industrial, institutional/governmental, landscape, losses, and other. Per-capita demand is calculated based on population for the respective year.

3.3.1.2 Urban Water Supply Data

Water supply data were extracted from "Table 6-8 Retail: Water Supplies – Actual" and "Table 6-9 Retail: Water Supplies – Projected." These data were joined with another dataset, as referred to above, to assign each supplier to a hydrologic region. Each supply category was then summed to give totals for each hydrologic region. The UWMPs combine all imported water sources into one category. For this study, this category was disaggregated into various imported sources of water, e.g., the Colorado River and the State Water Project, based on a six-year (2011-2016) average using data from DWR's Water Balances. The UWMPs combine all recycled water into one category, regardless of quality. Because of

65 WUEdata - Water Use Efficiency Data. Calif. Dep. Water Resources. WUEdata - Public Portal. Available at: https://wuedata.water.ca.gov/

66 UWMPs for 2020 are under development and will be submitted to DWR in 2021.

67 WUEdata - Water Use Efficiency Data. Calif. Dep. Water Resources. WUEdata - Public Portal. Available at: https://wuedata.water.ca.gov/

68 These suppliers are Calaveras County Water District, City of Corcoran, City of Exeter, Fruitridge Vista Water Company, City of Greenfield, City of Lemoore, South Feather Water and Power, and Truckee - Donner Public Utilities District.

69 Based on data from the California Department of Public Health via Pacific Institute's California Urban Water Map.

70 California Urban Water Use Map. Pacific Institute. Available at: URL https://pacinst.org/gpcd/map/

71 Water Portfolios. Calif. Dep. Water Resources. Available at: http://water.ca.gov/Programs/California-Water-Plan/Water-Portfolios

differences in the energy-intensity of recycled water for potable and non-potable applications, the authors split this category into potable and non-potable sources using Title 22 recycled water standards[72] and data from the 2015 UWMP "Table 6-4 Retail: Current and Projected Recycled Water Direct Beneficial Uses Within Service Area." The percentage split between potable and non-potable categories by hydrologic region was then applied to the supply volumes labeled as "recycled water" in the UWMP data.[73]

3.3.1.3 Urban Water Demand Scenarios

California's urban water demand has declined significantly over the last two decades (Cooley, 2020). A recent analysis of the state's 10 largest urban water suppliers, serving 25 percent of the population, finds that per-capita water demands declined by an average of 25 percent between 2000 and 2015.[74] Further, the study shows that many water suppliers did not adequately account for these trends in their Urban Water Management Plans, and overestimated total demand in 98 percent of the cases examined (Figure 2). Such overestimates of future water demands can result in investment in unneeded infrastructure and new sources of supply.[75]

In this analysis, three scenarios of future water demand were developed to study potential changes to California's water-related energy and GHG footprint:

i. **Water Supplier Projections Scenario (High-Case):** Assumes that total demand is maintained as reported in the 2015 UWMPs for 2020, 2025, and 2030. Given that future water supplies reported in the UWMP exceed future demand, water supplies were proportionally scaled down to match projected demand. This scenario represents the highest future water demands as envisioned by water suppliers and includes planned facilities (such as for desalination or water recycling), assumed future changes in per capita water demand, and water suppliers' projections of population growth.

ii. **2015 Constant Per-Capita Demand Scenario (Mid-Case):** Assumes system-wide per-capita water demand (i.e., for all urban end-use sectors) from the 2015 UWMPs is held constant for every future year. Total demand is then estimated by multiplying 2015 per-capita demand by projected population for each hydrologic region from the UWMP data. Supplies are then adjusted proportionally from UWMP projections to match demand by year and hydrologic region. The authors note that 2015 was not a "historically typical" year because of a statewide drought from 2012 to 2016—during which there was a mandate to reduce urban water use by 25 percent. However, monthly water use data from the State Water Resources Control Board suggest that urban water use increased slightly after the drought but remains lower than pre-drought levels.[76,77]

iii. **Declining Per-Capita Demand Scenario (Low-Case):** Assumes system per-capita demand is decreased by 2 percent annually, based on a 2020 Pacific Institute study which found a trend of such decreases among the 10 largest suppliers between the years 2000 to 2015.[78] This percentage decline is calculated using 2015 per-capita demand as the base year. Total demand is then estimated by multiplying future per-capita demand by projected population for each hydrologic region. Supplies are adjusted proportionally to match the demand volumes. This scenario represents

72 State Water Resources Control Board Regulations Related to Recycled Water. California Code of Regulations: Title 22. October 1, 2018. Available at: https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/lawbook/RWregulations_20181001.pdf

73 The final list of water source categories includes desalinated water (seawater and brackish), exchanges, groundwater, other, Central Valley Project deliveries, Colorado River Aqueduct deliveries, local imports, other federal deliveries, State Water Project deliveries, recycled water (potable), recycled water (non-potable), stormwater use, supply from storage, surface water, and transfers.

74 Abraham, S., Diringer, S., Cooley, H. "An Assessment of Urban Water Demand Forecasts in California." Pacific Institute. August 2020. Available at: https://pacinst.org/publication/urban-water-demand-forecasts-california/

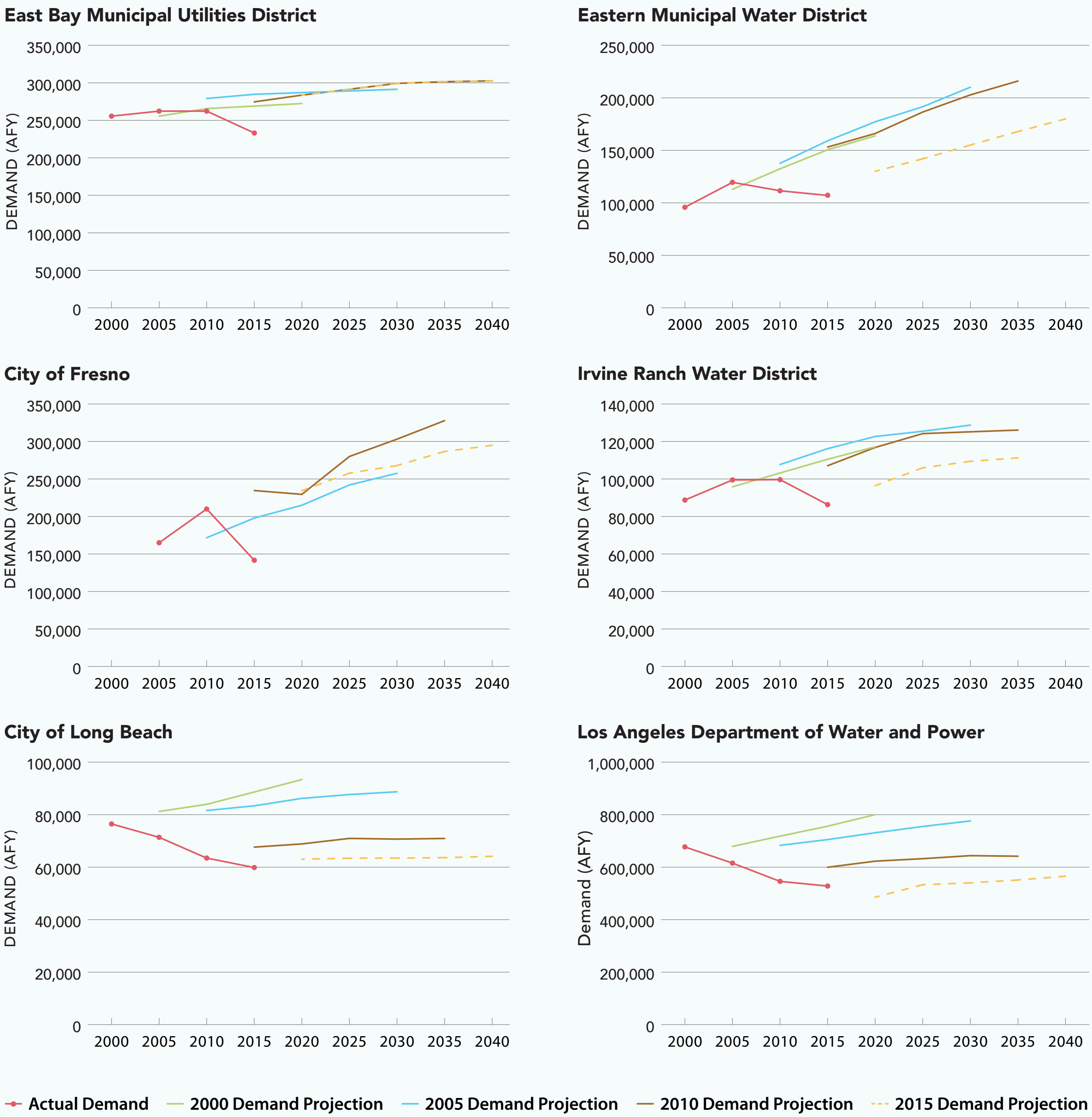
75 ibid.

76 ibid.

77 Cooley, H. "Urban and Agricultural Water Use in California, 1960-2015." Pacific Institute. June 2020. Available at: https://pacinst.org/wp-content/uploads/2020/06/PI_Water_Use_Trends_June_2020.pdf

78 Abraham, S., Diringer, S., Cooley, H. "An Assessment of Urban Water Demand Forecasts in California." Pacific Institute. August 2020. Available at: https://pacinst.org/publication/urban-water-demand-forecasts-california/

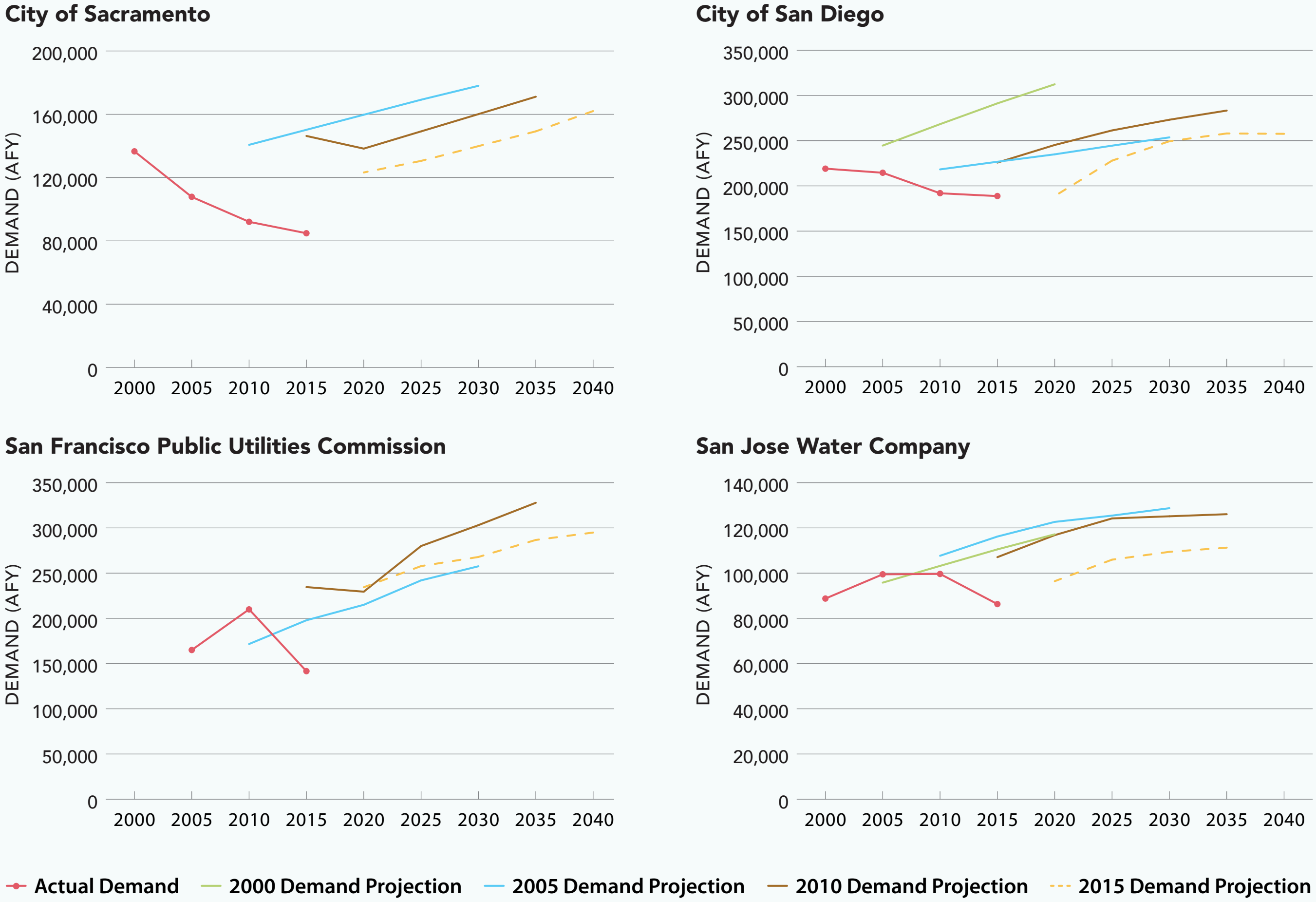
FIGURE 2 Actual and Projected Total Water Demands for Ten Selected Urban Water Suppliers (Acre-feet)



Source: Data from Abraham, S. Diringer S., Cooley, H. An Assessment of Urban Water Demand Forecasts in California. Pacific Institute, 2020.

Note: The 2000 UWMP was not available for the City of Fresno; the 2000 UWMPs for the City of Sacramento and San Jose Water Company did not contain total demand projections.

FIGURE 2 Actual and Projected Total Water Demands for Ten Selected Urban Water Suppliers (Acre-feet), Continued



Source: Data from Abraham, S. Diringer S., Cooley, H. An Assessment of Urban Water Demand Forecasts in California. Pacific Institute, 2020.

Note: The 2000 UWMP was not available for the City of Fresno; the 2000 UWMPs for the City of Sacramento and San Jose Water Company did not contain total demand projections.

a future pathway with more aggressive conservation and efficiency efforts to reduce urban water usage, and therefore the lowest total water demand.

Table 6 shows how total residential per-capita demand (R-gpcd) and indoor residential per-capita demand (indoor R-gpcd) changes between 2015 and 2035 under each of these scenarios. Under the Water Supplier Projections Scenario, both the statewide average R-gpcd and indoor R-gpcd increase 20% between 2015 (83 R-gpcd, 46 indoor R-gpcd) and 2035 (102 R-gpcd total, 56 indoor R-gpcd). However, if historical conservation trends continue as is assumed under the Declining Per-Capita Demand Scenario, statewide average residential usage drops to 59 R-gpcd and 32 indoor R-gpcd, respectively. While low, this scenario is similar to the water use already achieved in high-efficiency homes equipped with Energy Star and WaterSense appliances and fixtures[79] and in some other regions of the world, such as Israel where households on average use 36 R-gpcd.[80]

79 William B. DeOreo, Peter Mayer, Benedykt Dziegielewski, Jack Kiefer. “Residential End Uses of Water, Version 2 (No. PDF Report #4309b), Subject Area: Water Resources and Environmental Sustainability.” Water Research Foundation. 2016. Available at: https://www.redwoodenergy.tech/wp-content/uploads/2017/07/4309B-June-16-2016.pdf

80 Cooley, H. “Urban and Agricultural Water Use in California, 1960-2015.” Pacific Institute. June 2020. Available at: https://pacinst.org/wp-content/uploads/2020/06/PI_Water_Use_Trends_June_2020.pdf

3.3.2 Agricultural Water Sector

For this analysis, future water demand and supply delivery data were obtained from an analysis DWR conducted for its 2018 California Water Plan Update for the three hydrologic regions in Central Valley (Sacramento River, San Joaquin Valley, and Tulare Lake) under a number of population growth and climate-change scenarios.[81] The data are publicly available to download through a WEAP Tableau workbook.[82] These data are the results of simulations conducted with the integrated water supply and demand modeling platform called Water Evaluation and Planning (WEAP), which assessed future water conditions in the Central Valley for the urban and agricultural sectors under a combination of five urban growth scenarios and 20 climate scenarios from a base year of 2006 through 2100. The data include total demand, total supply delivered, and unmet demand (the difference between water demanded and actual supply delivered) for each year, Planning Area, and sector (this study analyzed only the agricultural sector results). To be consistent with the time horizon and geographic resolution of this study's urban analysis (described in Section 3.3.1), agricultural analysis was limited to 2015, 2020, 2025, 2030, and 2035, and the data were aggregated to the hydrologic region. For each of these years, a rolling 10-year average was calculated to smooth out the inter-annual variability from the climate projections. The agricultural analysis focused only on California's Central Valley, which comprises about 80 percent of total state agricultural water use.[83]

TABLE 6 Statewide Volume-Weighted Average Residential Daily per Capita Water Demand, by Scenario (Gallons per Capita per Day, R-gpcd and Indoor R-gpcd)

Scenario	Residential Segment	2015	2020	2025	2030	2035
Water Supplier Projections Scenario (High-Case)	R-gpcd	83	101	102	102	102
	Indoor R-gpcd	46	56	56	56	56
2015 Constant Per-Capita Demand Scenario (Mid-Case)[82]	R-gpcd	83	86	87	88	88
	Indoor R-gpcd	46	48	48	48	49
Declining Per-Capita Demand Scenario (Low-Case)	R-gpcd	83	78	71	65	59
	Indoor R-gpcd	46	43	39	36	32

Residential per-capita demand increases slightly under the 2015 Constant Per-Capita Demand Scenario, because we keep the residential share of total system demand the same as that of each year's share from the Water Supplier Demand Scenario. For example, under the Water Supplier Demand Scenario, in 2015 indoor residential water use was 34% of total urban demand (1,842,682/5,432,207 AF), but in 2035 the indoor residential water use share increased to 35% of total urban demand (2,723,160/7,815,382 AF).

3.3.2.1 Agricultural Water Demand Data

The "supplies delivered" variable from DWR's WEAP simulation results was utilized to represent agricultural water demand in this analysis, to be consistent with the report's urban analysis where demand and supply are balanced and because "supplies delivered" represents water use given supply availability to agricultural water users.[84]

The WEAP model simulates agricultural water conditions within the three hydrologic regions in Central Valley based on the effects of urban growth on agricultural land and climate change. The urban growth scenarios are a combination of a low-, mid-, or high-population growth rate, and a low-, central-, or high-level of population

81 Rayej, M., Kibrya, S., Shipman, P., Correa, M. "Future Scenarios of Water Supply and Demand in Central Valley, California through 2100: Impacts of Climate Change and Urban Growth, California Water Plan Update 2018 Supporting Document." California Department of Water Resources. June 2019. Available at: https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/California-Water-Plan/Docs/Update2018/Final/SupportingDocs/Future-Scenarios-of-Water-Supply-in-the-Central-Valley.pdf

82 WEAP Future Scenarios. Available at: https://public.tableau.com/views/WEAP_Scenarios/DemandSupplyMultiClimate?%3Aembed=y&%3AshowVizHome=no&%3Adisplay_count=y&%3Adisplay_static_image=y&%3AbootstrapWhenNotified=true&%3Alanguage=en&:embed=y&:showVizHome=n&:apiID=host0#navType=0&navSrc=Parse

83 Water Portfolios. California Department of Water Resources. Available at: http://water.ca.gov/Programs/California-Water-Plan/Water-Portfolios

84 We do not use the "water demand" variable from WEAP because it represents a theoretical "requested" water demand based on crop acreage and climate, which may not be met if there are insufficient supplies after the (user-specified) higher priority urban water demands are satisfied (Rayej, M., Kibrya, S., Shipman, P., Correa, M. "Future Scenarios of Water Supply and Demand in Central Valley, California through 2100: Impacts of Climate Change and Urban Growth, California Water Plan Update 2018 Supporting Document." California Department of Water Resources. June 2019. Available at: https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/California-Water-Plan/Docs/Update2018/Final/SupportingDocs/Future-Scenarios-of-Water-Supply-in-the-Central-Valley.pdf).

TABLE 7 Urban Growth Scenarios from DWR Simulations, and Effect on Agricultural Water Use

DWR Scenario Abbreviation	Scenario Description
CTP_CTD	Central population growth, current trends density -> mid-level agricultural water use
CTP_HID	Central population growth, high density -> mid-level agricultural water use
CTP_LOD	Central population growth, low density -> mid-level agricultural water use
HIP_LOD	High population growth, low density -> low-level agricultural water use
LOP_HID	Low population growth, high density -> high-level agricultural water use

density.[85] In the DWR analysis, it is assumed that population growth in Central Valley urban areas will cause agricultural land to go out of production, thereby reducing agricultural water demand.[86] This effect on agricultural water increases with population growth and decreases with population density. The urban growth scenarios available in the results are listed in Table 7.

The climate scenarios include results from 10 Global Circulation Models (GCMs), and two emissions scenarios (Representative Concentration Pathways or RCP 4.5 and RCP 8.5, which represent future radiative warming of 4.5 W/m^2 and 8.5 W/m^2, respectively), as recommended to capture the range of possible climate futures in California.[87] The list of GCMs and emissions scenarios are listed in Table 8. While the water supply availability and agricultural water demands are affected by changing temperature and precipitation patterns under each climate change scenario modeled in WEAP, the variation between climate scenarios (both GCMs and emission scenarios) is minimal within this study's near-term time horizon; the overall impact of climate change is expected to be more significant, and vary between GCMs and emissions scenarios, closer to the end-century period.[88]

TABLE 8 Climate Change Scenarios Modeled in DWR Analysis

GCMs	Emissions scenarios
Access10	RCP 4.5
Access10	RCP 8.5
Canesm2	RCP 4.5
Canesm2	RCP 8.5
Ccsm4	RCP 4.5
Ccsm4	RCP 8.5
Cesm1_bgc	RCP 4.5
Cesm1_bgc	RCP 8.5
Cmcc_cms	RCP 4.5
Cmcc_cms	RCP 8.5

3.3.2.2 Agricultural Water Supply

The supply deliveries in the DWR WEAP analysis results are reported as a total volume and do not include the share of water deliveries by source. To supplement this data, a separate dataset from DWR of historical water deliveries to the agricultural sector by hydrologic region and source for 1999 to 2016 was utilized. For each hydrologic region, the historical average share of supply from each water source was calculated (Table 9) and these shares

85 The low, mid, and high population forecasts from the data we use for this agricultural analysis from DWR's California Water Plan are not necessarily consistent with the population forecasts that are used in the urban analysis, which are based on individual water supplier's projections for their service territories. The DWR report and individual UWMPs do not provide enough information to compare the population forecasts used.

86 Rayej, M., Kibrya, S., Shipman, P., Correa, M., Future Scenarios of Water Supply and Demand in Central Valley, California through 2100: Impacts of Climate Change and Urban Growth, California Water Plan Update 2018 Supporting Document. California Department of Water Resources. 2019.

87 Lynn, E., Schwarz, A., Anderson, J., Correa, M. "Perspectives and Guidance for Climate Change Analysis." California Department of Water Resources, Climate Change Technical Advisory Group. August 2015. Available at: https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/All-Programs/Climate-Change-Program/Climate-Program-Activities/Files/Reports/Perspectives-Guidance-Climate-Change-Analysis.pdf

88 We note that because all the scenarios rely on climate model data which can have small differences for the historical period, there are slight differences in the 2015 data between scenarios. We use this simulated WEAP data for 2015 despite these small differences to have a fully consistent dataset, rather than mixing data with historical data collected from another source.

were multiplied by the total projected supply deliveries from each year of the WEAP analysis to estimate water supply by source. This is a simplifying assumption given available data and implies that the historical ratio of different supply sources will stay constant in the future.[89]

3.3.2.3 Agricultural Water Scenarios

For this analysis, combinations of urban growth and climate scenarios from DWR's WEAP simulations were selected that together result in a set of (i) low, (ii) mid, and (iii) high agricultural water use scenarios. The authors first selected the three bounding scenarios among urban growth scenarios (High Population Growth + Low Density, Central Population Growth + Central Density, and Low Population Growth + High Density). For each of these urban growth scenarios, the authors found the climate scenario that produces the highest and lowest unmet demand across the study period (2015–2035) for the aggregate Central Valley region. The unmet demand is sensitive to effects of climate on both supply availability and irrigation demand and therefore captures the cumulative climate change impact on agriculture for a given urban growth scenario. For the (i) High Population Growth scenario, the authors selected the climate scenario with the maximum unmet demand (greatest climate change impact), and for the (iii) Low Population Growth scenario they select the climate scenario resulting in minimum unmet demand (smallest climate change impact). For the (ii) Central Population Growth scenario, the climate scenario with maximum unmet demand was selected. The authors note that these scenarios are largely driven by DWR's assumptions of how urban population growth will affect agricultural land and subsequently water use, and do not account for economic factors, such as crop values on domestic and international markets, federal and state agricultural policies, and other factors that may have even greater impacts on farmers' land and water use choices.[90] For example, while California's agricultural water use has remained relatively flat since the 1980s, during this time the economic value of crop production has grown significantly, by shifting to higher value crops and increased adoption of more water-efficient irrigation technologies, such as drip and micro-sprinkler systems.[91]

TABLE 9 Historical 1999–2016 Average Share of Agricultural Water Supply by Source, by Hydrologic Region

Supply Sources	Sacramento Valley	San Joaquin Valley	Tulare Lake
State Water Project Deliveries	0.2%	0.3%	8.7%
Central Valley Project Deliveries	25%	16%	15%
Other Federal Deliveries	2.8%	0.2%	0.0%
Surface Water	33%	33%	18%
Local Imports	0.4%	0.0%	0.0%
Return Flows	6.8%	11%	0.1%
Groundwater	32%	39%	58%
Colorado River Deliveries	0.0%	0.0%	0.0%

i. **Low Agricultural Water Use Scenario:** HIP_LOD (lowest agricultural demand because of urban encroachment on agricultural land) with the maximum unmet demand (highest climate change impact) based on GCM: CMCC_CMS and emissions scenario: RCP 4.5.

ii. **Mid Agricultural Water Use Scenario:** CTP_CTD (central agricultural demand) with maximum unmet demand based on GCM: CMCC_CMS and emissions scenario: RCP 4.5

iii. **High Agricultural Water Use Scenario:** LOP_HID (highest agricultural demand because of least urban encroachment on agricultural land) with the minimum unmet demand (lowest climate change impact) based on GCM: GFdl_cm3 and emissions scenario: RCP 8.5

89 The historical agricultural water use categories in the DWR data we use do not include recycled water; however, we recognize that there is a small share of agricultural water-supplies that comes from recycled sources ("Volumetric Annual Reporting: Recycled Water Policy | California State Water Resources Control Board," n.d.).

90 Rayej, M., Kibrya, S., Shipman, P., Correa, M. "Future Scenarios of Water Supply and Demand in Central Valley, California through 2100: Impacts of Climate Change and Urban Growth, California Water Plan Update 2018 Supporting Document." California Department of Water Resources. June 2019. Available at: https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/California-Water-Plan/Docs/Update2018/Final/SupportingDocs/Future-Scenarios-of-Water-Supply-in-the-Central-Valley.pdf

91 Cooley, H. "Urban and Agricultural Water Use in California, 1960-2015." Pacific Institute. June 2020. Available at: https://pacinst.org/wp-content/uploads/2020/06/PI_Water_Use_Trends_June_2020.pdf

3.4 Total Energy and GHG of Urban and Agricultural Water Scenarios

In both the urban and agricultural analyses, for each future water scenario, hydrologic region, and year, the total water-related energy use and associated GHG emissions were calculated. For all the relevant stages of the water cycle described in Section 3.1.1, the corresponding energy intensities described in Section 3.1.2 were multiplied by the water supply and demand volumes of the scenarios in Sections 3.3.1.3 and 3.3.2.3, and finally summed to estimate total water-related energy usage for the urban and agricultural sectors, respectively, in each hydrologic region and scenario. For each urban and agricultural water scenario, the GHG intensity by fuel was multiplied by the total energy usage of the fuel to calculate total GHG emissions.

4. ANALYSIS RESULTS AND DISCUSSION

4.1 Urban Water Results

Here the projected demand, supply, energy, and GHG results of this report's analysis is described across scenarios for California in aggregate, by hydrologic region, by supply source and demand sector, and by water cycle stage for urban water. In each section, a high-level comparison across scenarios and detailed results for the "mid-case" 2015 Constant Per-Capita Demand Scenario are included; detailed results for the "high-case" Water Supplier Projections Scenario and the "low-case" Declining Per-Capita Demand Scenario are in the Appendix Section 9.2.

TABLE 10 State Urban Water Demand 2015–2035, by Scenario (AF)

Scenario	2015	2020	2025	2030	2035	% Change 2015-2035	Change 2015-2035
Water Supplier Projections Scenario (High-Case)	5,432,207	6,778,861	7,158,608	7,485,695	7,815,382	+44%	2,383,175
2015 Constant Per-Capita Demand Scenario (Mid-Case)	5,432,207	5,751,547	6,075,776	6,396,138	6,727,985	+24%	1,295,778
Declining Per-Capita Demand Scenario (Low-Case)	5,432,207	5,198,943	4,964,351	4,723,990	4,491,656	-17%	-940,550

TABLE 11 Annual Urban Water Demand by Sector (AF)—2015 Constant Per-Capita Demand Scenario (Mid-Case)

Demand Sector	2015	2020	2025	2030	2035	% Change 2015-2035	Change 2015-2035
Residential- Indoor	1,842,682	2,004,389	2,123,692	2,242,569	2,358,832	28%	516,151
Residential- Outdoor	1,448,045	1,603,035	1,709,520	1,816,070	1,922,994	33%	474,950
Commercial	682,261	720,403	753,573	785,961	821,041	20%	138,779
Industrial	216,065	217,743	223,731	227,876	240,385	11%	24,319
Institutional/ Governmental	162,886	133,502	142,866	152,689	156,521	-4%	-6,364
Large Landscape	315,900	296,957	306,808	321,261	338,634	7%	22,734
Losses	342,822	326,892	346,461	363,382	382,319	12%	39,497
Other	421,546	448,627	469,124	486,329	507,259	20%	85,713
Total	5,432,207	5,751,547	6,075,776	6,396,138	6,727,985	24%	1,295,778

4.1.1 Urban Water Demand: Historical and Future Scenarios

According to data reported by water suppliers in the UWMPs—which represent 90 percent of California's population—total urban water demand in 2015 was 5.4 million acre-feet (MAF). If per-capita water demand is held constant at 2015 levels according to the "mid-case" scenario, statewide total urban demand increases 24 percent (1.3 MAF) between 2015 and 2035 with population growth. This result is compared to water suppliers' projections ("high-case"), and the declining demand scenario ("low-case") that represents a continuation of historical conservation and efficiency trends in Table 10 and Figure 3.[92] Water suppliers project a 44 percent increase (2.4 MAF) in overall urban water demand between 2015 and 2035, about twice the rate of the 2015 Constant Per-Capita Demand Scenario. With increased conservation under the Declining Per-Capita Demand Scenario, statewide urban demand would fall by 17 percent (0.9 MAF) between 2015 and 2035.

Under the 2015 Constant Per-Capita Demand Scenario, the largest absolute and percentage change increases come from indoor residential water demand—which is also the most energy-intensive end-use sector—and from outdoor residential water demand, respectively (Table 11).[93] Across the hydrologic regions, (Figure 4), the largest absolute increases in residential water demand are in two regions with highly populated urban centers and the highest increase in overall urban demands in the state: South Coast (about +456,000 AF) and Sacramento (about +175,000 AF).

4.1.2 Urban Water Supply: Historical and Future Scenarios

To meet projected water demands under the "mid-case" 2015 Constant Per-Capita Demand Scenario, water supplies must increase by 1.3 MAF, or 24 percent, between

92 See the Appendix, for detailed tables of water demand results for the Water Supplier Projections Scenario and Declining Per-Capita Demand Scenario.

93 Because we do not have data on how water suppliers projected losses, there is a simplifying assumption that losses also scale proportionally with demand in the 2015 Constant Per-Capita Demand and Declining Per-Capita Demand Scenarios.

FIGURE 3a State Urban Water Demand 2015–2035 by Scenario

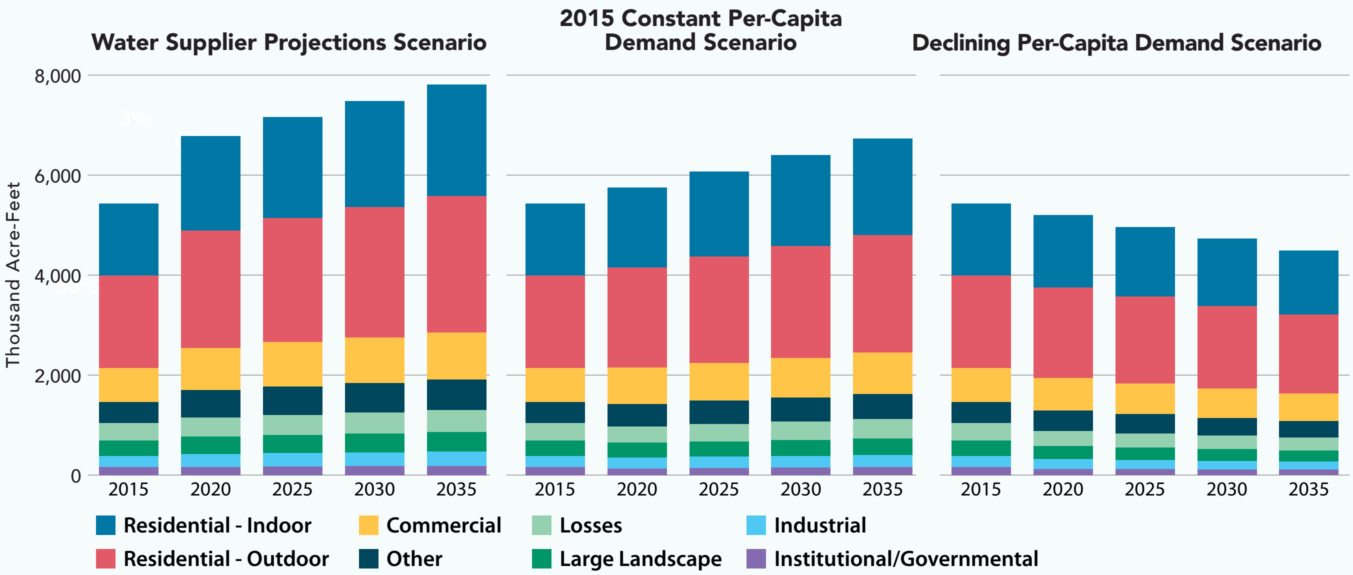
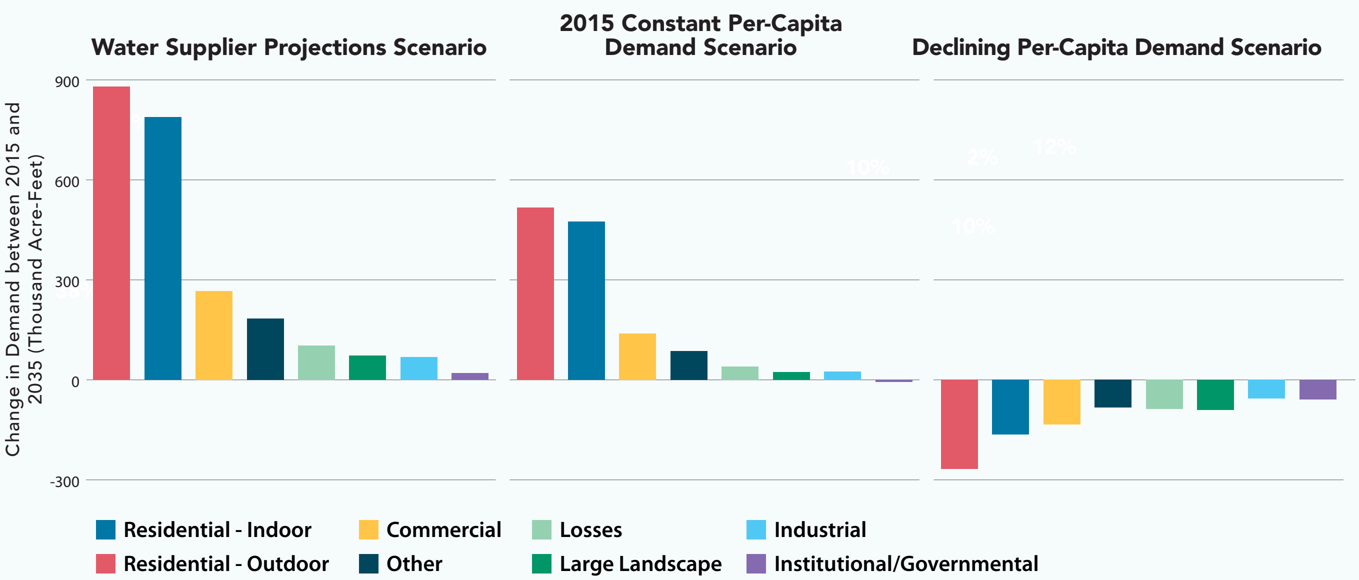


FIGURE 3b Change in State Urban Water Demand Between 2015 and 2035, by Scenario



2015 (5.4 MAF) and 2035 (6.7 MAF).[94] This supply increase is largely met using traditional water sources (groundwater and surface water)[95] (Table 12), but there are also shifts in the supply mix from imported water toward local alternative water sources , which have important energy and GHG implications. The largest percentage increases in supplies between 2015 and 2035 are from brackish desalination (+7000% increase in supply), potable recycled water (+300% increase in supply), and captured stormwater (+19,000% increase in supply). Further, there are decreases in the statewide shares of imported water from the SWP and CRA from 13 percent to 12 percent,

94 These water supply values are water production estimates and do not include conveyance losses, such as from the SWP, CRA, or CVP.

95 See the Appendix, for detailed tables of water supply results for the 2015 Constant Per-Capita Demand Scenario and Declining Per-Capita Demand Scenario.

FIGURE 4a 2015 Constant Per-Capita Demand Scenario (Mid-case): Change in Urban Water Demand Between 2015 and 2035, by Hydrologic Region

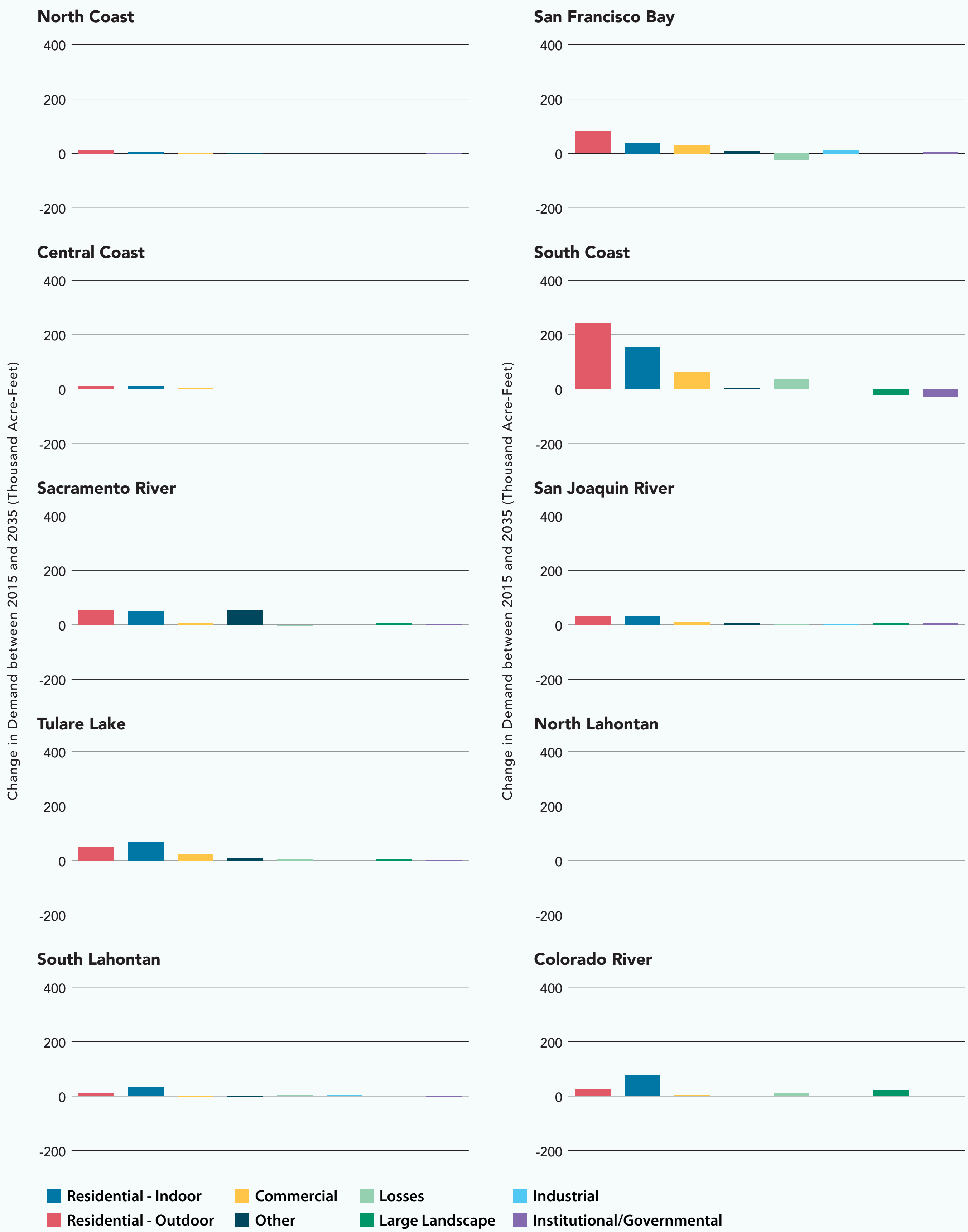
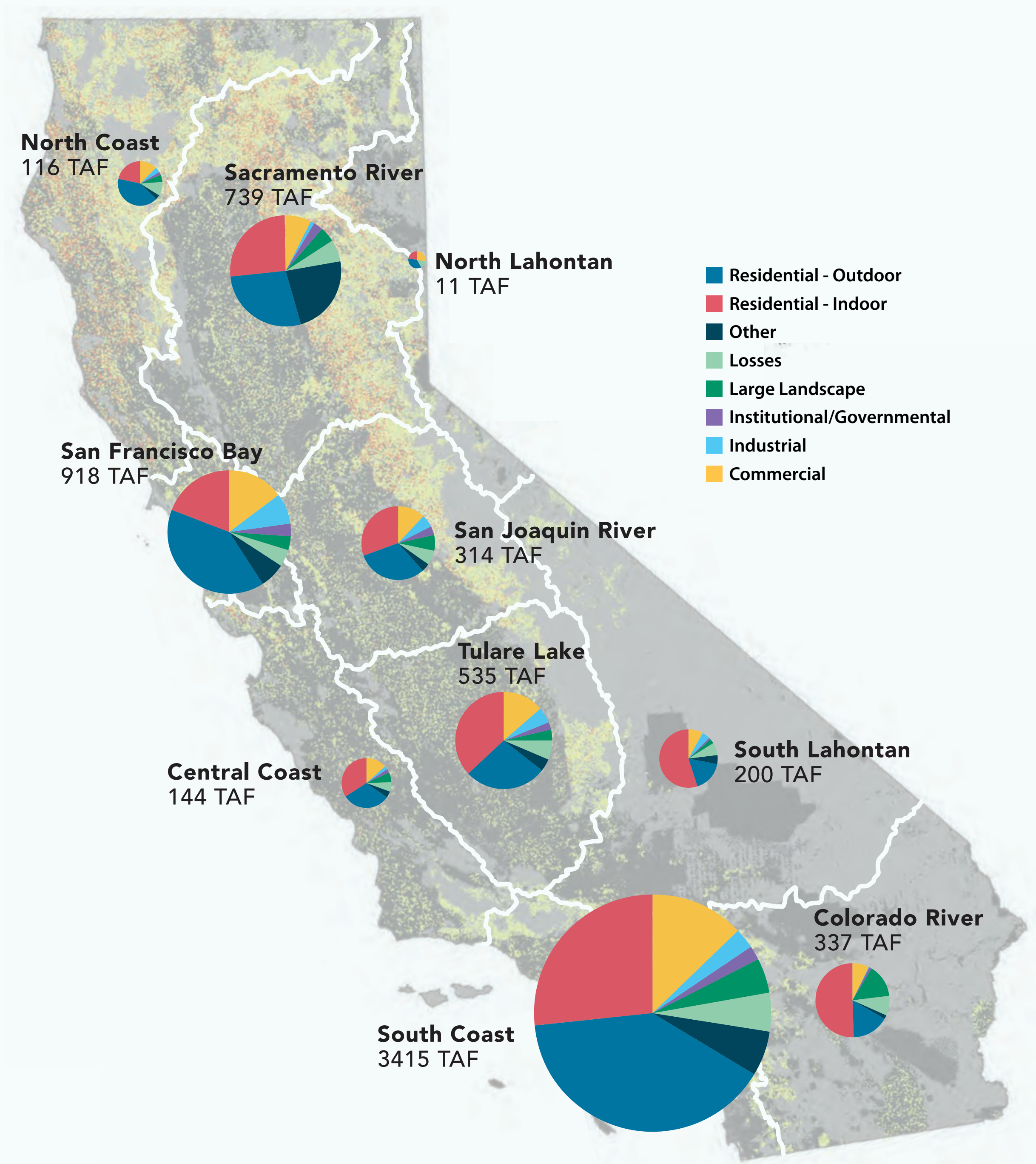


FIGURE 4b 2035 Urban Water Demand, by Hydrologic Region



and 16 percent to 13 percent respectively, between 2015 and 2035. Although many alternative water sources are energy-intensive because of the combined energy use for associated supply extraction/generation, treatment, and conveyance, in many regions, their energy needs are typically lower than for imported water (Table 4).

There is significant variation in how these supply changes are distributed across hydrologic regions under the 2015 Constant Per-Capita Demand Scenario (Figure 5). The absolute largest increases in groundwater and non-potable recycled water are projected to occur in the South Coast, which also sees increases in potable

TABLE 12 State Annual Water Supply by Source (AF)—2015 Constant Per-Capita Demand Scenario (Mid-Case)

Supply Source	2015	2020	2025	2030	2035	% Change 2015-2035	Change 2015-2035
Central Valley Project Deliveries	259,046	270,119	292,069	310,375	325,568	26%	66,522
Colorado River Deliveries	871,975	816,885	848,783	877,729	906,259	4%	34,283
Desalinated Water (Brackish)	205	3,495	7,206	10,860	14,595	7,013%	14,390
Desalinated Water (Seawater)	27,888	29,882	32,332	32,783	33,238	19%	5,350
Exchanges	2,216	3,858	1,162	1,083	1,169	-47%	-1,047
Groundwater	2,063,977	2,006,160	2,075,120	2,175,610	2,291,486	11%	227,509
Local Imports	365,972	350,455	367,474	383,598	400,499	9%	34,527
Other	98,094	196,039	200,210	212,057	219,965	124%	121,870
Other Federal Deliveries	28,565	26,593	29,107	31,143	32,428	14%	3,863
Recycled Water- Non Potable	287,519	346,256	403,475	454,109	495,238	72%	207,719
Recycled Water- Potable	17,010	29,555	61,305	63,599	68,653	304%	51,643
State Water Project Deliveries	716,384	687,402	723,632	754,014	784,892	10%	68,508
Stormwater Use	72	2,242	5,003	8,354	13,642	18,834%	13,569
Supply from Storage	14,329	24,266	24,801	25,456	26,155	83%	11,827
Surface Water	648,056	943,758	988,764	1,036,668	1,094,451	69%	446,396
Transfers	30,898	14,583	15,333	18,699	19,748	-36%	-11,150
Total	5,432,207	5,751,547	6,075,776	6,396,138	6,727,985	+24%	1,295,778

recycled water. Although there are also large absolute increases in SWP and Colorado River imports to the South Coast, these sources decrease in their shares of the region's total supply (21% to 18% SWP, 29% to 25% Colorado River) between 2015 to 2035. Increases in surface water are dominant in the San Francisco Bay, Sacramento River, and Tulare Lake hydrologic regions.

Under the 'high-case' Water Supplier Projections Scenario, the increase in supply needed to meet the 44 percent projected demand between 2015 and 2035 primarily comes from surface water, groundwater, and non-potable recycled water (Figure 6). In the Declining Per-Capita Demand Scenario, which requires 17 percent less water by 2035 compared to 2015, the largest absolute reductions in supply deliveries come from groundwater, Colorado River water, and SWP, all of which are relatively energy-intensive water sources.

TABLE 13 State Urban Water Supply Portfolio in 2015 and 2035—2015 Constant Per-Capita Demand Scenario (Mid-Case)

Supply Source	% of 2035 Total Supply	% of 2015 Total Supply
Central Valley Project Deliveries	5%	5%
Colorado River Deliveries	16%	13%
Desalinated Water (Brackish)	0.004%	0.2%
Desalinated Water (Seawater)	1%	0.5%
Exchanges	0.04%	0.02%
Groundwater	38%	34%
Local Imports	7%	6%
Other	2%	3%
Other Federal Deliveries	1%	0.5%
Recycled Water- Non Potable	5%	7%
Recycled Water- Potable	0.3%	1%
State Water Project Deliveries	13%	12%
Stormwater Use	0.001%	0.2%
Supply from Storage	0.3%	0.4%
Surface water	12%	16%
Transfers	1%	0.3%
Total	100%	100%

FIGURE 5a Change in Urban Water Supplies Between 2015 and 2035, by Hydrologic Region

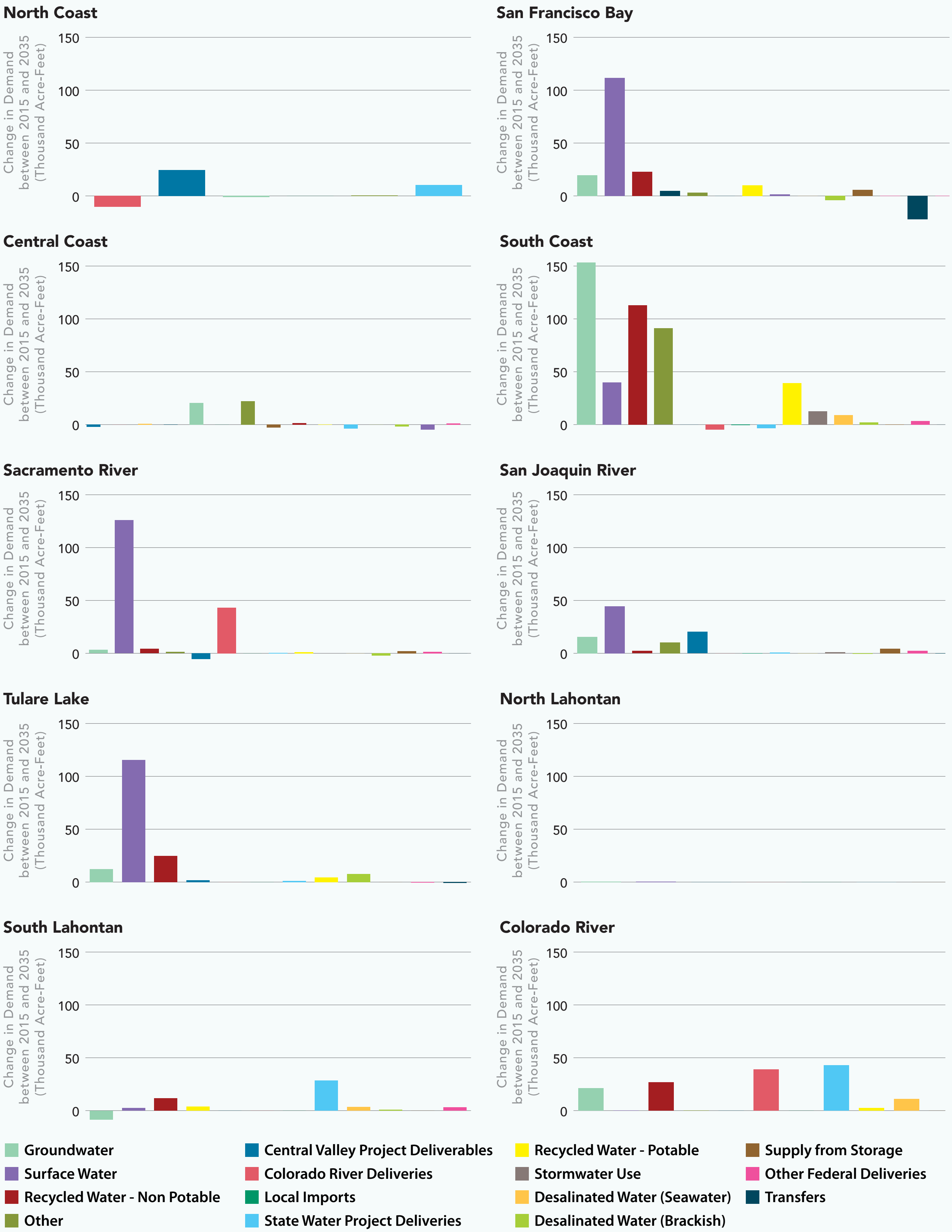


FIGURE 5b 2035 Urban Water Supplies, by Hydrologic Region

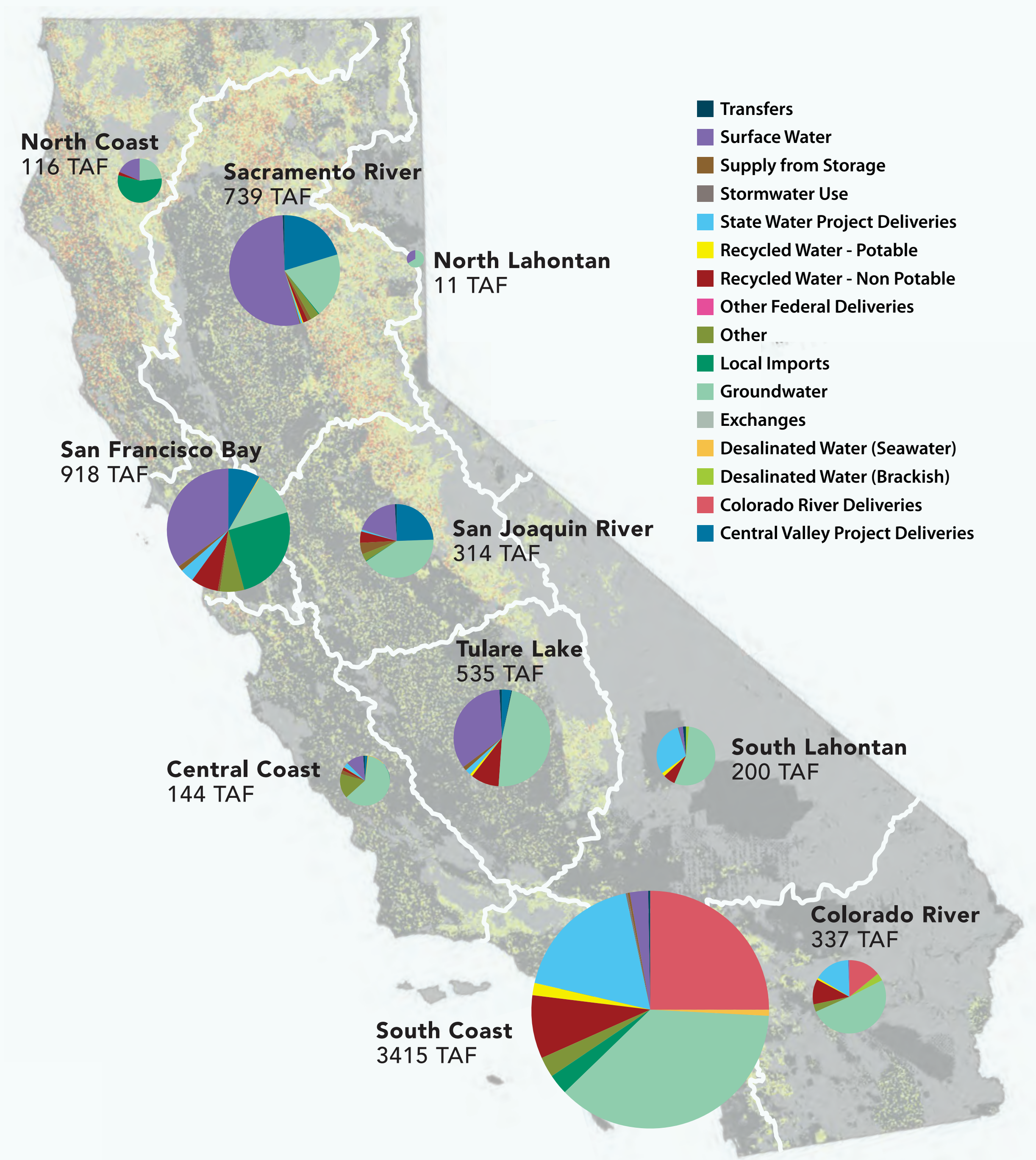


FIGURE 6a Annual Urban Water Supply by Source, California Total

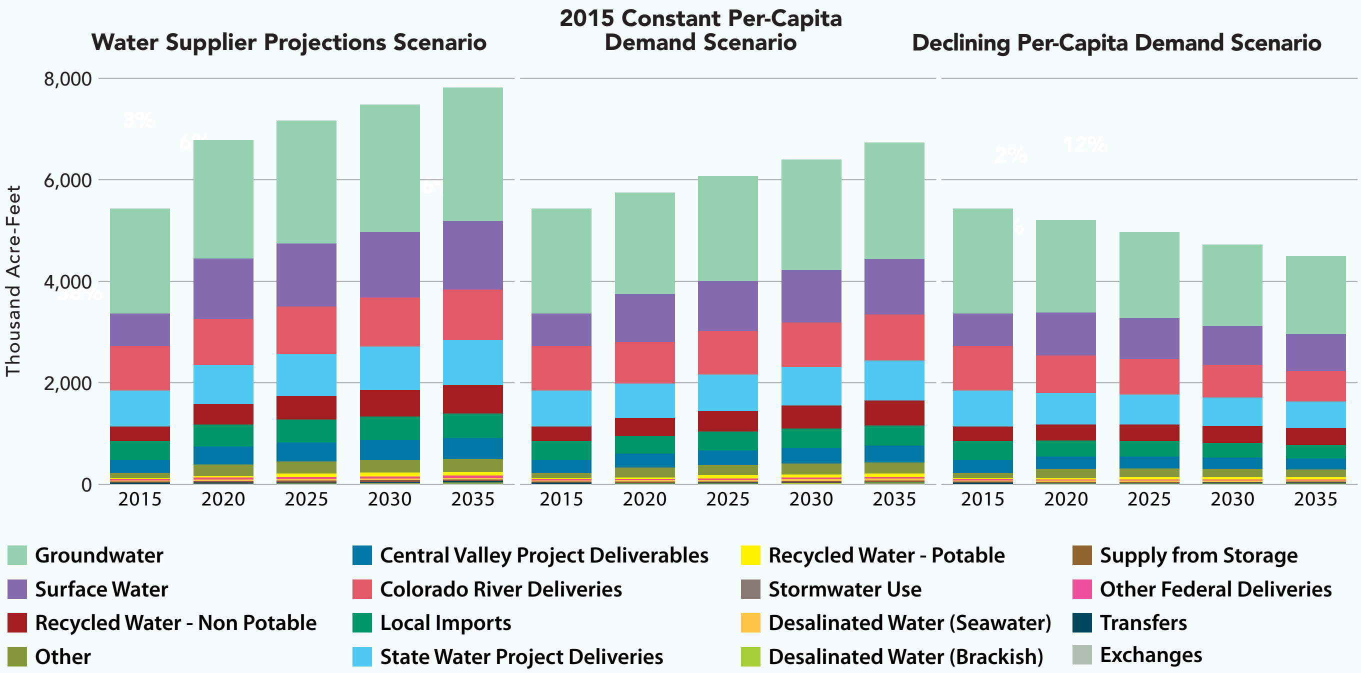


FIGURE 6b 2015-2035 Change in California Total Annual Urban Supply by Source

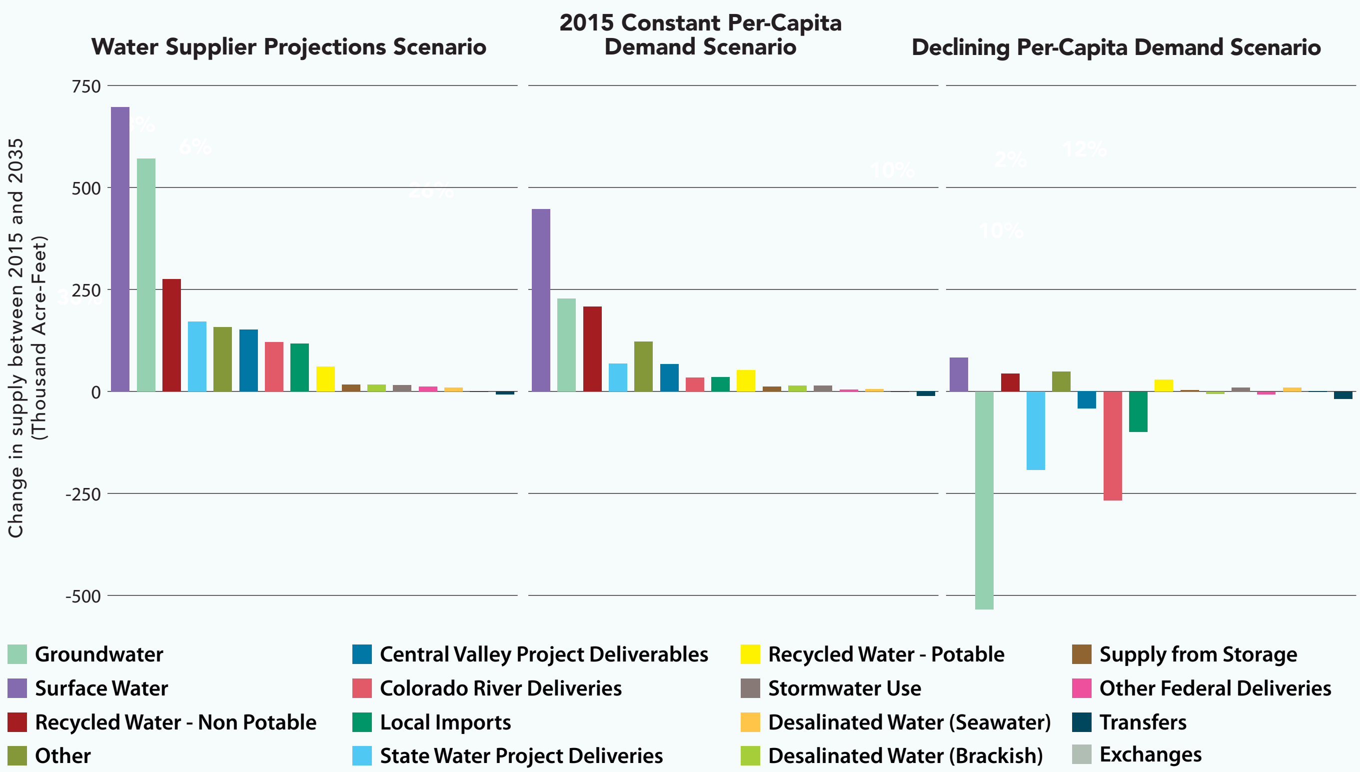


TABLE 14 State Annual Electricity Use Related to Urban Water, by Scenario (GWh)

Scenario	2015	2020	2025	2030	2035	% Change 2015-2035	Change 2015-2035
Water Supplier Projections Scenario (High-Case)	29,917	36,516	38,536	40,173	41,781	40%	11,864
2015 Constant Per-Capita Demand Scenario (Mid-Case)	29,917	31,287	32,994	34,610	36,259	21%	6,342
Declining Per-Capita Demand Scenario (Low-Case)	29,917	28,281	26,958	25,562	24,207	-19%	-5,710

The authors note several limitations of these results. These results are driven in part by the simplifying assumption that increases or decreases in supply deliveries for each year under the 2015 Constant Per-Capita Demand Scenario and Declining Per-Capita Demand Scenario are divided among water sources in the same proportion as water sources for each year in the Water Supplier Projections Scenario. As discussed in Section 3.3.1.3, it is unclear whether urban water supplier projections of these supply source changes are physically, economically, ecologically, or legally possible; these estimates are taken as given and the authors make no assessment or adjustment of supplies for feasibility, but do note there are already serious constraints on existing supply options. In the two alternative demand scenarios, it is also not assumed that water agencies would change how they prioritize which supply sources to increase or conserve, such as based on energy intensity or cost. The authors also note that projections of groundwater usage to 2035 are from the 2015 UWMP and do not account for the Sustainable Groundwater Management Act (SGMA), which was passed in 2014 and seeks to limit groundwater pumping by 2040.[96] Additionally, what appears to be a statewide increase in CVP and SWP volumes from 2015 to 2035 may be a consequence of below-average deliveries from those sources in 2015 due to the 2012 to 2016 statewide drought.

4.1.3 Energy Use for Urban Water: Historical and Future Scenarios

The changing water demands and shifts in supply sources described in the previous sections can have significant effects on the urban water-related electricity footprint. Between 2015 and 2035, the report authors found the total annual water-related electricity usage increases by about 21 percent, about 6,300 GWh annually, under the "mid-case" 2015 Constant Demand Scenario (Table 14). For context, California's total economy-wide annual electricity consumption (not only related to water) is currently about 300,000 GWh, suggesting that under this scenario projected increases in urban water demand could increase the state's overall annual electricity consumption by about 2 percent by 2035. If per-capita demand increases according to water supplier projections ("high-case"), annual electricity usage for urban water increases by about twice that amount (40% or 12,000 GWh) between 2015 and 2035 (Table 14, Figure 7).

In contrast, water conservation and efficiency improvements can lead to significant energy savings along the entire managed water cycle (Figure 1) from avoided water supply, conveyance, treatment, distribution, heating, and wastewater collection and treatment energy. The Declining Per-Capita Demand Scenario ("low-case") leads to a reduction in total electricity usage for urban water by 19 percent between 2015 to 2035, corresponding with an annual savings of 5,700 GWh (Table 14, Figure 7).

In all scenarios, the largest share of statewide electricity use is from end-uses, followed by conveyance, distribution, and wastewater treatment energy (Figure 7). Under the 2015 Constant Per-Capita Demand Scenario (Table 15), between 2015 and 2035, the increase in electricity usage in absolute terms is also dominated by growing end-use electricity.[97]

96 Implications of SGMA on groundwater use in California's agricultural sector are explored in the case study in Section 5.3.

97 See the Appendix, for detailed tables of energy results for the Water Supplier Projections Scenario and Declining Per-Capita Demand Scenario.

TABLE 15 State Annual Electricity Use Related to Urban Water, by Water Cycle Category (GWh) —2015 Constant Per-Capita Demand Scenario (Mid-Case)

Water Cycle Category	2015	2020	2025	2030	2035	% Change 2015-2035	Change 2015-2035
Extraction or Generation	1,277	1,309	1,416	1,495	1,585	24%	308
Conveyance	4,321	4,155	4,352	4,518	4,684	8.4%	363
Treatment	1,308	1,382	1,459	1,529	1,604	23%	296
Distribution	2,483	2,596	2,714	2,825	2,942	19%	459
End-Use	18,152	19,312	20,381	21,436	22,500	24%	4,348
Wastewater Collection	323	345	364	382	400	24%	77
Wastewater Treatment	2,053	2,189	2,309	2,425	2,544	24%	491

While the total urban water-related electricity use increases in the "mid-case" scenario (and the "high-case" scenario), the statewide average energy intensity—the total electricity use divided by total water use—decreases by two percent between 2015 and 2035 (Table 16).[98] This appears to be driven primarily by a reduced energy intensity of urban water in the South Coast region, which has California's highest total water-related electricity usage (Figure 8), due to its relatively high residential water demand (Figure 3) and energy-intensive water supply mix (Figure 5).[99] By 2035, under the 2015 Constant-Per Capita Demand Scenario, the South Coast has a reduced share of energy-intensive imported resources (21% to 18% of South Coast supplies from SWP, 29% to 25% of South Coast supplies from Colorado River, from 2015 to 2035) and an increase in local water sources (such as 1% to 2% potable recycled water, 6% to 9% non-potable recycled water, and 0 to 0.4% captured stormwater, between 2015 and 2035).

TABLE 16 Urban Water System Energy Intensity (Electricity) by Hydrologic Region (kWh/AF)

Hydrologic Region	2015	2035	% Change 2015-2035
Central Coast	4,639	4,638	0.0%
Colorado River	2,824	3,056	8.2%
North Coast	5,169	5,170	0.0%
North Lahontan	4,771	4,887	2.4%
Sacramento River	3,485	3,466	-0.5%
San Francisco Bay	5,886	6,104	3.7%
San Joaquin River	4,241	4,215	-0.6%
South Coast	6,356	6,274	-1.3%
South Lahontan	4,102	4,262	3.9%
Tulare Lake	4,101	4,011	-2.2%
State Volume-Weighted Average Urban Energy Intensity	5,507	5,389	-2%

Local, alternative water sources have relatively high treatment energy requirements compared to traditional water sources; however, in regions like the South Coast, they are still typically lower than the energy requirements for conveyance of imported water (except for the most energy-intensive source, seawater desalination). For example, extraction, conveyance, and drinking water treatment requires about 350 kWh/AF for local surface water and 400 kWh/AF to 700 kWh/AF, depending on the region, for groundwater (Table 4). By comparison, extraction/generation, conveyance, and drinking water treatment requires 500 kWh/AF for non-potable recycled water, 700 kWh/AF for captured stormwater, 1,800 kWh/AF for indirect potable recycled water, 2,100 kWh/AF for brackish groundwater desalination, and 4,600 kWh/AF for seawater desalination. Energy requirements for SWP and Colorado River conveyance and treatment can reach up to 4,200 kWh/AF and 2,300 kWh/AF, respectively, depending on the region.

98 The energy intensity for each hydrologic region for a given year is the same across scenarios because we use the Water Supplier Projections Scenario proportions of energy supplies and demands per year and per hydrologic region for all scenarios.

99 The San Francisco Bay and Sacramento hydrologic regions are the second and third highest overall electricity users, driven by high residential water demand. The San Francisco Bay, North Lahontan, South Lahontan, and Colorado River regions also all see an increase in energy intensity by 2035, and Tulare Lake has a decrease in energy intensity. The remaining regions (North Coast, Central Coast, Sacramento, and San Joaquin Valley) have negligible changes (+ or - < 1%) between 2015 and 2035.

FIGURE 7a State Urban Water-Related Electricity Use 2015 – 2035, by Scenario

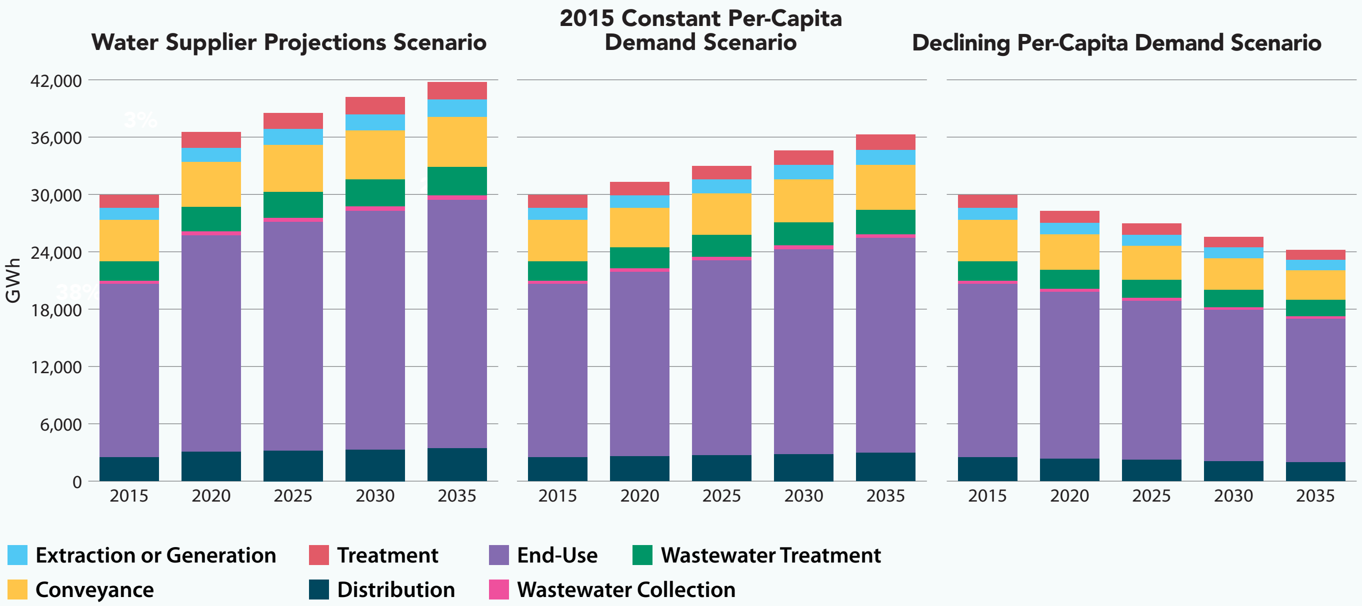


FIGURE 7b Change in State Urban Water-Related Electricity Use Between 2015 and 2035, by Scenario

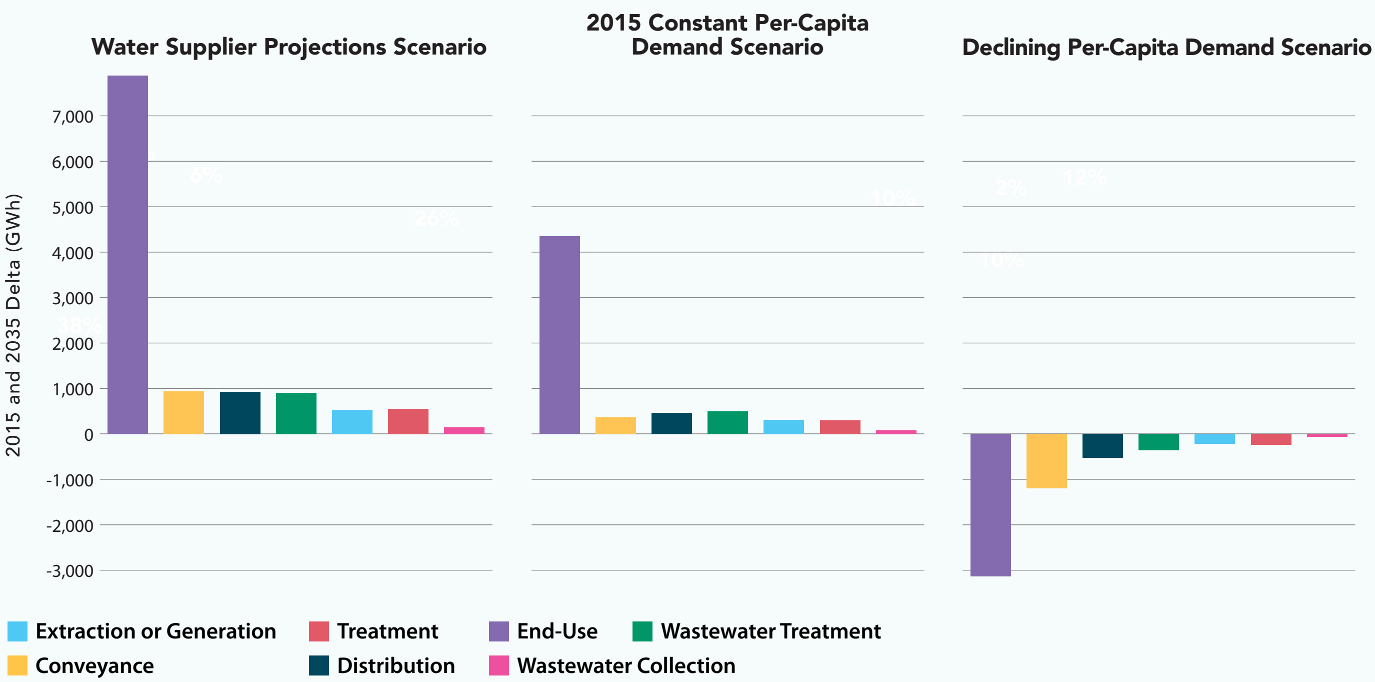


FIGURE 8a 2015 Constant Per-Capita Demand Scenario (Mid-Case): Change in Urban Water-Related Electricity Use

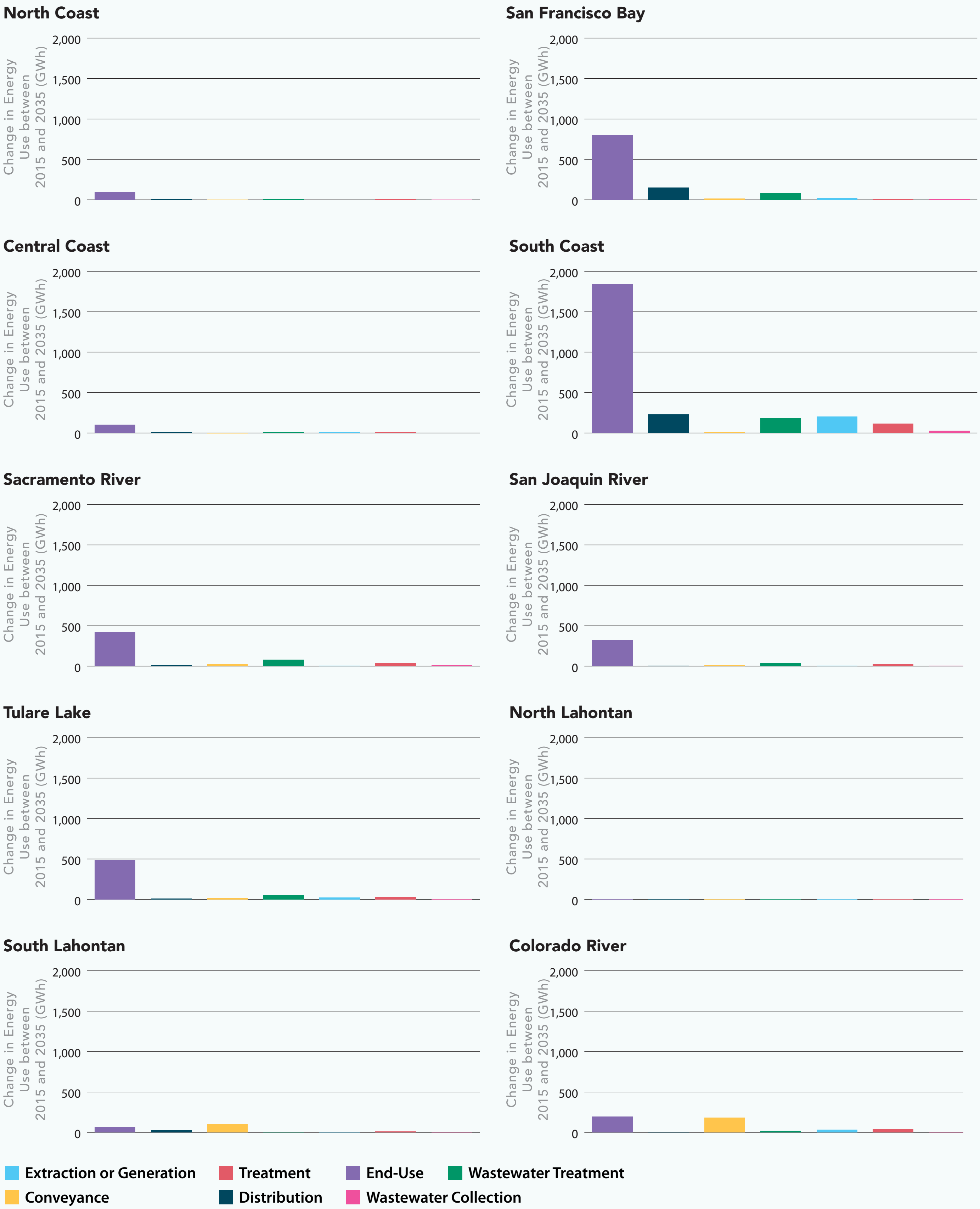


FIGURE 8b 2035 Urban Water-Related Electricity Use, by Hydrologic Region

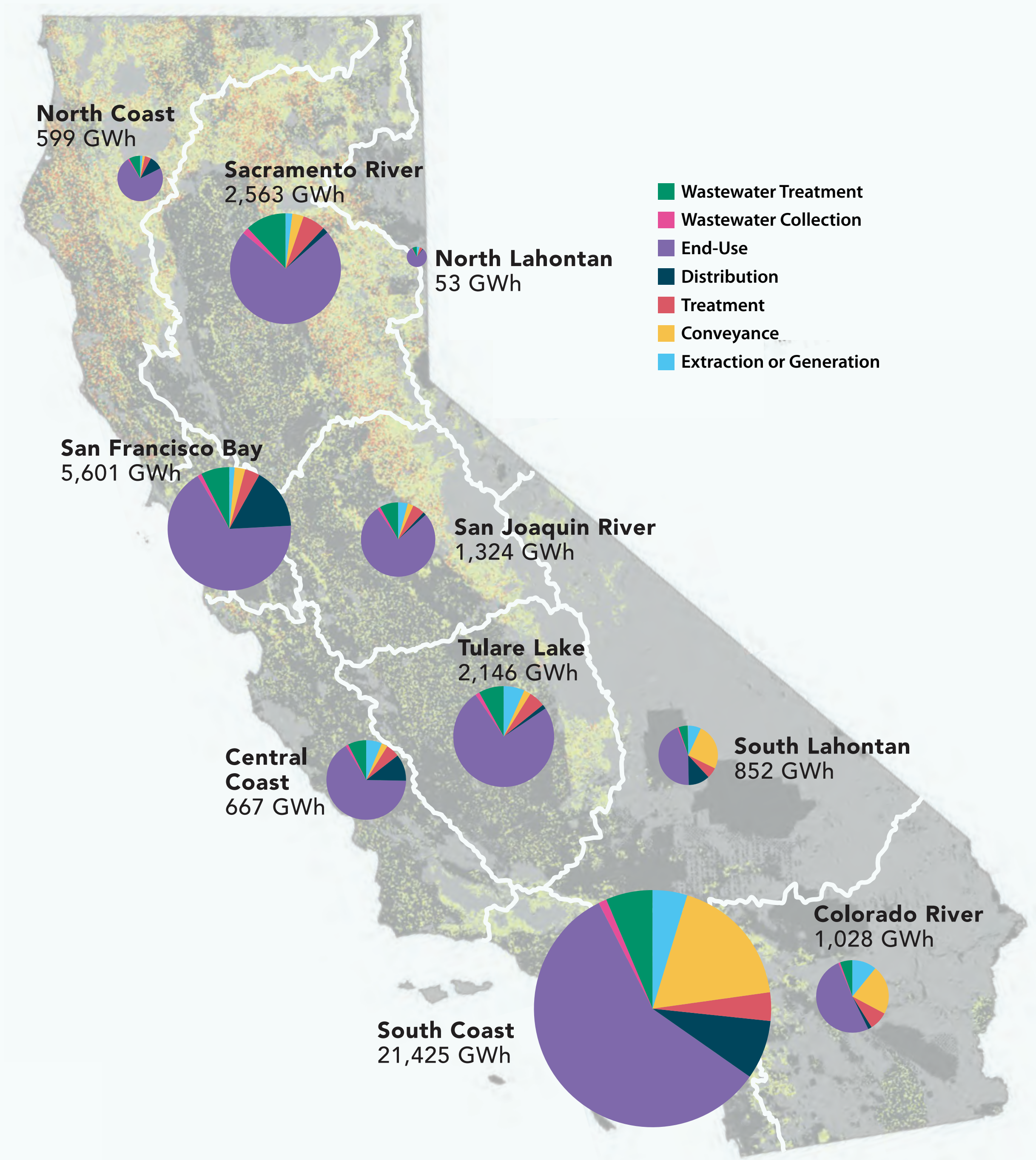


TABLE 17 State Annual Natural Gas Use by Urban Water Heating End-Uses, by Scenario (MMBtu)

Scenario	2015	2020	2025	2030	2035	% Change 2015-2035	Change 2015-2035
Water Supplier Projections Scenario (High-Case)	154,350,857	194,004,931	205,011,788	214,461,995	223,580,559	45%	69,229,701
2015 Constant Per-Capita Demand Scenario (Mid-Case)	154,350,857	165,430,605	174,822,102	184,120,659	193,396,108	25%	39,045,251
Declining Per-Capita Demand Scenario (Low-Case)	154,350,857	149,536,164	142,842,381	135,985,823	129,112,787	-16%	-25,238,070

As noted in Section 3.1.1, California currently does not allow for direct potable reuse because state regulators have not yet developed water quality and public health standards.[100] As a result, for potable applications, water suppliers are currently required to pump treated recycled water to an environmental buffer and then treat it a second time at a conventional drinking water treatment plant before distribution and use.[101] The authors estimate that this increases energy usage for indirect potable recycled water by approximately 580 kWh/AF. This would be higher in regions with hilly terrain where energy requirements for pumping between the wastewater treatment plant to the buffer and drinking water treatment plant are higher. While the regulatory requirements for direct potable reuse have not yet been established, this suggests that the energy footprint of potable recycled water could be substantially lower than indirect potable reuse because it avoids these additional steps.[102] Additionally, some energy-water research suggests that there are opportunities to lower the energy usage and/or shift the timing of energy demands to avoid peak times of some certain parts of the managed water cycle, such as at wastewater treatment plants, through demand response programs and the installation of variable speed drives.[103] It is unclear however, if typical treatment plants have the water storage capacity available to implement such programs.

Increased water demand, especially for indoor residential uses, is expected to also raise natural gas usage. The authors found that between 2015 and 2035, natural gas usage for water heating in the residential and CII sectors increases 25 percent in the 2015 Constant Per-Capita Demand Scenario (from about 150,000,000 to 190,000,000 MMBtu), and 45 percent in the Water Supplier Projections Scenario (Table 17). As with electricity, the Declining Per-Capita Demand Scenario shows that water efficiency improvements save natural gas; annual water heating natural gas usage in 2035 is 16 percent lower (or about 25,000,000 MMBtu) than in 2015.

4.1.4 GHG Emissions Related to Urban Water: Historical and Future Scenarios

The results of this study show that the decarbonization of California's electricity generation to meet SB 100 goals will reduce the GHG emissions associated with urban water-related electricity usage. Despite an overall

100 Regulating Direct Potable Reuse in California. California State Water Resources Control Board. Available at: https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/direct_potable_reuse.html

101 Environmental Protection Agency and CDM Smith. "2017 Potable Reuse Compendium." Environmental Protection Agency. 2017. Available at: https://www.epa.gov/sites/production/files/2018-01/documents/potablereusecompendium_3.pdf

102 In this analysis we assume that proportion of non-potable to potable recycled water is as projected by water suppliers in the future which does not take possible change in legislation into account; the energy usage would be higher if a higher share of recycled water is treated to potable quality.

103 Zohrabian, A., Sanders, K.T. "The Energy Trade-Offs of Transitioning to a Locally Sourced Water Supply Portfolio in the City of Los Angeles." Energies 13, 5589. 2020. Available at: https://doi.org/10.3390/en13215589

TABLE 18 Urban Water-Related GHG Emissions from In-State Electricity, by Scenario (Million Tons CO_2-Equivalent)

Scenario	Fuel	2015	2020	2025	2030	2035	% Change 2015-2035	Change 2015-2035
Water Supplier Projections Scenario (High-Case)	Electricity	7.7	7.0	6.8	5.3	4.3	-44%	-3
	Natural Gas	8.2	10.3	10.9	11.4	11.9	45%	4
	Total	15.9	17.3	17.7	16.7	16.2	2%	0.3
2015 Constant Per-Capita Demand Scenario (Mid-Case)	Electricity	7.7	6.0	5.8	4.6	3.7	-52%	-4
	Natural Gas	8.2	8.8	9.3	9.8	10.3	25%	2
	Total	15.9	14.8	15.1	14.3	14.0	-12%	-2
Declining Per-Capita Demand Scenario (Low-Case)	Electricity	7.7	5.4	4.7	3.4	2.5	-68%	-5
	Natural Gas	8.2	7.9	7.6	7.2	6.9	-16%	-1
	Total	15.9	13.4	12.3	10.6	9.3	-41%	-7

increase in electricity use, GHG emissions decline by more than half (-52%) between 2015 and 2035 in the 2015 Constant Per-Capita Demand Scenario (Table 18) because of large reductions in in-state electricity GHG intensity (Table 5). The decrease in GHG emissions is more dramatic in the Declining Demand Scenario (-68%), but still substantial under Water Supplier Projections Scenario (-44%). This analysis assumes that water-related electricity demand is met by in-state generation; if California meets water-related electricity demand by importing electricity from neighboring regions that have more GHG-intensive (fossil fuel) generating portfolios, overall GHG emissions will be higher.

However, when GHG emissions from natural gas water heating end-uses are accounted for, the authors find total GHG emissions (from electricity plus natural gas) increase two percent in the Water Supplier Projections Scenario between 2015 and 2035 (Table 18). GHG emissions still decline under the 2015 Constant Per-Capita Demand Scenario and Declining Per-Capita Demand Scenario, but at more modest rates (-12% and -41%, respectively). In this analysis, the electric share of water heaters in the residential and CII sectors is held constant at current levels (about 30% and 44%, respectively). However, with the state's energy policy moving in favor of electrification across the building sector, a greater share of water heaters may shift to electric from natural gas, which would have the effect of driving down overall GHG emissions from the water system.

TABLE 19 Central Valley Agricultural Water Supply Delivered, by Scenario (AF)

Level of Ag Use	Urban Growth, Climate Scenarios	2015	2020	2025	2030	2035	% Change 2015-2035	Change 2015-2035
Low Ag Water use	HIP_LOD, Cmcc_cms, RCP 4.5	23,342,447	23,863,569	23,775,521	23,223,430	22,618,405	-3%	-724,043
Mid Ag Water use	CTP_CTD, Cmcc_ cms,RCP 4.5	23,448,421	24,050,344	24,034,625	23,554,631	23,071,053	-2%	-377,368
High Ag Water use	LOP_HID, GFdl_cm3, RCP 8.5	25,084,130	24,300,280	23,479,049	24,275,013	23,877,242	-5%	-1,206,889

4.2 Agricultural Water Results

Here, the projected agricultural demand, supply, energy, and GHG results of the analysis across scenarios are provided for Central Valley in aggregate, by hydrologic region, and by supply source and demand sector.

4.2.1 Agricultural Water Demand: Historical and Future Water Scenarios

Under all three scenarios of future agricultural water (Table 19), total Central Valley water supply deliveries[104] decline between 2015 and 2035, decreasing by three percent (0.7 MAF) under the Low Ag Water Use Scenario, by two percent (0.3 MAF) under the Mid Ag Water Use Scenario, and by five percent (1.2 MAF) under the High Ag Water Use Scenario.[105] As noted in Section 3.3.2.3, these overall declining trends are largely driven by DWR's assumptions that urban population growth will reduce agricultural land and subsequently water use. However, these scenarios do not account for economic factors, such as crop values on domestic and international markets, federal and state agricultural policies, and other factors that affect farmers' land use choices.[106] Even with decadal averaging, differences in agricultural water deliveries between years are also affected by natural inter-annual variations in climatic conditions (temperature, precipitation, and evapotranspiration drive irrigation demands).[107] The overall effect of climate change across the scenarios appears to be minimal in this near-term time horizon.

104 The report authors use the "supplies delivered" variable from DWR's WEAP simulation results to represent agricultural water demand to be consistent with the urban analysis where we balance demand to equal supply, and because "supplies delivered" represents the actual water use given supply availability to agricultural water users in Central Valley. We do not use the "water demand" variable from WEAP because it represents a theoretical "requested" water demand based on crop acreage and climate, which may not be met if there are insufficient supplies after the (user-specified) higher priority urban water demands are satisfied (Rayej, M., Kibrya, S., Shipman, P., Correa, M. "Future Scenarios of Water Supply and Demand in Central Valley, California through 2100: Impacts of Climate Change and Urban Growth, California Water Plan Update 2018 Supporting Document." California Department of Water Resources. June 2019. Available at: https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/California-Water-Plan/Docs/Update2018/Final/SupportingDocs/Future-Scenarios-of-Water-Supply-in-the-Central-Valley.pdf).

105 The 2015 values differ by scenario because they are all simulated data, even for the historical period, using simulated historical climate data from each GCM (climate model) which differ slightly. 2006 is the base year for DWR's WEAP simulations. We use this simulated data for all years to maintain a consistent dataset across all scenarios, rather than mixing with historical observed data for 2015. For reference, observed data for 2015 from DWR Water Balance Data shows that the total Applied Crop Water across the three Central Valley Hydrologic regions was 24.3 MAF, about equivalent to the average between the "Low Ag water use" and "High Ag water use" scenarios (24.2 MAF) ("Water Portfolios." *California Department of Water Resources Water Portfolios*, http://water.ca.gov/Programs/California-Water-Plan/Water-Portfolios. Accessed 13 May 2019.).

106 Rayej, M., Kibrya, S., Shipman, P., Correa, M. "Future Scenarios of Water Supply and Demand in Central Valley, California through 2100: Impacts of Climate Change and Urban Growth, California Water Plan Update 2018 Supporting Document." California Department of Water Resources. June 2019. Available at: https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/California-Water-Plan/Docs/Update2018/Final/SupportingDocs/Future-Scenarios-of-Water-Supply-in-the-Central-Valley.pdf

107 The Low Ag water use and High Ag water use scenarios are based on DWR WEAP simulations with two different climate models, which may have different climate data for particular years and different patterns of underlying inter-annual variability. This results in the 2025 water supply deliveries in the High Ag water use scenario to be lower than in the Low Ag water use scenario, even though the trend is for the High Ag water use scenario to be higher in the remaining years of this analysis.

TABLE 20 Agricultural Water Supply Deliveries by Hydrologic Region, by Scenario (AF)

Hydrologic Region	Level of Ag Use	Urban Growth, Climate Scenarios	2015	2020	2025	2030	2035	% Change 2015-2035	Change 2015-2035
Sacramento River	Low Ag Water Use	HIP_LOD, Cmcc_cms, RCP 4.5	7,791,897	8,124,773	8,281,018	8,054,964	7,926,691	2%	134,794
San Joaquin River			6,407,804	6,547,874	6,548,395	6,478,338	6,209,435	-3%	-198,369
Tulare Lake			9,142,747	9,190,922	8,946,108	8,690,128	8,482,279	-7%	-660,468
Sacramento River	Mid Ag Water Use	CTP_CTD, Cmcc_cms, RCP 4.5	7,827,603	8,188,157	8,372,529	8,170,778	8,084,196	3%	256,593
San Joaquin River			6,445,920	6,615,489	6,644,809	6,602,755	6,374,638	-1%	-71,282
Tulare Lake			9,174,898	9,246,698	9,017,288	8,781,097	8,612,219	-6%	-562,679
Sacramento River	High Ag Water Use	LOP_HID, GFdl_cm3, RCP 8.5	8,291,290	8,140,020	7,859,446	8,118,026	8,169,114	-1%	-122,177
San Joaquin River			6,912,865	6,640,439	6,403,358	6,671,952	6,501,189	-6%	-411,677
Tulare Lake			9,879,975	9,519,821	9,216,245	9,485,035	9,206,939	-7%	-673,036

TABLE 21 Central Valley Annual Agricultural Water Supply by Source (AF)—Mid Ag Water Use Scenario

Supply Source	2015	2020	2025	2030	2035	% Change 2015-2035	Change 2015-2035
State Water Project Deliveries	827,354	834,614	815,022	794,036	778,624	-6%	-48,730
Central Valley Project Deliveries	4,384,778	4,513,291	4,529,638	4,436,782	4,352,714	-1%	-32,064
Other Federal Deliveries	233,993	244,505	249,760	243,989	241,072	3%	7,079
Surface water	6,386,804	6,575,142	6,604,000	6,480,093	6,345,748	-1%	-41,056
Local Imports	29,808	31,165	31,852	31,099	30,750	3%	942
Return Flows	1,261,943	1,305,528	1,321,200	1,302,645	1,270,991	1%	9,048
Groundwater	10,323,741	10,546,099	10,483,153	10,265,987	10,051,153	-3%	-272,588
Total	23,448,421	24,050,344	24,034,625	23,554,631	23,071,053	-2%	-377,368

FIGURE 9a Central Valley Agricultural Water Supply 2015–2035, by Scenario

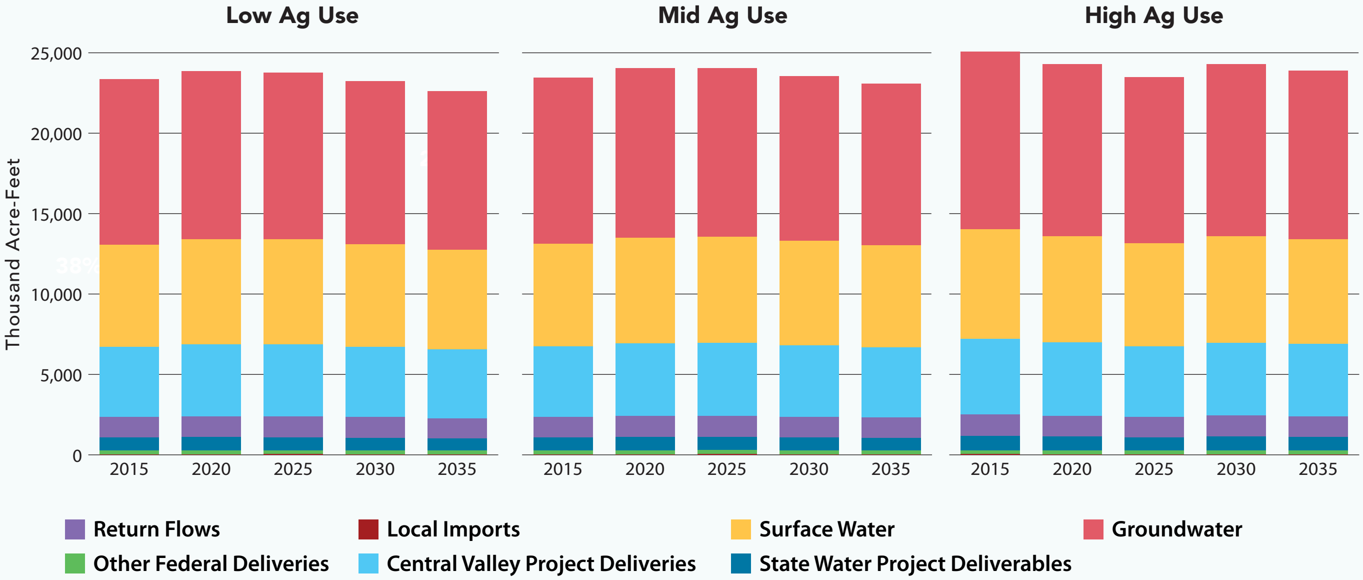
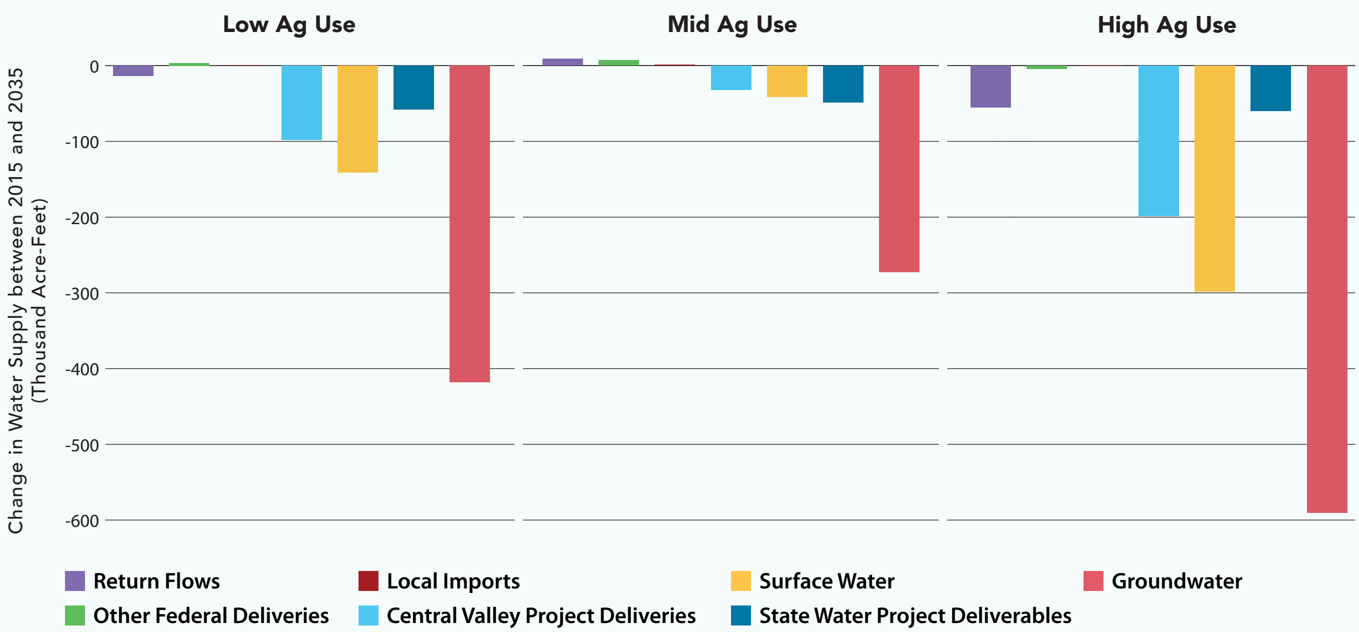


FIGURE 9b Change in Total Central Valley Agricultural Water Supply Between 2015 and 2035, by Scenario



Across all three scenarios (Table 20), the Tulare Lake hydrologic region, which has the highest agricultural water demand among the Central Valley regions, experiences the largest percentage declines (up to -7%) in supply deliveries between 2015 and 2035. In contrast, the Sacramento River hydrologic region sees an increase in supply deliveries in all but the High Ag Water Use Scenario.

4.2.2 Agricultural Water Supply: Historical and Future Water Scenarios

The analysis found that the largest absolute and percentage decreases in Central Valley agricultural water supplies come from SWP deliveries and groundwater, both of which are relatively energy-intensive water sources. Table 21 shows results for the Mid Ag Water Use Scenario, and Figure 9

FIGURE 10a Mid Ag Use Scenario: Change in Agricultural Water Supply by Source Between 2015 and 2035, by Hydrologic Region

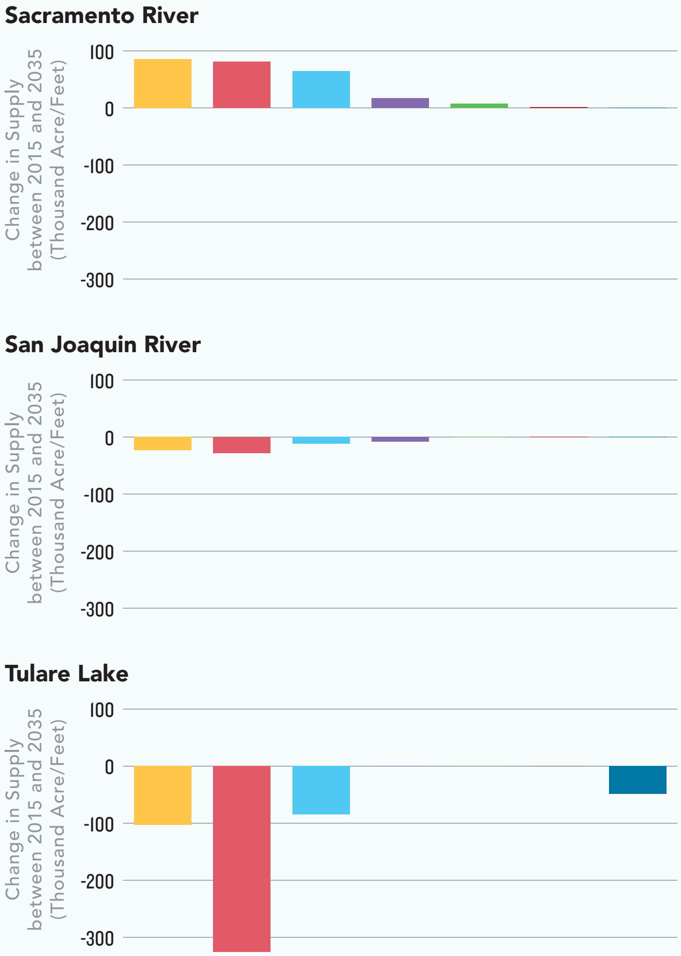
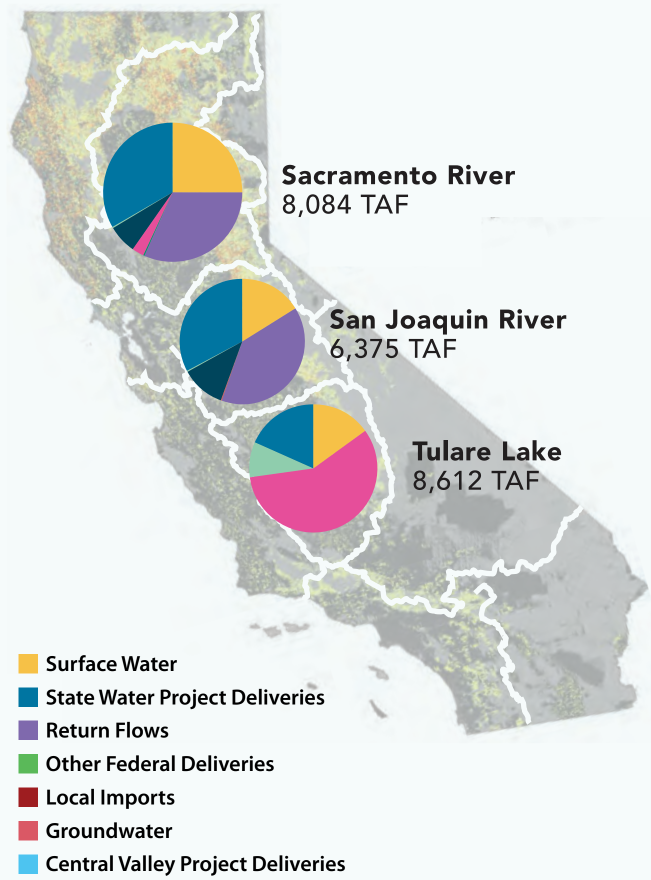


FIGURE 10b Mid Ag Use Scenario: 2035 Agricultural Water Supply Volumes by Source, by Hydrologic Region



compares differences between 2015 and 2035 supplies across scenarios. The authors note that these results would change if it was not assumed that future agricultural water supplies maintain the historical proportion of sources. However, declines in SWP deliveries may be likely in the future due to climate change impacts,[108] and decreased groundwater use is consistent with the goals of SGMA especially in regions with over-drafted basins, such as in Tulare Lake, where Figure 10 shows that supplies are dominated by groundwater use.

4.2.3 Energy Use for Agricultural Water: Historical and Future Scenarios

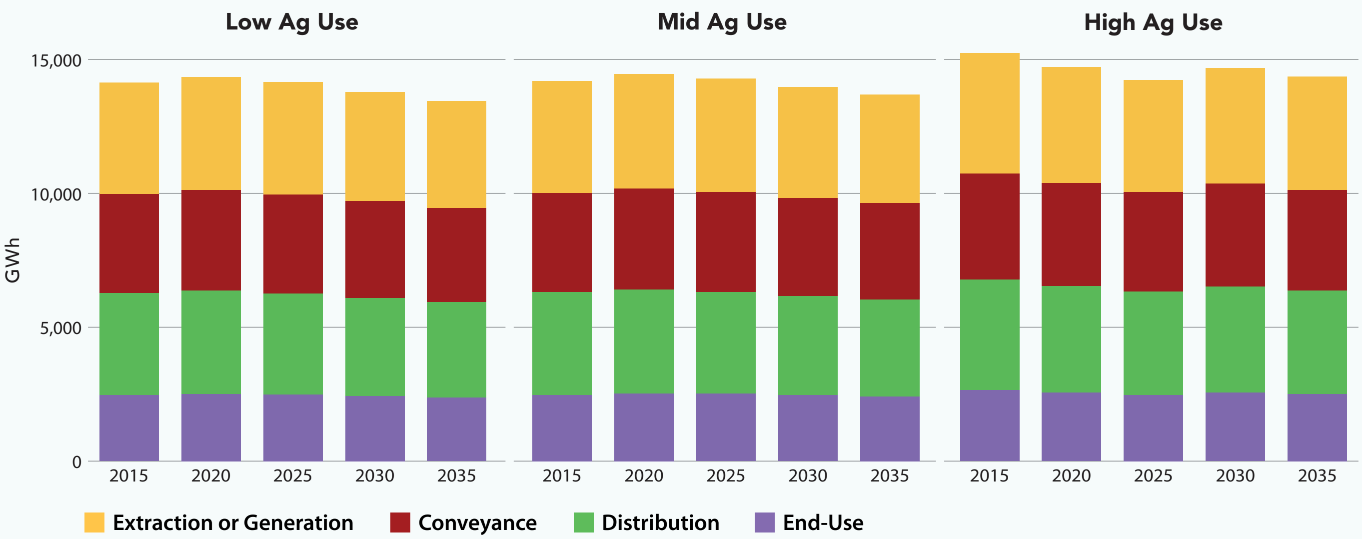
Despite almost double the water volumes, the authors found that water-related electricity use for agriculture in the Central Valley is about half that of California's urban areas (14,000 GWh in the Mid Ag water use scenario compared to 36,000 GWh in the urban mid-case scenario) in 2035. This relatively lower energy usage is due to much lower end-use energy use (compared to energy-intensive water heating), and the very limited, if any, energy requirements for water treatment, waste-

108 Selmon, Michelle, et al. *Climate Change Action Plan, Phase 3: Climate Change Vulnerability Assessment.* California Department of Water Resources, Feb. 2019, https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/All-Programs/Climate-Change-Program/Climate-Action-Plan/Files/CAP-III-Vulnerability-Assessment.pdf?la=en&hash=7DF13A5B51C4B4FA808166C596F7EAE67ED58AC5.

TABLE 22 Central Valley Electricity Use Related to Agricultural Sector, by Scenario (GWh)

Level of Ag Use	Urban Growth, Climate Scenarios	2015	2020	2025	2030	2035	Change 2015-2035	% Change 2015-2035
Low Ag Water Use	HIP_LOD, Cmcc_cms, RCP 4.5	14,135	14,342	14,144	13,788	13,434	-701	-5%
Mid Ag Water Use	CTP_CTD, Cmcc_cms, RCP 4.5	14,193	14,444	14,282	13,964	13,678	-515	-4%
High Ag Water Use	LOP_HID, GFdl_cm3, RCP 8.5	15,230	14,714	14,228	14,684	14,354	-876	-6%

FIGURE 11 Central Valley Electricity Use by Agricultural Water, by Scenario



water collection, and wastewater treatment within the agricultural sector. Declining supply deliveries over time in the scenarios further decrease electricity use related to agricultural water in the Central Valley. Across the three scenarios of agricultural water use, electricity use decreases 5 percent (700 GWh) under the Low Ag Water Use Scenario and decreases 6 percent (876 GWh) under the High Ag Water Use Scenario (Table 22). Among the water cycle categories (Figure 11), Central Valley-wide electricity use for agricultural is much more evenly split between supply extraction/generation, conveyance, distribution, and end-use than in urban areas.

Electricity use is greatest in Tulare (Figure 12), not just because of high overall agricultural water use but also because of relatively high energy intensities for distribution (389 kWh/AF) and groundwater pumping (450 kWh/AF) compared to neighboring San Joaquin Valley (19 kWh/AF for distribution, 365 kWh/AF for groundwater pumping) and Sacramento River (19 kWh/AF for distribution, 350 kWh/AF for groundwater pumping). The 2035 energy intensity for Tulare's combined agricultural water supply and demands is 1,009 kWh/AF, about three times that in the Sacramento River (313 kWh/AF) and San Joaquin River (396 kWh/AF) (Table 23).

FIGURE 12a Change in Agricultural Water Supply by Source Between 2015 and 2035, by Hydrologic Region

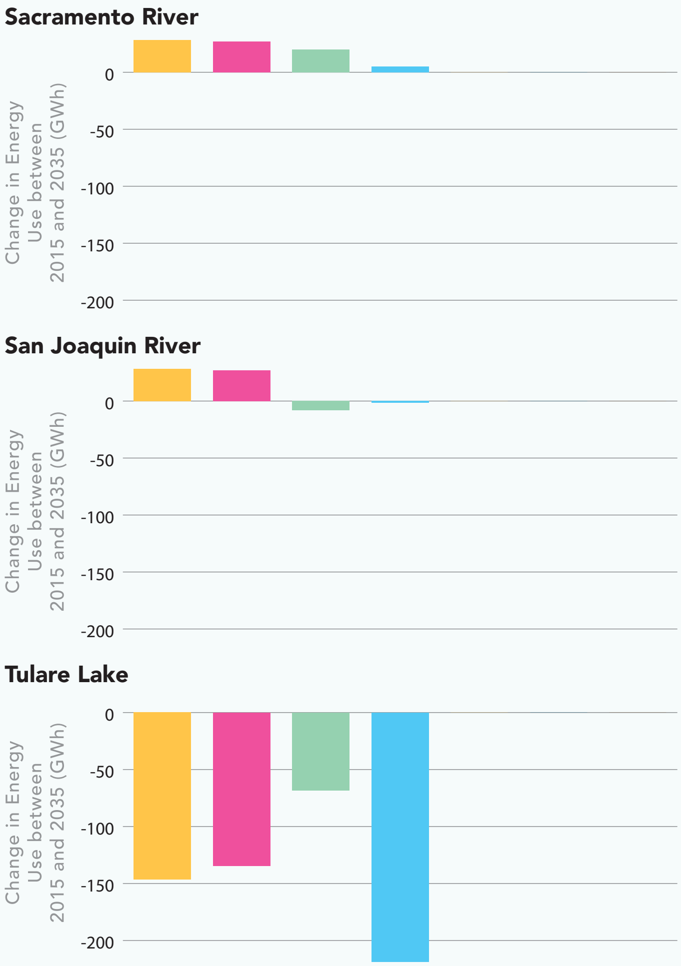


FIGURE 12b 2035 Agricultural Water Supply Volumes by Source, by Hydrologic Region

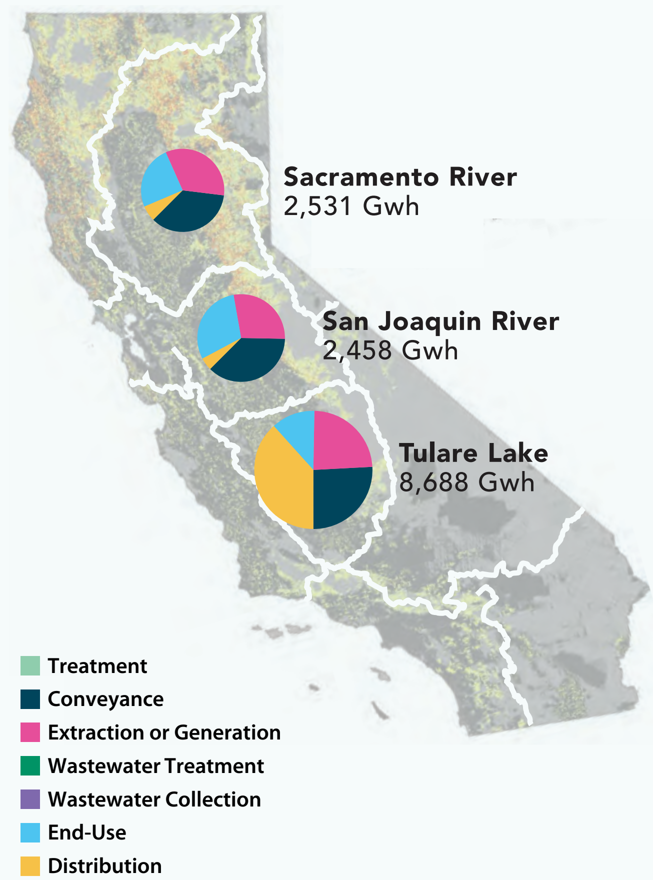


TABLE 23 2035 Agricultural Water System Energy Intensity (Electricity) by Hydrologic Region (kWh/AF)

Hydrologic Region	Energy Intensity (kWh/AF)
Sacramento River	313
San Joaquin River	386
Tulare Lake	1,009
Central Valley Volume-Weighted Average Agricultural Energy Intensity	593

TABLE 24 Central Valley Agricultural Water-Related GHG Emissions from In-State Electricity, by Scenario (Million Metric Tons CO_2-equivalent)

Level of Ag Use	Urban Growth, Climate Scenarios	2015	2020	2025	2030	2035	Change 2015-2035	% Change 2015-2035
Low Ag Water Use	HIP_LOD, Cmcc_cms, RCP 4.5	3.65	2.75	2.49	1.82	1.38	-2.3	-62%
Mid Ag Water Use	CTP_CTD, Cmcc_cms, RCP 4.5	3.67	2.77	2.51	1.84	1.41	-2.3	-62%
High Ag Water Use	LOP_HID, GFdl_cm3, RCP 8.5	3.94	2.82	2.51	1.94	1.48	-2.5	-62%

4.2.4 GHG Emissions Related to Agricultural Water: Historical and Future Scenarios

Across all scenarios, GHG emissions associated with Central Valley's agricultural water sector decrease by more than 60 percent (about two million tons) by 2035, due to the combined effect of lower electricity use and declining GHG intensity of California's electricity generating resources (Table 24). Since this analysis does not include natural gas energy use for agriculture, this result captures the full effect of the decarbonization of California's electricity generation mix. In comparison, in urban California where natural gas GHG emissions are included (and total water demand is rising), total GHG increases by one million tons in the Water Supplier Projections Scenario. Emissions from agricultural pumps that use diesel fuel are also not included in this analysis because of limited available data, but indications are that only a very small share of pumps are diesel-powered in the state.[109]

109 2018 Irrigation and Water Management Survey. Available at: https://www.nass.usda.gov/Publications/AgCensus/2017/Online_Resources/Farm_and_Ranch_Irrigation_Survey/index.php

5. CASE STUDIES

5.1 Energy Recovery at EBMUD's Wastewater Treatment Plant

5.1.1 Introduction

Wastewater treatment, as currently practiced, is an energy-intensive process. Across the United States, municipal wastewater systems use 0.8 percent of total electricity use in the country, which amounts to about $2 billion in annual electric costs.[110,111] However, wastewater holds the potential to generate far more energy than is needed for treatment, held in the form of chemical or thermal energy. By some estimates, this could be 6 to 9 times more than the energy than it consumes.[112] This means that wastewater treatment systems have the capacity to be net energy-positive or neutral, and further, have the ability to meaningfully reduce greenhouse gas emissions.

East Bay Municipal Water District (EBMUD), which provides water and wastewater service to approximately 1.3 million people in Alameda and Contra Costa counties, has been a leader in implementing energy recovery at its main wastewater treatment plant in Oakland, California, and in 2012, its treatment plant became the first in North America to be a net energy producer. This case study examines the incentives and barriers behind this achievement and how this may be a model for other wastewater treatment plants across the country.

5.1.2 Energy from Waste

EBMUD operates a wastewater treatment plant that serves 740,000 people along the eastern shore of the San Francisco Bay and treats an average of 50 million gallons of wastewater per day. Like many wastewater systems, the treatment plant utilizes anaerobic digestion as part of the process to break down organic matter in wastewater, producing methane. In 1985, EBMUD installed three 2.5 MW engines driven entirely by methane produced during anaerobic digestion to power the system. In 2002, the facility began accepting trucked waste, and now accepts food waste, industrial waste, and other organic materials from neighboring cities and counties. The facility now uses approximately 100 percent biogas, about two-thirds from high-strength waste and the remaining from municipal sludge.

Over the years, several actions have increased the amount of energy generated at the treatment plant. EBMUD received funding from the California Energy Commission in 2004 to install a solid-liquid waste receiving station, allowing high-strength wastes to be taken directly to the wastewater treatment facility for energy recovery. In 2013, they installed a 4.5 MW turbine, which increased the onsite energy production capacity of the system from 40 to 50 percent to over 80 percent of total onsite energy consumption. Since 2013, the facility has generated more energy than is needed to power the plant, selling the excess energy to the power grid through an agreement with the Port of Oakland. This agreement includes both electricity as well as Renewable Energy Credits, in compliance with California's Renewable Portfolio Standard.

By producing energy onsite, the facility improves their energy reliability, and saves approximately $2.5 million in power costs and exports electricity with a revenue of about $750,000 a year. However, in addition to generating surplus power, the facility also produces excess methane that is disposed of through flaring. This excess gas is created because of the timing of solid waste deliveries. Deliveries come in in the latter half of the week and therefore, gas must be flared off in the first half of the week and is used to produce electricity in the second half. EBMUD is exploring options on alternative uses for this excess gas, particularly in their transportation division.

While there are numerous environmental and economic benefits to utilizing onsite energy for wastewater treatment, there are also several challenges. The value of Renewable Energy Credits and electricity has been declining, driving down the value of selling energy back to the grid. Further, alternative waste disposal options, such as landfills and compost, can be cheaper.[113] Regulatory hurdles are a

110 Electric Power Research Institute/Water Research Foundation. Electricity Use and Management in the Municipal Water Supply and Wastewater Industries. 2013. Available at: https://www.waterrf.org/research/projects/electricity-use-and-management-municipal-water-supply-and-wastewater-industries

111 U.S. Department of Energy. Energy Data Management Manual for the Wastewater Treatment Sector. December 18, 2017. Available at: https://www.energy.gov/eere/slsc/downloads/energy-data-management-manual-wastewater-treatment-sector

112 Capodaglio, A.G., Olsson, G. "Energy Issues in Sustainable Urban Wastewater Management: Use, Demand Reduction and Recovery in the Urban Water Cycle." Sustainability 12. December 2019. Available at: https://doi.org/10.3390/su12010266

113 Zulkepli, N.E., Muis, Z.A., Mahmood, N. a. N., Hashim, H., Ho, W.S. "Cost Benefit Analysis of Composting and Anaerobic Digestion in a Community: A Review." Chem. Eng. Trans. 56, 1777–1782. 2017. Available at: https://doi.org/10.3303/CET1756297

key barrier in this process. The digestion of food waste is a relatively new concept, and EBMUD, being one of the first to explore this concept, played a significant role in paving the regulatory pathway. However, the future may look different. California legislation passed in 2016 (SB 1383) to reduce methane emissions, will require diversion of organic wastes from landfills and creates a policy incentive for organic wastes to instead go to wastewater treatment facilities for co-digestion with sewage sludge.[114] Offsetting emissions that would have been produced by waste in landfill is a key benefit of the municipal wastewater treatment plant. However, as GHG reporting currently stands, EBMUD is unable to receive full credit for their GHG reductions. Requiring water suppliers to reduce GHG emissions could provide additional incentive for this energy recovery model. EBMUD might also be able to benefit from demand response programs if the treatment plant can be operated to reduce its energy use during peak periods, and/or by shifting operations to increase generation during those times.[115] Further, EBMUD may be able to reduce the flaring of excess methane and coincide power production with peak times by coordinating the timing of deliveries of waste used in the co-digestion process.

Overall, this model has the potential to be scaled. It can leverage existing wastewater infrastructure, which may have excess digestor capacity, and use the proximity of waste generators to wastewater facilities to create a system that powers itself, reduces GHG emissions, and diverts landfill waste. However, logistic, regulatory, and economic challenges remain to be addressed to make the model truly cost-effective and sustainable.

TABLE 25 Volumes of Water by Source for Each Supply Scenario

	Volume of Water (AF)				
Supply Category	**Baseline 2015**	**Projected 2035**	**Projected 2035-SW**	**Projected 2035-IPR**	**Projected 2035-DPR**
Groundwater	90,438	114,670	114,670	114,670	114,670
LA Aqueduct	57,535	288,600	288,600	288600	288,600
MWD- SWP	210,659	28,256	0	0	0
MWD- CRA	151,948	32,374	0	0	0
Recycled Water (non-potable reuse)	10,421	68,940	68,940	68940	68,940
Stormwater Use	0	16,600	77,230	16600	16,600
Indirect Potable Reuse	0	0	0	60630	0
Direct Potable Reuse	0	0	0	0	60,630
TOTAL	521,001	549,440	549,440	549,440	549,440

5.2 Shifting Los Angeles' Water Portfolio from Imported to Local Sources

5.2.1 Introduction

The Los Angeles Department of Water and Power (LADWP), established in 1902, provides water and power to more than four million residents of the City of Los Angeles (LA). LADWP built the Los Angeles Aqueduct in 1913 to import water from the Owens Valley in the Eastern Sierra Nevada and ensure a reliable water supply for the growing city. Today, the Los Angeles Aqueduct represents about 38 percent of LADWP's water supply, which also includes water imported from Northern California through the State Water Project (SWP) (41%) and from the Colorado River Aqueduct (CRA) (8%), local groundwater (11%), and recycled water (2%).[116] Water imports

114 Rashi Gupta (Carollo Engineers, Inc.), Sarah Deslauriers (Carollo Engineers, Inc.), Elizabeth Charbonnet (Carollo Engineers, Inc.), Chelsea Ransom (Carollo Engineers, Inc.), Robert Williams (UC Davis). "Co-Digestion Capacity Analysis Prepared for the California State Water Resources Control Board under Agreement #17-014-240." June 2019. Available at: https://www.waterboards.ca.gov/water_issues/programs/climate/docs/co_digestion/final_co_digestion_capacity_in_california_report_only.pdf

115 Zohrabian, A., Sanders, K.T. The Energy Trade-Offs of Transitioning to a Locally Sourced Water Supply Portfolio in the City of Los Angeles. Energies 13, 5589. October 2020. Available at: https://doi.org/10.3390/en13215589

116 LADWP Facts & Figures. Los Angeles Dept. Water Power. Available at: https://www.ladwp.com/ladwp/faces/ladwp/aboutus/a-water/a-w-factandfigures;jsessionid=9rvGgGvQc9Gnz0GyhGh2HQqhgSkSmrWsF1Rp4hzhMqnwTldgFJ9G!1912823497?_adf.ctrl-state=jshn5ui58_21&_afrLoop=37708847717811&_afrWindowMode=0&_afrWindowId=null#%40%3F_afrWindowId%3Dnull%26_afrLoop%3D37708847717811%26_afrWindowMode%3D0%26_adf.ctrl-state%3D1cjn6i6kwb_4

from the SWP and CRA are delivered via the Metropolitan Water District of Southern California (MWD). In recent years, climate pressures, environmental regulations, and groundwater contamination have put pressure on LA's water supplies and increased reliance on imported water from MWD. To diversify water sources, ensure water security, and adapt to climate change, LA is turning to local sources of supply. This case study examines the energy effects of moving supplies away from energy-intensive imported sources to more local supplies, including stormwater capture, indirect potable reuse, and direct potable reuse.

TABLE 26 Total Energy Use Related to LADWP's Water Supply System, for Each Scenario

	Total Energy Use (GWh)			
Scenario	Water Generation and Extraction	Conveyance	Treatment	TOTAL
Baseline 2015	4.4	1,015	95	1,115
Projected 2035	103	176	91	370
Projected 2035-SW	103	23	91	217
Projected 2035-IPR	177	37	91	305
Projected 2035-DPR	177	15	77	269

5.2.2 Policy Landscape

The major drought in California from 2012–2016 was a wake-up call for the state and the city of LA that water supplies are increasingly vulnerable to climate change. In response, LA's mayor Eric Garcetti set a goal for LA to reduce per capita water use, reduce the purchase of imported water, and create an integrated water strategy to improve local water security. Following this directive, Mayor Garcetti released the first citywide Sustainable City pLAn in April 2015, with an update in 2019, as a roadmap to create a cleaner environment, stronger economy, and a commitment to equity for the city.[117] The pLAn establishes a 2050 goal for a zero-carbon grid, zero-carbon transportation, zero-carbon buildings, zero waste, and zero-wasted water. It also sets an ambition for the city to lead the nation in water conservation and source most of its water from local sources. Specifically, the 2035 goal is to source 70 percent of L.A.'s water locally—i.e., local groundwater, conservation, stormwater capture, and recycled water, and to recycle 100 percent of all wastewater for beneficial reuse.[118] Some of the near-term priority initiatives are to expand recycled water production using indirect and direct potable reuse (IPR/DPR), such as through Operation NEXT. It is noteworthy that the reduction of imported water was also part of the city's climate goals to reduce energy consumption and associated GHG emissions.

5.2.3 Energy Implications of Shifting to Local Water Sources

This study estimated the energy implications of providing water to the city of LA by shifting to local water sources under a baseline (2015) and three future water supply scenarios. The water supply portfolio for the Baseline and Projected 2035 scenarios were based on estimates provided in LADWP's 2015 Urban Water Management Plan for 2015 and 2035, respectively.[119] Three alternative scenarios for 2035 were then constructed, where water supplies imported through MWD were replaced with local stormwater (Project 2035-SW), indirect potable reuse (Project 2035-IPR), and direct potable reuse (Project 2035-DPR). The water supply portfolios for each of the scenarios are shown in Table 25. The energy requirements for water supply generation and extraction, conveyance, and treatment were then estimated under each of the five scenarios by multiplying the amount of water from each source by its energy intensity using values in Table 4 of this report. To assess the

117 L.A.'s Green New Deal: Sustainable City pLAn 2019. Available at: https://plan.lamayor.org

118 The LA Aqueduct is not considered 'local supplies' in LA's water-related goals. However, it is not considered an imported source either since the Aqueduct is managed by the city and supply from the Aqueduct is expected to stay consistent in the future. Goals around reducing imported water purchases refer to MWD supplies.

119 Los Angeles Department of Water and Power (LADWP). Urban Water Management Plan 2015. Available at: https://www.ladwp.com/ladwp/faces/ladwp/aboutus/a-water/a-w-sourcesofsupply/a-w-sos-uwmpln?_afrLoop=923157928852772&_afrWindowMode=0&_afrWindowId=null#%40%3F_afrWindowId%3Dnull%26_afrLoop%3D923157928852772%26_afrWindowMode%3D0%26_adf.ctrl-state%3Dv1sjl5ymy_4

overall embedded energy for water used in Los Angeles, the energy use required to convey water to the LADWP service territory is also included in this analysis, even if the energy consumption occurs outside the LADWP service territory. For example, imported SWP water requires pumping at the Edmonston pumping plant, which is located outside LADWP's boundaries.[120]

In this case study, additional water conservation and efficiency opportunities are not evaluated, although these are examined in other sections of this report. If implemented, however, conservation could reduce future energy requirements for providing water to LA. Likewise, the implications of seawater desalination as an alternative to imported water are not examined, as LADWP does not have any planned desalination projects.[121] Finally, opportunities to shift from the LA Aqueduct to local water sources are not examined.

Table 26 shows the energy implications of each scenario. The actual 2015 water supply is the most energy-intensive scenario, using more than 1,100 GWh of electricity. The highest energy use in this case is for conveyance due to large volumes of imported water from MWD. In 2035, LADWP's water-related energy use would decline 67 percent to 370 GWh due to reduced imports from MWD and more water from stormwater and the LA Aqueduct. Shifting to stormwater has the lowest overall energy use at nearly 220 GWh, followed by direct potable reuse, and indirect potable reuse.

Indirect potable reuse is the most energy-intensive due to multiple levels of treatment required. As described in Section 3.1.1, the authors assume indirect potable reuse involves a treatment train following the Orange County Water District Groundwater Replenishment System (i.e., after secondary treatment at a wastewater treatment plant, water is treated with microfiltration, reverse osmosis, and UV/Advanced Oxidation Processes (AOP)), and water is stored in an environmental buffer before receiving conventional drinking water treatment. Shifting imported supplies to direct potable reuse instead of indirect potable reuse would save 36 GWh of electricity. These results are consistent with a recent study, which found that LA city's water supply including imported water, groundwater pumping, treatment, and distribution used a total of 348 GWh, comparable to the 2035 projection in Table 26.[122]

These results suggest that shifting towards local water sources, especially stormwater and direct potable reuse, can be an effective way to cut the overall energy requirements related to providing water to LA. However, these shifts in supply will affect the spatial distribution of energy use within the broader South Coast region.[123] For example, energy use that currently occurs outside LADWP's territory for pumping imported water will likely decrease, while an increase in local supplies will raise treatment energy within the LADWP area.

120 If we were to analyze energy use where it occurred, shifts to local water and away from imported water will likely change local energy use for LADWP because new treatment loads for IPR or DPR will be inside of LADWP's territory and decreases in SWP pumping will be outside LADWP's territory.

121 Los Angeles Department of Water and Power (LADWP). Urban Water Management Plan 2015. Available at: https://www.ladwp.com/ladwp/faces/ladwp/aboutus/a-water/a-w-sourcesofsupply/a-w-sos-uwmpln?_afrLoop=923157928852772&_afrWindowMode=0&_afrWindowId=null#%40%3F_afrWindowId%3Dnull%26_afrLoop%3D923157928852772%26_afrWindowMode%3D0%26_adf.ctrl-state%3Dv1sjl5ymy_4

122 Porse, E., Mika, K.B., Escriva-Bou, A., Fournier, E.D., Sanders, K.T., Spang, E., Stokes-Draut, J., Federico, F., Gold, M., Pincetl, S. Energy use for urban water management by utilities and households in Los Angeles. Environ. Res. Commun. 2, 015003. January 2020. Available at: https://doi.org/10.1088/2515-7620/ab5e20

123 Zohrabian, A., Sanders, K.T. "The Energy Trade-Offs of Transitioning to a Locally Sourced Water Supply Portfolio in the City of Los Angeles." Energies 13, 5589. 2020. Available at: https://doi.org/10.3390/en13215589

5.3 The Sustainable Groundwater Management Act and Energy for Groundwater

5.3.1 Introduction

In 2014, in the middle of the historic 2012 to 2016 drought, California signed into law the Sustainable Groundwater Management Act (SGMA), the state's first framework for regulating groundwater.[124] SGMA applies to all high- and medium-priority unadjudicated alluvial basins in the state. It mandates that local stakeholders in these basins form groundwater sustainability agencies (GSAs) which are then required to develop groundwater sustainability plans (GSPs) that detail how the basin will ensure groundwater levels are maintained at sustainable levels through measurable objectives and minimum thresholds (MT). The main indicators of sustainability that must be considered are: groundwater-level declines, groundwater-storage reductions, land subsidence, interconnected surface-water depletions, seawater intrusion, and water-quality degradation. GSAs in critically overdrafted basins were required to submit GSPs by 2020, and the remaining are required to submit by January 2022. The intent of the GSP is to plan for long-term sustainable groundwater management; however, they only come into effect 20 years after plan submission, in 2040. In the interim period, GSAs will create infrastructure to support maintaining sustainable groundwater levels, such as increased groundwater storage.

According to SGMA, the GSPs are required to set a minimum threshold for groundwater levels in their basin. This is a quantified level of groundwater beyond which any reduction would cause an undesirable effect in the basin. The minimum thresholds, however, only come into effect in 2040. In several Central Valley basins, where the agricultural sector relies heavily on groundwater, these GSP minimum thresholds are actually set at lower depths than current levels, implying that energy use for pumping may increase from current rates as conditions are allowed to worsen.[125] Because the energy consumption for groundwater pumping increases with depth, declining groundwater levels increase the energy required to pump water and contribute to higher GHG emissions. This case study examines the energy implications of declining groundwater levels in the San Joaquin Valley and Tulare Lake regions, as put forth in GSPs submitted in high-priority basins.

5.3.2 Implications for Groundwater Pumping Energy

In this section, the authors calculated the expected change in energy use for groundwater pumping in the San Joaquin Valley and Tulare Lake regions if groundwater depths decreased about 100 feet from 2019 levels (average of 168 feet) to the minimum threshold levels (average of 273 feet).[126] This estimate evaluates the additional energy use, if pumping continued to withdraw historical volumes (2020) of groundwater for agriculture, but depths declined to the minimum threshold levels prescribed by the GSP plans submitted for high-priority basins. The analysis was performed for 2020, the most recent year of available data. Further, the authors also recognize this is an aggregate estimate, and depths and volumes vary across the region. Based on literature estimates, pump efficiency is assumed to be 30 percent (low efficiency), 50 percent (medium efficiency), and 70 percent (high efficiency).[127,128]

The authors estimate that pumping one acre-foot of water from 2019 depths using a medium efficiency (50%) pump, which is an average pump efficiency in

124 SGMA Groundwater Management. Available at: http://water.ca.gov/Programs/Groundwater-Management/SGMA-Groundwater-Management

125 Bostic, D., Dobbin, K., Pauloo, R., Mendoza, J., Kuo, M., London, J. "Sustainable for Whom? The Impact of Groundwater Sustainability Plans on Domestic Wells." UC Davis Center for Regional Change. September 2020. Available at: https://pacinst.org/publication/sustainable-for-whom/

126 Pauloo, R., Bostic, D., Monaco, A., Hammond, K. "GSA Well Failure: forecasting domestic well failure in critical priority basins." 2021. Available at: https://www.gspdrywells.com

127 Burt, C., Howes, D., Wilson, G. "California Agricultural Water Electrical Energy Requirements (No. ITRC Report No. R 03-006)." Prepared by Irrigation Training and Research Center for the California Energy Commission. December 2003. Available at: https://digitalcommons.calpoly.edu/cgi/viewcontent.cgi?referer=www.google.com/&httpsredir=1&article=1056&context=bae_fac

128 Green, W., Allen, G. Irrigation pump efficiency – the evolving essentials. REDtrac LLC and the Center for Irrigation Technology at California State University, Fresno. 2018. Available at: https://ucanr.edu/sites/calasa/files/287377.pdf

TABLE 27 Averaged Calculated Energy Intensity for Groundwater Pumping in San Joaquin and Tulare Regions

	At 2019 Groundwater Depths	At Minimum Threshold (MT) Groundwater Depths	Difference
		kWh/AF	
Using a High Efficiency Pump (70%)	244	399	155
Using a Medium Efficiency Pump (50%)	342	559	217
Using a Low Efficiency Pump (30%)	569	932	362

Sources: Groundwater levels from (Pauloo et al., 2021). GW levels are as calculated for the valley floors of the San Joaquin Valley and Tulare Lake hydrologic regions. The authors assume that there is minimal agricultural groundwater use in the mountainous regions. Groundwater pumping coefficient from (Peacock, n.d. Energy and Cost Required to Lift or Pressurize Water). Pump efficiency is based on information found in (Burt et al., 2003; Green and Allen, n.d. irrigation pump efficiency the evolving essentials)

TABLE 28 Total Energy Use for Groundwater Withdrawal in the San Joaquin and Tulare Region, if Groundwater Use Stays Constant at 2015 Levels

	At 2019 Groundwater Depths	At Minimum Threshold (MT) Groundwater Depths	Difference between 2019 and MT Depths	Total 2035 San Joaquin and Tulare Ag Energy Use (Mid Ag Use Scenario)	% Change in Total Ag Energy Use From 2019 to MT Groundwater Depths
			GWh/year		
Using a High Efficiency Pump (70%)	1,941	3,176	1,236	11,147	+11%
Using a Medium Efficiency Pump (50%)	2,717	4,447	1,730	11,147	+16%
Using a Low Efficiency Pump (30%)	4,528	7,412	2,883	11,147	+26%

Sources: Groundwater levels from (Pauloo et al., 2021). GW levels are as calculated for the valley floors of the San Joaquin Valley and Tulare Lake hydrologic regions. The authors assume that there is minimal agricultural groundwater use in the mountainous regions. Groundwater pumping coefficient from (Peacock, n.d.). Pump efficiency is based on information found in (Burt et al., 2003; Green and Allen, n.d.) Groundwater volumes for agriculture in 2015 were summed across San Joaquin Valley and Tulare Lake hydrologic regions. Volumes were calculated in this report for the 'mid-ag use' scenario, from total supply delivery volumes found in DWR's Central Valley simulations (Rayej et al., 2019) and historical shares of groundwater from DWR's water balance data for the agricultural sector as described in the Agricultural water results section of this report.

California,[129] requires 342 kWh of electricity.[130] This increases by two-thirds to 559 kWh per acre-foot when groundwater is pumped from minimum threshold depths. This analysis found that pumping 7.9 million acre-feet of groundwater, equivalent to 2020 groundwater use, from minimum threshold depths increases energy use by 1,200 to 2,800 GWh per year, or by 64 percent. For the San Joaquin and Tulare regions, if groundwater pumping uses 559 kWh/AF at minimum threshold levels, the systemwide energy intensity is estimated to increase to 462 kWh/AF and 1,072 kWh/AF, representing a 20 percent and 6 percent increase for each region, respectively.

Declining groundwater levels make energy efficiency improvements more financially attractive. This analysis

129 Burt, C., Howes, D., Wilson, G. "California Agricultural Water Electrical Energy Requirements (No. ITRC Report No. R 03-006)." Prepared by Irrigation Training and Research Center for the California Energy Commission. December 2003. Available at: https://digitalcommons.calpoly.edu/cgi/viewcontent.cgi?referer=www.google.com/&httpsredir=1&article=1056&context=bae_fac

130 The calculated energy intensity (342 kWh/AF) of groundwater pumping with a medium efficiency pump for this case study is very similar to the average energy intensity from across the literature (365 kWh/AF) for the San Joaquin Valley, which we use for the main urban and agricultural analysis in this report. The average energy intensity from the literature that we use for the Tulare Lake region, which generally has lower depths, is 450 kWh/AF.

assumed an electricity rate of $0.40 per kWh during peak times (5pm to 8pm), during summer months.[131] For a grower using a medium efficient pump during the peak hours of summer months, the energy cost per AF to pump groundwater increases by about $90 for a 100-foot decline in groundwater levels. Switching from a low- to high- efficiency pump to extract groundwater from current levels during the peak summer months would save $130 per AF in electricity costs. These cost savings increase to over $200 per AF when groundwater has declined 100 feet and is at the minimum threshold levels. At these minimum threshold groundwater depths, switching from a low to a high efficiency pump can produce energy savings of about 4000 GWh per year across the San Joaquin and Tulare Lake regions (Table 28).

In addition to higher efficiency pumps, growers may consider the benefits of installing variable frequency drives, which adjust the motor speed of the pump to match operating conditions.[132] These pumps can also be controlled in a more flexible way through demand response programs to coincide with the timing of renewable generation on the electric grid, thereby further reducing the GHG footprint and cost of agricultural water.[133,134]

131 The agricultural electricity rate varies based on the size of the pump, season, and hours of use. $0.40/kWh is the rate during peak hours (5pm-8pm) during the summer months for farms with single-motor installations smaller than 35 kilowatts (kW) ("Electric Schedule Ag: Time-of-use Agricultural Power," 2021). For farms of this size, the rate is $0.24/kWh during off-peak hours during the summer, suggesting that there are also opportunities for saving money on pumping by shifting to off-peak hours. Farms with larger motors (pumps) pay $0.18 to $0.34/kWh for peak summer hours, and $0.14 to $0.18/kWh for off-peak summer hours.

132 Hanson, B., Weigand, C., Orloff, S. Variable-frequency drives for electric irrigation pumping plants save energy. Calif. Agric. 50, 36–39. January 1996. Available at: http://calag.ucanr.edu/Archive/?article=ca.v050n01p36

133 Aghajanzadeh, A., Sohn, M., Berger, M. Water-Energy Considerations in California's Agricultural Sector and Opportunities to Provide Flexibility to California's Grid. 2019. Available at: https://escholarship.org/uc/item/2qx647xg

134 Alstone, P., Potter, J., Piette, M.A., Schwartz, P., Berger, M.A., Dunn, L.N., Smith, S.J., Sohn, M.D., Aghajanzadeh, A., Stensson, S., Szinai, J., Walter, T., McKenzie, L., Lavin, L., Schneiderman, B., Mileva, A., Cutter, E., Olson, A., Bode, J., Ciccone, A., Jain, A. "Final Report on Phase 2 Results, 2025 California Demand Response Potential Study: Charting California's Demand Response Future." Lawrence Berkeley National Laboratory, Energy and Environmental Economics, and Nexant. March 2017. Available at: https://buildings.lbl.gov/publications/2025-california-demand-response

6. CONCLUSIONS

This analysis evaluated the combined impact of emerging pressures on California's water—including population growth, climate change, and policies to shift to water efficiency and alternative water supplies—and of electricity generation decarbonization on the energy and GHG footprints for urban and agricultural water from 2015 to 2035.

6.1 Urban

Report authors find that if urban per-capita water demand is maintained at current (2015) levels, statewide urban water demand increases 24 percent (1.3 million acre-feet, or MAF) between 2015 and 2035 with population growth. This "mid-case" scenario would result in a 21 percent increase in water-related electricity use (from about 30,000 GWh to 36,000 GWh) and a 25 percent increase in natural gas use (from about 150,000,000 to 190,000,000 MMBtu). In contrast, if per-capita water demand increases to levels consistent with urban water suppliers' projections (a "high-case" scenario), urban water demand increases by 44 percent increase (2.4 MAF) between 2015 and 2035, resulting in a 40 percent and 45 percent increase in related electricity and natural gas use, respectively. As the state replaces fossil-fuel generators with more renewable resources, the GHG intensity of California's electricity is expected to decline, and consequently GHG emissions associated with urban water-related energy use (electricity and natural gas) is projected to decrease about 12 percent in the mid-case scenario. However, in the high-case scenario, GHG emissions increase two percent because growing natural gas use dampens the effect of decarbonization in the electricity sector.

More comprehensive water conservation and efficiency efforts in urban California can reduce water-related electricity usage by 19 percent, natural gas use by 16 percent, and GHG emissions by 41 percent between 2015 and 2035. Because indoor residential water use is the most energy-intensive subsector (driven by high energy requirements for end-use, treatment, and wastewater treatment), water conservation and efficiency improvements for this subsector could dramatically decrease the energy use and GHG emissions that would result from the mid- and high-case scenarios.

While the total annual electricity use related to urban water increases in the mid-case scenario, the average energy intensity of California's urban water—the total electricity used per unit of water used—decreases by two percent between 2015 and 2035. This decrease is driven in part by a shift in water supplies away from energy-intensive imports towards alternative sources, including brackish desalination, potable recycled water, and captured stormwater. While the shares of these alternative sources among the statewide urban water supply portfolio are still relatively very small, they have important implications for total energy use because, they are less energy-intensive than imported water in most regions of California, especially in the largest urban water region of South Coast. For example, Los Angeles' move to more local water with increased water recycling, and stormwater recharge, has reduced the overall increase in energy use compared to imported water. In 2035, the city plans to significantly reduce imported water and shift towards local sources, reducing energy use by 64 percent compared to 2015 values. Further, if the city shifted all imported sources to stormwater or direct potable reuse, energy use is estimated to further decrease between 27 percent and 40 percent.

6.2 Agricultural

Central Valley agricultural water use under the mid-case scenario (assuming central urban growth and density scenario) is projected to decline by two percent, or 0.3 MAF, between 2015 (23.4 MAF) and 2035 (23 MAF). This decline is driven only by DWR's projection that urban population growth will encroach on agricultural lands, not including any changes from crop prices, changes in agricultural markets, or other external factors that would also affect agricultural water use. Under this scenario, the associated electricity use decreases four percent (from 14,000 GWh to 13,600 GWh), and GHG emissions decrease about 60 percent (from 3.7 to 1.4 million tons CO_2).[135] The proportionally larger reduction in electricity usage compared to water use is due to expected reductions in supply from relatively energy-intensive water sources, i.e., groundwater (350 kWh/AF in Sacramento, 365 kWh/AF in San Joaquin, 450 kWh/AF in Tulare) and SWP deliveries (240 kWh/AF in Sacramento, 500 kWh/AF in San Joaquin, 2100 kWh/AF in Tulare). Likewise, the proportionally larger reduction in GHG emissions is due to statewide efforts to decarbonize its electricity generation. Climate change has minimal impacts on agricultural water use by 2035 in all three scenarios; however, changes in temperature, precipitation, and evapotranspiration are likely to have a much larger effect on both supply availability and irrigation water demand toward the end of century.

135 GHG emissions are entirely from electricity because we do not calculate natural gas agricultural use.

There are also large uncertainties in the future energy use of Central Valley agriculture because of its dependence on groundwater, which the state has mandated through SGMA to reach sustainable levels by 2040. The agricultural case study featured in this report evaluated the sensitivity of agricultural energy use in the San Joaquin Valley and Tulare regions to changing groundwater depths. If pumping volumes are maintained at current levels and groundwater depths drop to the minimum thresholds, overall agricultural water system energy intensity are projected to increase by 20 percent and 6 percent for the San Joaquin and Tulare regions, respectively. This would increase energy use in the San Joaquin and Tulare regions by about 16 percent in 2035. Permitting groundwater levels to rise can reduce the magnitude of the increase, as can improvements in pump efficiency. Likewise, shifting the timing of energy usage to coincide with times of renewable electricity generation could reduce the impact on GHG emissions.

6.3 Cross-Cutting Findings

Urban water efficiency improvements can have the largest statewide effect on California's water-related energy use and GHG emissions because urban water is much more energy-intensive than agricultural water. Even though Central Valley agricultural water use (~23 MAF) is projected to be about three times that of the urban sector (~7 MAF) by 2035, agriculture's water-related electricity usage is about half, primarily because irrigation end-uses are less energy-intensive than water heating for urban end-uses. By 2035 in the mid-case, the energy intensity and total GHG emissions related to urban water statewide are about 9 times that of Central Valley's agricultural water (5,400 kWh/AF and 14 million tons CO2 for urban water, compared to 600 kWh/AF and 1.4 million tons CO2 for agricultural water by 2035).

Water-related GHG emissions are driven by the pace of California's electricity decarbonization and end-use electrification. With increased renewable resources on the grid, the GHG intensity of electricity generation is projected to decrease from 0.26 to 0.1 tons of CO2-equivalent/MWh between 2015 and 2035. This decrease is estimated to effectively minimize the electricity component of the GHG emissions related to urban water. Natural gas usage, mostly for heating water in residential and non-residential settings, is projected to rise, causing urban GHG emissions to still increase overall. Therefore, there is an opportunity for water-energy partnerships to promote the electrification of water-end uses (water heaters) to reduce the state's GHG footprint.

7. RECOMMENDATIONS

This analysis identifies specific water policies that can play an important role in helping the state meet energy and GHG goals. The authors provide the following recommendations for energy- and GHG-conscious water policies for (1) reducing energy and GHG emissions associated with end-uses of water, (2) reducing energy and GHG emissions associated with the provision of water and wastewater services; and (3) supporting cross-sectoral collaborations.

7.1 Reducing Water, Energy, and GHG Emissions Associated with End-Uses

Expand urban water conservation and efficiency efforts.

Urban water efficiency, for both indoor and outdoor uses of water and within the water distribution system, can save energy and avoid the associated GHG emissions for water extraction and generation, conveyance, treatment, and distribution. Indoor efficiency can further reduce end-use energy requirements and GHG emissions by avoiding, for example, water heating, as well as wastewater collection and treatment. Prior studies have shown there is significant urban conservation and efficiency potential in California—between 2.9 to 5.2 MAF per year[136]—through programs that cut water losses, encourage uptake of efficient devices and landscapes, and promote behavioral change through social norming.[137] One analysis found that water-efficiency programs during the most recent California drought saved as much energy as, and were cost-competitive with, the state's electric investor-owned utility efficiency programs during the same period.[138] Coordinating water and efficiency programs between water and energy suppliers can help both sectors meet water and energy goals and make these programs more cost-effective.

Accelerate water heater electrification.

Within the water management cycle, natural gas water heaters are the single largest emitters of GHGs. Electric heat pump water heaters are up to five times more thermally efficient than natural gas heaters[139] and can also provide significant GHG savings as the electricity system is decarbonized. However, the initial cost of electric heat pump water heaters is typically higher than natural gas heaters. Customer incentives that reduce the upfront cost of electric heaters can encourage more fuel-switching, reducing the state's overall GHG emissions. There is momentum at the state and local level to accelerate this transition. In 2020, the California Public Utilities Commission revised a previous policy preventing utilities from offering fuel-switching incentives and subsequently approved $45 million of the state's Self-Generation Investment Program budget to fund electric heat pump water heater rebates.[140] Further, several cities around California have passed regulations prohibiting natural gas in new housing developments.[141,142] Together with water efficiency programs that reduce hot water usage, incentives for electrification of water heaters can help lower the energy and GHG emissions from residential and non-residential water use.

Maintain groundwater levels and expand flexible, high-efficiency groundwater pumps.

Maintaining groundwater levels above the minimum thresholds identified in GSPs can reduce energy use, energy costs, and GHG emissions. More efficient pumps and variable frequency drives can provide additional reductions, and rebates can lower the upfront cost of these upgrades.[143] Through demand-response programs, farmers can also be compensated for operating their groundwater pumps to coincide with the timing of lower electricity

136 Gleick, P., Cooley, H., Poole, K., Osann, E. Issue Brief: The Untapped Potential of California's Water Supply: Efficiency, Reuse, and Stormwater (Issue Brief No. IB:14-05-C), California Drought Capstone. Pacific Institute and Natural Resources Defense Council. June 2014. Available at: https://pacinst.org/wp-content/uploads/2014/06/ca-water-capstone.pdf

137 Lede, E., Meleady, R., Seger, C.R. Optimizing the influence of social norms interventions: Applying social identity insights to motivate residential water conservation. J. Environ. Psychol. 62, 105–114. April 2019. Available at: https://doi.org/10.1016/j.jenvp.2019.02.011

138 Spang, E.S., Holguin, A.J., Loge, F.J. The estimated impact of California's urban water conservation mandate on electricity consumption and greenhouse gas emissions. Environ. Res. Lett. 13, 014016. January 2018. Available at: https://doi.org/10.1088/1748-9326/aa9b89

139 Product Finder — ENERGY STAR Certified Water Heaters. Available at: https://www.energystar.gov/productfinder/product/certified-water-heaters/results?page_number=0

140 Gerdes, J. "California Moves to Tackle Another Big Emissions Source: Fossil Fuel Use in Buildings." Greentech Media. February 4, 2020. Available at: https://www.greentechmedia.com/articles/read/california-moves-to-tackle-another-big-emissions-source-fossil-fuel-use-in-buildings

141 Ivanova, I. "Cities are banning natural gas in new homes, citing climate change." CBS News. December 6, 2019. Available at: https://www.cbsnews.com/news/cities-are-banning-natural-gas-in-new-homes-because-of-climate-change/

142 Mulkern, A.C. California Is Closing the Door to Gas in New Homes. Scientific American. January 4, 2021. Available at: https://www.scientificamerican.com/article/california-is-closing-the-door-to-gas-in-new-homes/

143 Get Big Rebates For Small Agricultural Pumps. PGE. Available at: https://www.pge.com/en/mybusiness/save/smbblog/article/get_big_rebates_for_small_agricultural_pumps.page?redirect=yes

prices and renewable electricity generation on the grid,[144] and variable frequency drives can further be automated to adjust to grid needs.[145] This can help integrate renewable electricity and lower overall GHG emissions from electricity generation.

7.2 Reducing Water, Energy, and GHG Emissions Associated with the Provision of Water and Wastewater Services

Provide financial incentives and regulatory pathways for water suppliers to reduce the energy- and GHG-intensity of water systems.

California should make existing financial incentives and programs for energy efficiency and GHG reduction available to water suppliers for shifting to less energy-intensive water supplies. Energy- and GHG-related programs, such as the state's cap-and-trade funds,[146] or state bond money, such as a Climate Resilience Bond,[147] are potential funding sources that could be provided to water suppliers for developing alternative local sources that save energy and reduce GHG emissions. It may also be possible to stack incentives across sectors, such as from electric investor-owned utility efficiency programs to account for the range of co-benefits of energy and GHG savings.

California should also prioritize creating regulatory pathways that enable water and wastewater services to reduce energy and GHG emissions. Guidance on direct potable reuse standards is expected to be issued from the State Water Resources Control Board by December 2023. Clear state guidelines and regulations allowing direct potable reuse may offer energy and GHG benefits over indirect potable reuse, as it could avoid energy, GHG emissions, and costs, from the additional conveyance and treatment that is currently required for indirect potable reuse. In addition, regulations that address challenges of co-digestion and resource recovery at wastewater treatment plants can lower GHG emissions, generate renewable energy, and divert organic waste from landfills with existing wastewater infrastructure. Coordination between electric and water utilities may provide opportunities to implement demand response programs at urban water and wastewater treatment plants to reduce or shift the timing of energy use. This could help alleviate stress on the electric grid from additional water-related energy use and allow energy demand to coincide with renewable generation to reduce the overall GHG intensity related to water.

7.3 Water and Energy Data Reporting and Planning

Expand and standardize water data reporting and energy usage tracking.

A unified set of projections of future water supply and demand portfolios for both urban and agricultural water suppliers is not publicly available, therefore the authors used different urban and agricultural datasets for this analysis. Such data—reported in a standardized way across water suppliers with harmonized assumptions (such as for population growth and climate change impacts) between urban and agricultural suppliers is essential to understand future water system conditions. These data should also include mandatory reporting of energy usage and energy intensity of the water cycle stages for each water supplier. Ultimately the energy intensity of the water system must be tracked alongside other state environmental indicators to help California meet its energy and GHG goals.

144 Aghajanzadeh, A., Sohn, M., Berger, M. Water-Energy Considerations in California's Agricultural Sector and Opportunities to Provide Flexibility to California's Grid. 2019. Available at: https://escholarship.org/uc/item/2qx647xg

145 Alstone, P., Potter, J., Piette, M.A., Schwartz, P., Berger, M.A., Dunn, L.N., Smith, S.J., Sohn, M.D., Aghajanzadeh, A., Stensson, S., Szinai, J., Walter, T., McKenzie, L., Lavin, L., Schneiderman, B., Mileva, A., Cutter, E., Olson, A., Bode, J., Ciccone, A., Jain, A. "Final Report on Phase 2 Results, 2025 California Demand Response Potential Study: Charting California's Demand Response Future." Lawrence Berkeley National Laboratory, Energy and Environmental Economics, and Nexant. March 2017. Available at: https://buildings.lbl.gov/publications/2025-california-demand-response

146 California Climate Investments. California Air Resources Board. Available at: https://ww2.arb.ca.gov/our-work/programs/california-climate-investments

147 Cart, J. "Bonds on the ballot: Will billions of dollars help California cope with climate change?" CalMatters. January 22, 2020. Available at: https://calmatters.org/environment/2020/01/bonds-on-the-ballot-will-billions-of-dollars-help-california-cope-with-climate-change/

Formalize coordination between water and energy regulatory agencies about forecasted energy demand changes

If water system energy demands grow as projected, California's electricity and natural gas systems will need to incorporate changes in their infrastructure planning to ensure that energy supply will reliably meet energy demand. Formal regulatory proceedings and reporting between water suppliers, state water agencies, electric and natural gas utilities, state energy regulators, and planning agencies can help facilitate coordinated cross-sectoral planning. For example, currently there is no explicit reporting of expected changes in water-related energy demand in California's Integrated Energy Policy Report and associated energy demand forecast.[148] As a result, it is unclear if the energy use growth anticipated based on water supplier projections has been factored into electricity and natural gas planning and procurement decisions. Improvements in coordination between agencies should lead to better integrated energy and water planning, reduced costs to consumers, and faster decarbonization of California's water system.

Addressing California's Water-Energy Nexus

To adequately address California's joint water and climate challenges, coordinated policy and planning are necessary to ensure that sustainable and safe water supplies can be delivered reliably and cost-effectively, without increasing the greenhouse gas emissions from the state's water sector. This report provides an in-depth analysis of how the state can do just that – and actually reduce GHG emissions in the process. Through comprehensive policy solutions like those suggested here, California can strengthen its commitment to climate goals while ensuring a sustainable path forward for water resource management in the state.

148 California Energy Commission. "Integrated Energy Policy Report - IEPR." *California Energy Commission*, California Energy Commission, current-date, https://www.energy.ca.gov/data-reports/reports/integrated-energy-policy-report.

January 24th, 2022

Tom Luster
California Coastal Commission
45 Freemont St, Ste 2000
San Francisco, California 94105

Sent via email: *Tom.Luster@coastal.ca.gov*

Re: Expert Reports: Feasibility of Subsurface Intakes at the Poseidon – Huntington Beach Desalination Plant

Dear Mr. Luster,

On behalf of the environmental coalition, we appreciate your consideration of the attached expert reports and their inclusion into the administrative record. Poseidon asserts that subsurface intakes are infeasible for the Poseidon – Huntington Beach Project proposal. The expert reports enclosed within are evidence to be considered as part of the administrative record and demonstrate that Poseidon's assertions that subsurface intakes are infeasible are legally flawed.

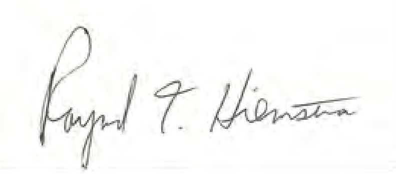
The three enclosed expert reports were commissioned by Orange County Coastkeeper to offer an independent third-party analysis of the legal, economic, and technical accuracy of Poseidon's application materials as they relate to the feasibility of subsurface intakes.

- **HydroFocus Expert Reports Huntington Beach Seawater Desalination Facility Groundwater Model)** – The first HydroFocus report prepared in 2016 identified limitations and uncertainty with the Geosyntec model developed on behalf of Poseidon to conclude slant wells were infeasible at Poseidon's predetermined site. HydroFocus concluded that the Geosyntec model results were inconclusive until physical tests could verify the computer modeling. The second HydroFocus study prepared in 2020 concluded slant wells may help manage seawater intrusion of the Talbert Aquifer. Also included with these reports are a presentation used by HydroFocus at the Regional Water Board hearing and a State of California Manual for the Best Management Practices for Groundwater modeling.

- **Hanemann Expert Report (2018) An Assessment of the Reports on the Proposed Huntington-Poseidon Seawater Desalination Project Prepared by the Independent Scientific Technical Advisory Panel (ISTAP)** – The Hanemann report concluded that the ISTAP Phase 1 and Phase 2 reports inappropriately asserted that slant wells are technically or economically infeasible according to the requirements set forth in the Ocean Desalination Amendment to the California Water Quality Control Plan for Ocean Water.

We respectfully request these three expert reports be considered by the Coastal Commission as part of the administrative record. The reports individually, and in whole, demonstrate that Poseidon's assertions are legally flawed and do not meet their burden of demonstrating that subsurface intakes are infeasible for the Poseidon – Huntington Beach project proposal.

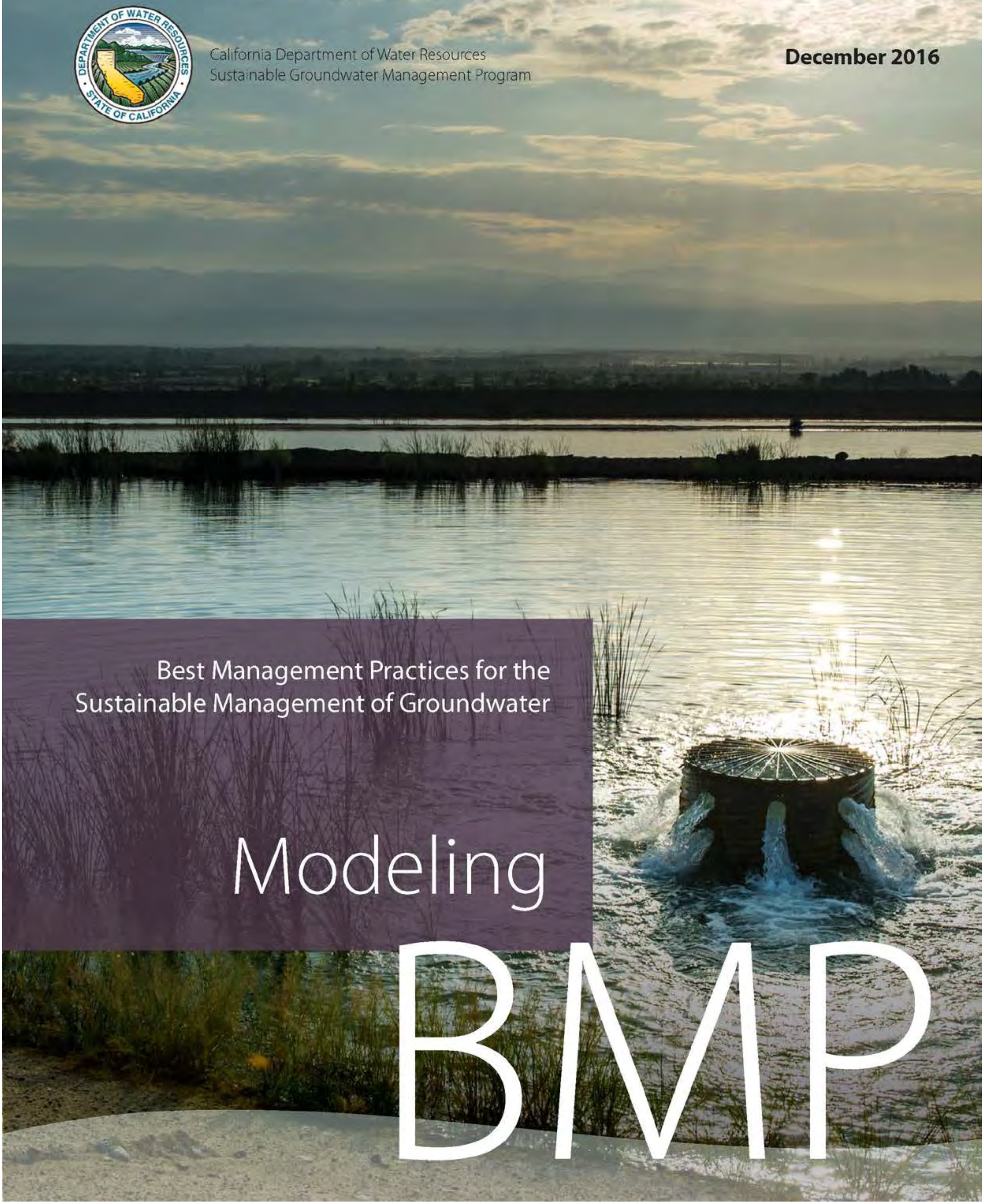
Sincerely,



Raymond Hiemstra
Associate Director of Programs
Orange County Coastkeeper

California Department of Water Resources
Sustainable Groundwater Management Program

December 2016



Best Management Practices for the
Sustainable Management of Groundwater

Modeling BMP

State of California
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California Natural Resources Agency
John Laird, Secretary for Natural Resources

Department of Water Resources
Mark W. Cowin, Director

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Modeling
Best Management Practice

1. OBJECTIVE

The objective of this *Best Management Practice* (BMP) is to assist with the use and development of groundwater and surface water models. The California Department of Water Resources (the Department or DWR) has developed this document as part of the obligation in the Technical Assistance chapter (Chapter 7) of the Sustainable Groundwater Management Act (SGMA) to support the long-term sustainability of California's groundwater *basins*. Information in this BMP provides technical assistance to Groundwater Sustainability Agencies (GSAs) and other stakeholders on how to address modeling requirements outlined in the Groundwater Sustainability Plan (GSP) Emergency Regulations (GSP Regulations). This BMP identifies available resources to support the development of groundwater and surface water models.

This BMP includes the following sections:

1. Objective. The objective and outline of the contents of this BMP.
2. Use and Limitations. A description of the use and limitation of this BMP.
3. Modeling Fundamentals. A description of fundamental modeling concepts.
4. Relationship of modeling to other BMPs. A description of how modeling relates to other BMPs and is a tool used to develop other GSP requirements.
5. Technical Assistance. A description of technical assistance for the development of a model, potential sources of information, and relevant datasets that can be used to further define model components.
6. Key Definitions. Definitions relevant for this BMP as provided in the GSP Regulations, Basin Boundary Regulations, and SGMA.
7. Related Materials. References and other materials related to the development of models.

2. USE AND LIMITATIONS

BMPs developed by the Department provide technical guidance to GSAs and other stakeholders. Practices described in these BMPs do not replace the GSP Regulations, nor do they create new requirements or obligations for GSAs or other stakeholders. In addition, using this BMP to develop a GSP does not equate to an approval determination by the Department. All references to GSP Regulations relate to Title 23 of the California Code of Regulations (CCR), Division 2, Chapter 1.5, and Subchapter 2. All references to SGMA relate to California Water Code sections in Division 6, Part 2.74.

3. Modeling Fundamentals

As modified from Barnett and others (2012), a model is any computational method that represents an approximation of the hydrologic system. While models are, by definition, a simplification of a more complex reality, they have proven to be useful tools over several decades for addressing a range of groundwater problems and supporting the decision-making process. Models can be useful tools for estimating the potential hydrologic effects of proposed water management activities.

Surface water and groundwater systems are affected by natural processes and human activity. They require targeted and ongoing management to maintain surface water and groundwater resources within acceptable limits, while providing desired economic and social benefits. *Sustainable groundwater management* and policy decisions must be based on knowledge of the past and present behavior of the surface and groundwater system, the likely response to future changes and management actions, and the understanding of the *uncertainty* in those responses.

The location, timing, and magnitude of hydrologic responses to natural or human-induced events depend on a wide range of factors. Such factors include the nature and duration of the event that is impacting groundwater, the subsurface properties, and the connection with surface water features such as rivers and oceans. Through observation of these characteristics, a conceptual understanding of the system can be developed. Often observational data are scarce (both in space and time), so understanding of the system remains limited and generally uncertain.

Models provide insight into the complex system behavior and (when appropriately designed) can assist in developing conceptual understanding. Models provide an important framework that brings together conceptual understanding, data, and science in a hydrologically and geologically consistent manner. In addition, models can estimate and reasonably bound future groundwater conditions, support decision-making about monitoring networks and management actions, and allow the exploration of alternative management approaches. However, there should be no expectation that a single 'true' model exists. All models and model results will have some level of uncertainty. Models can provide decision makers an estimate of the predictive uncertainty that exists in model forecasts. By gaining a sense of the magnitude of the uncertainty in model predictions, decision makers can better accommodate the reality that all model results are imperfect forecasts and actual *basin* responses to management actions will vary from those predicted by modeling.

GENERAL TYPES OF MODELS AND MODELING SOFTWARE

There are various modeling approaches, methods, and software that can be used for GSP development and implementation. This section provides a general description of a few widely used types of models and the variety of software typically used for modeling. These model types are not mutually exclusive. For example, an integrated groundwater and surface water model can also be described as a numerical model.

Each GSA is responsible for determining the appropriate modeling method, software, and the level of detail needed to demonstrate that *undesirable result*s can be avoided and the *sustainability goal* in each basin is likely to be achieved within 20 years of *GSP implementation*. A table of select, currently available, modeling codes (the model computation engine) and applications (the constructed model including inputs) is provided in Appendix A.

TYPES OF MODELS

Conceptual Models

A conceptual model is often considered the first step in understanding the groundwater flow system and developing a mathematical model. A conceptual model includes a narrative interpretation and graphical representation of a basin based on known characteristics and current management actions. Conceptual models do not necessarily include quantitative values. For more details on developing a conceptual model, please refer to the Hydrogeologic Conceptual Model (HCM) BMP.

Mathematical Models

A model that simulates *groundwater flow* or solute transport by solving an equation, or series of equations, that reasonably represents the physical flow and transport processes is referred to as a mathematical model. Mathematical models differ from conceptual models in that they are capable of providing quantitative estimates of the *water budget* components. Mathematical models are often divided into two categories: analytical and numerical models or tools.

Analytical Models and Tools

Analytical models generally require assumptions that significantly simplify the physical system being evaluated. For example, topographic boundary conditions are generally limited to simple geometric shapes in these solutions, and aquifer properties are often required to be homogeneous and isotropic. The physical configuration of the management action is also typically idealized for the purposes of analysis and, therefore, influences related to project geometry are ignored. Often only one component (a measured or simulated value or relationship) of the groundwater system is evaluated at a time, and this approach omits the evaluation of potential interactions with other components. For example, a spreadsheet could use a simple equation to estimate the aquifer drawdown in one location based on pumping at another location, without considering the potential influence on nearby streams.

However, analytical models and tools can successfully and inexpensively be employed to gain strong conceptual and general quantitative understanding of groundwater basin dynamics, which includes interactions with pumping, groundwater storage, groundwater quality, seawater intrusion, land subsidence, and interaction with surface water. Therefore, the applicability of this approach is most suited to initial scoping studies or basins with simple hydrologic conditions or easily idealized basins. This analysis may be limited when used as the only modeling tool.

Numerical Models and Tools

Numerical modeling tools are widely used in groundwater flow and transport analysis to evaluate the change to the groundwater system caused by changes in conditions due to management actions, changes in population and land use, climate change, or other factors. These numerical models allow for a more realistic representation of the physical system, including geologic layering, complex boundary conditions, and stresses due to pumping, recharge and land use demands. GSPs developed for complex basins with significant groundwater withdrawals and/or surface water - groundwater interaction may require the use of a numerical groundwater - surface water model to demonstrate that the GSP will avoid undesirable results and achieve the sustainability goal within the basin. Several of the available modeling codes and associated applications are discussed in more detail in Appendix A.

Integrated Hydrologic Water Models

A fully integrated surface water and groundwater model refers to a suite of codes that jointly solve the numerical solutions for surface processes (such as irrigation deliveries and stream diversions), surface flows and groundwater heads together. Many models include the ability to simultaneously simulate streamflow and its interconnection with the aquifer system.

Coupled Groundwater and Surface Water Models

A coupled groundwater and surface water model uses separate models for surface water and the groundwater systems. Coupled models are set up such that the solution from one model (i.e., surface water modeling output) can be used as input into the second model (i.e., groundwater model) to solve the groundwater flow equations and to consider the stresses (boundary conditions) imposed by the surface water information.

Transport Models

Transport model codes add a layer of complexity beyond what is provided by groundwater-flow models. These models allow for the assessment of a variety of problems, including the potential migration of existing contaminant plumes due to management actions, or the changes in groundwater quality over time after a remediation project is implemented. These types of models are not as widely used for water resources planning, but need to be considered for basins in which existing contamination impairs the use of groundwater as the source of supply and/or affect other areas of the basin now or as a potential result of future management actions.

TYPES OF MODELING SOFTWARE

Groundwater modeling typically requires the use of a number of software types, including the following (modified from Barnett and others, 2012):

- The model code that solves the equations for groundwater flow and/or solute transport, sometimes called simulation software or the computational engine
- A graphical user interface (GUI) that facilitates preparation of data files for the model code, runs the model code and allows visualization and analysis of results
- Software for processing spatial data, such as a geographic information system (GIS), and software for representing hydrogeological conceptual models
- Software that supports model calibration, sensitivity analysis and uncertainty analysis
- Programming and scripting software that allows additional calculations to be performed outside of or in parallel with any of the above types of software
- A wide range of model codes to solve problems related to groundwater flow and/or transport, such as model codes that simulate farm water management, plant-water interactions, unsaturated zone flow and transport processes, stream flow processes, surface water - groundwater interactions, land subsidence, watershed processes, climate, geochemical reactions, economic water management optimization, or parameter calibration

Some software is public domain and open-source (freely available and able to be modified by the user) and some is commercial and closed (proprietary design that is only available in an executable form that cannot be modified by the user).

Some software fits several of the above categories; for example, a model code may be supplied with its own GUI or a GIS may be supplied with a scripting language. Some GUIs support one model code while others support many. Most model codes that solve the groundwater flow and/or transport equation have an integrated capability to also simulate some or many of the related processes listed above, such as surface water - groundwater interaction.

COMMON MODEL USES

The following provides a partial list of general and SGMA-related uses for models

General Uses (modified from Barnett and others, 2012)

- Improving hydrogeological understanding (synthesis of data).
- Aquifer simulation (evaluation of aquifer behavior).
- Calculating and verifying water budget components, such as recharge, discharge, change in storage and the interaction between surface water and groundwater systems (water resources assessment).
- Predicting impacts of alternative hydrological or development scenarios (to assist decision-making).
- Managing resources (assessment of alternative policies).
- Sensitivity and uncertainty analysis (to guide data collection and risk-based decision-making).
- Visualization (to communicate aquifer behavior).
- Providing a repository for information and data that influence groundwater conditions.

GSP-Related Uses

- Developing an understanding and assessment of how historical conditions concerning hydrology, water demand, and surface water supply availability or reliability have impacted the ability to operate the basin within *sustainable yield*.
- Assessing how annual changes in historical inflows, outflows, and changes in basin storage vary by *water year* type (hydrology) and water supply reliability.
- Evaluating how the surface and groundwater systems respond to the annual changes in the water budget inflows and outflows.
- Identifying which management actions and water budget situations commonly result in overdraft conditions or undesirable results.

- Facilitating the estimate of sustainable yield for the basin.
- Optimizing proposed projects and management actions and evaluating the potential effects those activities have on achieving the sustainability goal for the basin.
- Evaluating future scenarios of water demand uncertainty associated with projected changes in local land use planning, population growth, and climate.
- Informing monitoring requirements.
- Informing development and quantification of sustainable management criteria, such as the sustainability goal, undesirable results, *minimum thresholds*, and measureable objectives.
- Helping identify potential projects and management actions and optimizing their design to achieve the sustainability goal for the basin within 20 years of GSP implementation.
- Identifying *data gaps* and uncertainty associated with key water budget components and model forecasts, and developing an understanding of how these gaps and uncertainty may affect implementation of proposed projects and water management actions.

MODELS IN REFERENCE TO THE GSP REGULATIONS

Developing and applying models to aid in determining sustainable groundwater management results in multiple benefits to GSAs and stakeholders. Constructing and calibrating the model improves understanding of the critical processes that influence *sustainability indicators* within the basin. The application of the model to forecast the influence of projects and management actions on basin conditions provides a framework within which a GSA can screen and select appropriate projects and management actions that lead to the achievement of the sustainability goal for the basin. Additionally, models can play a critical role in simulating the changing climate conditions that may occur during the 50-year *planning and implementation horizon* required under SGMA. It should be noted that in general, groundwater and surface water models are more effective at comparing the benefits and impacts of various management strategies with respect to one another rather than predicting exact management outcomes. So while a model can assist in selecting the best alternative from a variety of options, uncertainty will still remain in the forecasted outcome of a particular alternative. Adaptive management will always be a necessary component of program implementation.

A significant consideration that must be addressed by all GSAs is whether modeling is necessary or required for developing and implementing its GSP. In most basins, the spatial and temporal complexity of the data will require some application of modeling to accurately assess the individual and cumulative effects of proposed projects and management actions on avoiding or eliminating undesirable results and achieving the basin's sustainability goal. It is each GSA's role to carefully consider if changing basin conditions and proposed projects and management actions have the potential to trigger undesirable results within the basin or in adjacent basins, and whether a model is necessary to demonstrate that the proposed projects and management actions will achieve the sustainability goal. Therefore, the use of models for developing a GSP is highly recommended, but not required. The use of a model will ultimately depend on the individual characteristics and complexity of the *basin setting*, the presence or absence of undesirable results, and the presence or absence of *interconnected surface water* systems. As stated in GSP Regulation sections §354.18 (f) and §354.28(c)(6), "if a numerical groundwater and surface water model is not used to quantify the water budget and depletions of interconnected surface water, the GSP shall identify and describe an equally effective method, tool, or analytical model to accomplish these requirements".

Similar to the question of whether models should be used during GSP development is the question of the appropriate level of model complexity. Simple models require fewer data, less complex software, and are, therefore, often less expensive, and have much shorter run times. These characteristics are advantageous when focusing on a single undesirable result. However, simple models may overlook important system components and the interconnectedness of undesirable results, and may be difficult to calibrate to historical data. Complex models can incorporate more data and professional judgment. Therefore, they often result in a more accurate representation of the groundwater system. However, complex models are more expensive and difficult to build, require more data and more technical expertise, and the complexity can lead to a false impression of accuracy; a complex model may in fact be less accurate.

Fundamentally, a good model strategy is to follow the principle of parsimony: to build the simplest model that honors all relevant available data and knowledge, while providing a reasonable modeling tool to achieve the desired decision support at a desirable level of certainty. It may be necessary to use complex models to assess certain undesirable results, and it may be possible to use simple models to assess other undesirable results.

Some guidance on what might influence model complexity is provided in the modeling considerations section of this BMP. Since significant professional judgment goes into the development of a model, two models of the same basin – even if they are built with the same model code - are likely to differ in their design and their outcome. Where multiple models exist, differences between model outcomes, after a careful assessment of the differences in model design and assumptions, may provide an important opportunity to further assess uncertainty in predicted outcomes and to further direct future data collection programs. Importantly, multiple models with differing outcomes should not be interpreted *a priori* as one model being (more) right and others being (more) wrong.

While models are useful and often invaluable tools for understanding a basin and predicting future basin conditions, in most cases, they are not the only available means for demonstrating that a basin has met its sustainability goal. Satisfactorily demonstrating that all undesirable results have been avoided and the sustainability goal has been met will be a function of the data collected and reported during GSP implementation.

4. RELATIONSHIP OF MODELING TO OTHER BMPS

The purposes of modeling in the broader context of SGMA implementation include:

1. Supporting the development of the water budget
2. Establishing the Sustainable Management Criteria (sustainability goal, undesirable results, minimum thresholds, and *measurable objectives*)
3. Supporting identification and development of potential projects and management actions to address undesirable results that exist or are likely to exist in the future
4. Supporting the refinement of the monitoring network in the basin over time

Modeling is also linked to other related BMPs as illustrated in **Figure 1**. This figure provides the context of the BMPs as they relate to logical progression to sustainability as outlined in the GSP Regulations. The modeling BMP is part of the planning step in the GSP Regulations.

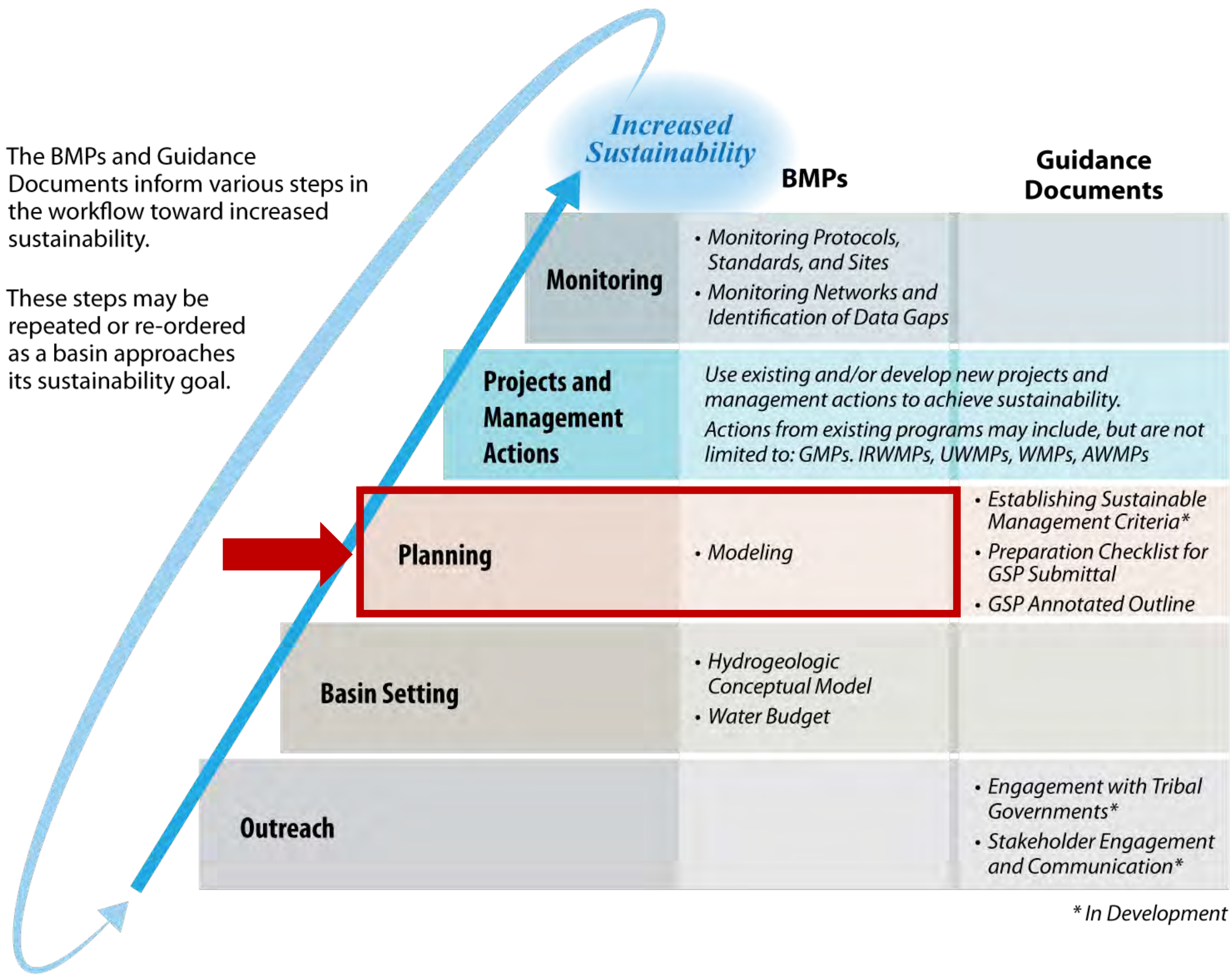

Figure 1 – Logical Progression of Basin Activities Needed to Increase Basin Sustainability

5. Technical Assistance

This section provides technical assistance and guidance to support the development of models under SGMA and the GSP Regulations, including potential sources of information and relevant datasets that can be used to develop and implement the various modeling components.

GUIDING PRINCIPLES FOR MODELS USED IN SUPPORT OF GSPS

The Department is providing the following four modeling principles to help foster SGMA's intent to promote transparency, coordination, and data sharing. They help guide GSAs in their selection and use of models for sustainable groundwater management, and expedite Department review of GSP-related modeling analysis and findings.

1. Model documentation (documentation of model codes, algorithms, input parameters, calibration, output results, and user instructions) is publicly available at no cost. In particular, the model documentation should explain (or refer to available literature that explains) how the mathematical equations for the various model code components were derived from physical principles and solved, and guidance on limitations of the model code.

2. The mathematical foundation and model code have been peer reviewed for the intended use. Peer review is not intended to be a "stamp-of-approval" or disapproval of the model code. Instead, the goal of peer review is to inform stakeholders and decision-makers as to whether a given model code is a suitable tool for the selected application, and whether there are limits on the temporal or spatial uses of the model code, or other analytic limits.

3. The GSP descriptions of the conceptual model, the site-specific model assumptions, input parameters, calibration, application scenarios, and analytical results demonstrate that the quantification of the forecasted water budget, sustainable management criteria (sustainability goal, undesirable results, minimum thresholds, and measurable objectives), proposed projects and management actions are reasonable and within the range of identified uncertainties, to evaluate the GSP-identified outcomes of sustainability for the basin.

4. If requested, provide the Department with a free working copy of the complete modeling platform (for example native MODFLOW and IWFM input files,

output files, and executables) that allows the Department to run the model, create and verify results, view input and output files, or perform any other evaluation and verification.

GENERAL MODELING REQUIREMENTS

23 CCR §352.4(f) Groundwater and surface water models used for a Plan shall meet the following standards:

(1) The model shall include publicly available supporting documentation.

(2) The model shall be based on field or laboratory measurements, or equivalent methods that justify the selected values, and calibrated against site-specific field data.

(3) Groundwater and surface water models developed in support of a Plan after the effective date of these regulations shall consist of public domain open-source software.

The intent of requiring standards for models in the GSP Regulations is to promote a consistent approach to the development and coordination of models in California. This will allow the Department to evaluate these models and related GSPs within basins and between basins across the state. A description of the specific modeling standards listed in §352.4(f) is provided below.

(1) The model shall include publicly available supporting documentation.

Models used for a GSP are required to provide publicly available supporting documentation in the form of:

1. An explanation of the modeling code, the physical processes simulated by the code, associated mathematical equations, and assumptions, which are typically found in publicly available theoretical documentation, user instructions or manuals. This information should be referenced by the model developer in their documentation of the model application.

2. A description of the model application, including the construction of the model by the GSA that describes the conceptual model, simulation model development, assumptions, data inputs, boundary conditions, calibration, uncertainty analysis, and other applicable model application elements. This documentation should be a component of a GSP, and included as an appendix to characterize the technical work that went into developing and applying the model for GSP development and implementation. The California Water and Environmental Modeling Forum (CWEMF) has developed a framework for documenting and archiving a

groundwater flow model application that can be tailored for GSA use (CWEMF, 2000).

(2) The model shall be based on field or laboratory measurements, or equivalent methods that justify the selected values, and calibrated against site-specific field data.

The development of a mathematical model starts with assembling applicable information relevant to the basin or site-specific characteristics. A detailed HCM forms the basis of the model by providing relevant physical information of the aquifer and surface systems, as well as applicable boundary conditions of the basin and stressors (such as pumping and artificial recharge). Previous field evaluations, studies and literature may provide additional data for the model development. For more site-specific information, field testing can be performed, e.g., targeted aquifer tests to determine parameters such as hydraulic conductivity, transmissivity, and storage coefficients. In addition, field tests allow for the calibration of the model to field data. Calibration of the model should be performed by comparing simulated values to observed field data such as groundwater levels, groundwater flow directions, groundwater discharge rates, water quality concentrations, land subsidence observations, measurements of surface water and groundwater exchange, or chloride concentrations as an indicator for seawater intrusion. Additional information on these topics is provided in the modeling considerations and modeling process sections.

(3) Groundwater and surface water models developed in support of a Plan after the effective date of these regulations shall consist of public domain open-source software.

Public domain codes published through government agencies like the Department, the U.S. Army Corps of Engineers Hydrologic Engineering Center, and United States Geological Survey (USGS), are often widely distributed, relatively inexpensive, and generally accepted model codes with features that can be and have been used to simulate a wide range of hydrogeological conditions. Public domain codes, including many listed in Appendix A, have received extensive peer review, case studies document their general applicability, and their limitations have been published in the scientific literature. Many were originally developed, and are continually being refined, by government agencies such as the Department and USGS. Proprietary codes may share many attributes with public domain codes; however, the source code is not generally available for review, they require the purchase of a license to use the software, and the peer review may be limited.

The GSP Regulations require that all new models developed in support of a GSP after the effective date of the GSP Regulations (August 15, 2016) use public domain open-source software to promote transparency and expedite review of models by the Department. The requirement to use public domain open-source software allows for different agencies, stakeholders, and the Department to view input and output data, and run the model, without using a proprietary code; this requirement may help encourage collaborative actions and data sharing that could lead to increased coordination within and between basins. Models developed and actively used in groundwater basins prior to the GSP Regulations effective date can be used for GSP development and implementation, even if they do not use public domain and open-source software as shown in **Figure 2**.

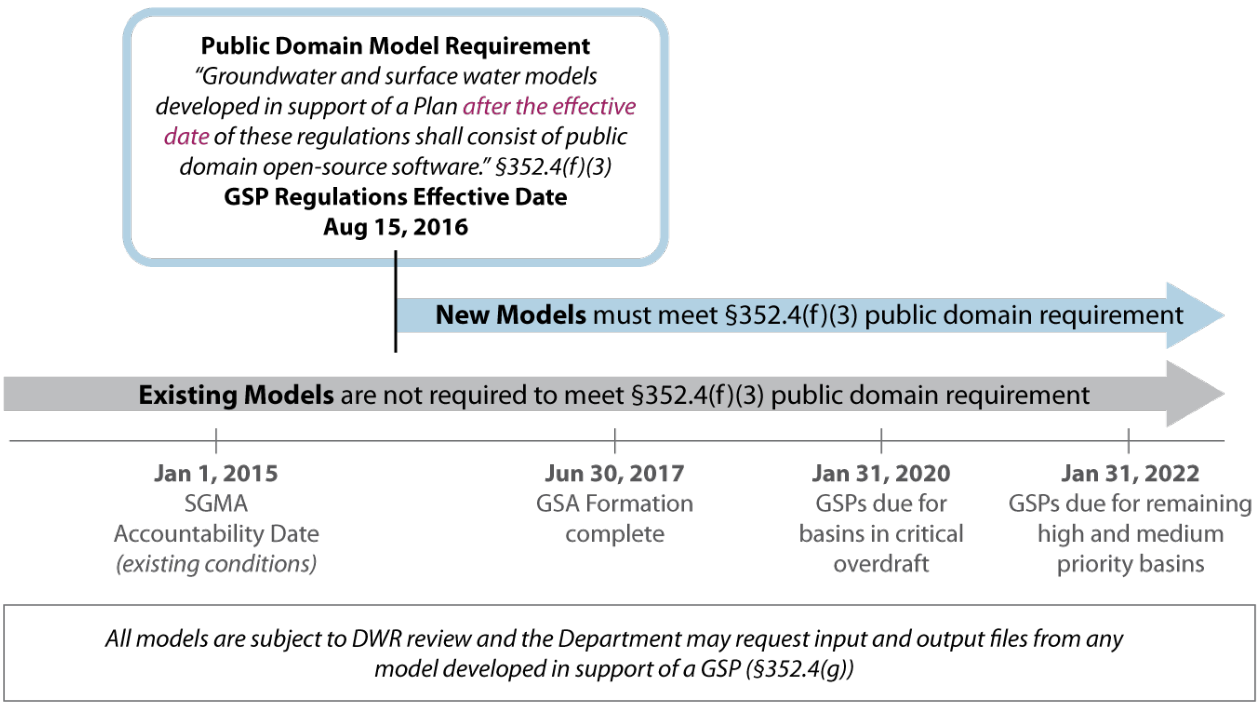

Figure 2 - GSP Regulations Effective Date and Model Development Timeline

The public domain and open-source software requirement only applies to model codes that solve the equations for groundwater flow and transport, and does not apply to other supporting software used to generate model input files or process model output data (such as Microsoft Excel, various GUIs, or GIS mapping software). In addition, the public domain and open-source software requirement does not apply to other boundary evaluation models or tools that provide input to the model or GSP, including watershed evaluation models, estimates of runoff, irrigation demand (if calculated outside the groundwater model), municipal demand (if calculated outside the groundwater model), or other related models.

23 CCR §352.4(g) The Department may request data input and output files used by the Agency, as necessary. The Department may independently evaluate the appropriateness of model results relied upon by the Agency, and use that evaluation in the Department's assessment of the Plan.

All models are subject to Department review and the Department may request input and output files from any model developed in support of a GSP, including any software-specific files.

MODELING CONSIDERATIONS

A model should be selected and developed with clearly defined objectives to provide specific information in support of developing a GSP. Examples of the GSP needs and modeling objectives that should be considered when selecting and developing a model include the following.

Addressing Sustainability Indicators

The management of each sustainability indicator poses unique technical challenges. Each GSA will need to characterize the current and projected status of each sustainability indicator in the basin, and identify the point at which conditions in the basin cause undesirable results. Models must be selected and developed that provide GSAs ample information about the future condition of each sustainability indicator relevant to the basin, and improve the GSA's ability to avoid undesirable results and achieve the Sustainability Goal in the basin.

The need to model each sustainability indicator will be specifically related to the current and potential presence and magnitude of undesirable results in the basin. As the magnitude and distribution of undesirable results increase, the complexity associated with adequately identifying appropriate projects and management actions to achieve sustainability may surpass the ability of simple analytical tools and lead towards the need to apply more complex numerical modeling techniques. Models are also tools that can help establish the Sustainable Management Criteria. Specific modeling considerations for each of the sustainability indicators are described below.

Lowering of Groundwater Levels

One of the most common effects of unsustainable groundwater management is the chronic lowering of groundwater levels. While an assessment of current and/or historical groundwater pumping on groundwater levels can be performed based on groundwater level measurements, forecasting future conditions that may differ from historical conditions will likely require the development of a model. All models are capable of simulating the effects of groundwater pumping on groundwater levels and, therefore, forecasts of groundwater level impacts due to basin management actions are readily available from any model of adequate detail and complexity. However in basins where surface water - groundwater interaction plays a significant role in the basin water budget, the groundwater flow model selected to forecast basin conditions resulting from management actions should be capable of accounting for the effects of pumping on streamflow. Addressing this sustainability indicator does not promote or exclude any particular models. Instead, the GSA should assess which modeling tool will provide estimates of groundwater levels at the appropriate spatial distribution to support GSP development and implementation.

Reduction of Groundwater Storage

Estimates of changes in groundwater storage volume can be computed based on observed groundwater level changes, along with knowledge of the geometry and hydraulic and hydrogeologic properties of the aquifer system. Therefore, historical changes in groundwater storage can be estimated from aquifer and groundwater monitoring data. However, forecasting future storage changes due to projects and management actions will likely require a modeling tool of some type. In addition, models are capable of providing the geographic distribution of changes in storage at specific locations. All transient groundwater and surface water models are capable of computing changes in groundwater storage within a basin due to particular management actions and, therefore, estimation of change in groundwater storage is readily available from any transient model of adequate detail and complexity. Addressing this sustainability indicator does not promote or exclude any particular model. Instead, the GSA should assess which modeling tool will provide estimates of groundwater storage changes at the appropriate spatial distribution and accuracy to support GSP development and implementation, particularly based on the types of management actions considered in the basin.

Seawater Intrusion

Basins adjacent to the ocean or parts of the Sacramento-San Joaquin Delta are susceptible to seawater intrusion. Seawater intrusion into a freshwater aquifer due to groundwater pumping is a complex process that very likely will need to be addressed with a model. If seawater intrusion may be a threat to long-term groundwater quality in a basin, there are several types of model codes available for analyzing potential effects of seawater intrusion on a basin and associated basin management decisions (see Appendix A). For example, the groundwater budget can indicate whether water is generally flowing from onshore or offshore at the ocean boundary. Particle tracking can supplement the groundwater budget to show where water is flowing onshore and where water is flowing offshore. Sharp-interface approaches are also effective at estimating seawater intrusion fronts. Finally, there are model codes capable of accounting for or simulating the effects of density-driven flow in groundwater and that can simulate groundwater quality over time.

Degraded Water Quality

In basins with impaired water quality, the GSP's projects and management actions could cause impaired groundwater to flow towards municipal or other water supply wells. In these basins, the model code or codes (see Appendix A) should be capable of simulating the extent and flow direction of the impaired groundwater. This could require a model with particle tracking capabilities or a model with chemical transport capabilities. To satisfy the requirement that an open-source public domain flow model code be used for all new models under SGMA, groundwater quality will likely be simulated with open source particle tracking or transport codes that can be coupled to the flow model, such as PATH3D or MT3D.

Land Subsidence

Groundwater basins may be subject to subsidence from groundwater pumping. In these basins, the GSA should implement a model code or codes (see Appendix A) capable of accurately simulating significant groundwater level changes over time, the resulting potential for drawdown-induced subsidence, and the loss of inelastic groundwater storage due to sediment compaction. If the historical subsidence has been significant, the GSA may want to select a model code that incorporates land subsidence directly into the groundwater flow process. If the amount of historical subsidence is not significant, controlling and abating subsidence could be estimated with simpler, one-dimensional calculations that are external to the groundwater flow model.

Depletion of Interconnected Surface Water

23 CCR §354.28 (b) The description of minimum thresholds shall include the following:
(1) The information and criteria relied upon to establish and justify the minimum thresholds for each sustainability indicator. The justification for the minimum threshold shall be supported by information provided in the basin setting, and other data or models as appropriate, and qualified by uncertainty in the understanding of the basin setting.

(6) Depletions of Interconnected Surface Water. The minimum threshold for depletions of interconnected surface water shall be the rate or volume of surface water depletions caused by groundwater use that has adverse impacts on beneficial uses of the surface water and may lead to undesirable results. The minimum threshold established for depletions of interconnected surface water shall be supported by the following:

> *(A) The location, quantity, and timing of depletions of interconnected surface water.*
> *(B) A description of the groundwater and surface water model used to quantify surface water depletion. If a numerical groundwater and surface water model is not used to quantify surface water depletion, the Plan shall identify and describe an equally effective method, tool, or analytical model to accomplish the requirements of this Paragraph.*

Depletion of interconnected surface water occurs when groundwater levels decline beneath a surface water system that is hydraulically connected at any point by a continuous saturated zone between the underlying aquifer and the overlying surface water system. The pattern of surface water depletion can be complex, both spatially and temporally, depending on the characteristics of the streambed sediments and the distribution of drawdown in the underlying aquifer system. If groundwater in a basin is in hydraulic connection with the surface water system, the selected model code or codes (see Appendix A) used to evaluate basin sustainability must be capable of accurately depicting the effects of changing groundwater levels and stream stages on the resulting depletion of interconnected surface water. This objective could be met by either using a fully-integrated surface water - groundwater model, or coupling a groundwater flow model with an external set of equations or surface water model that can quantify the stream boundary conditions for use in the groundwater flow model simulations.

If a numerical groundwater and surface water model is not used to quantify surface water depletions, an equally effective method, tool, or analytical model must be identified and described in the GSP (§354.28(b)(6)(B)).

Developing Water Budgets

> *23 CCR §354.18 (e) Each Plan shall rely on the best available information and best available science to quantify the water budget for the basin in order to provide an understanding of historical and projected hydrology, water demand, water supply, land use, population, climate change, sea level rise, groundwater and surface water interaction, and subsurface groundwater flow. If a numerical groundwater and surface water model is not used to quantify and evaluate the projected water budget conditions and the potential impacts to beneficial uses and users of groundwater, the Plan shall identify and describe an equally effective method, tool, or analytical model to evaluate projected water budget conditions.*
>
> *(f) The Department shall provide the California Central Valley Groundwater-Surface Water Simulation Model (C2VSIM) and the Integrated Water Flow Model (IWFM) for use by Agencies in developing the water budget. Each Agency may choose to use a different groundwater and surface water model, pursuant to Section 352.4.*

Groundwater and surface water models are useful tools to develop water budgets as they have the ability to account for all inflows and outflows to the basin and estimate changes in storage over time. Specifically, a model can be used to predict water budgets at varying scales under future conditions and climate change, as well as with the inclusion of management scenarios. The Water Budget BMP includes more details on the development of surface water and groundwater budget and the associated required components.

If a numerical groundwater and surface water model is not used to quantify and evaluate the projected water budget conditions, an equally effective method, tool, or analytical model must be identified and described in the GSP (§354.18(e)).

Forecasting Future Conditions

One significant and important benefit of using a model is the computational ability to forecast and evaluate multiple basin conditions over time. Any modeling approach should be capable of readily simulating reductions in available surface water supplies, changes in land use and associated water demands, and the effects of climate change influencing meteorological conditions across the basin, and quantifying the uncertainty in these predictions.

Assessing Impacts of Potential GSP Projects and Management Actions

Each GSP must demonstrate how the selected projects and management actions will achieve the sustainability goal for the basin within 20 years of GSP implementation. Impacts on sustainability indicators from the various projects and management actions in a GSP can be best estimated by an appropriately developed and calibrated model. Model simulations can include a variety of potential projects and management actions, and identify those that appear to be successful at achieving the sustainability goal for the basin. Furthermore, the model simulations can demonstrate sustainability over the range of climatic patterns that may occur in the future. Simulations of future conditions, with or without projects, must include an assessment of prediction uncertainty about these simulated outcomes based on appropriate statistical analysis of parameter/boundary condition uncertainty during the sensitivity analysis and calibration process.

GSAs may additionally want to weigh a number of alternative strategies that can all achieve sustainability and identify those that can be implemented at the lowest cost. The selected model should be accurate and detailed enough to demonstrate the different impacts on various parties from proposed projects and management actions, and allow GSAs to choose among various alternative strategies. Formal groundwater management optimization routines are one type of tool that may be used, in conjunction with groundwater (or integrated hydrologic) models, to achieve this goal.

Identifying Data Gaps and Monitoring Needs

Models can help GSAs identify additional data that could reduce uncertainty in the GSP development and implementation. Models can perform a large number of simulations, each with a different set of hydrogeologic parameters, to assess: 1) which parameters have the greatest sensitivity on model estimates of key sustainability indicators, and 2) the magnitude of variability imparted in model forecasts of sustainability due to the level of uncertainty in the value of key model parameters. Results from a model's uncertainty analysis can be used to prioritize data collection activities according to which parameters are most influential on various sustainability indicators. For example, if modeling results indicate that achieving sustainability is heavily dependent on infiltration of surface water, it will be important to focus characterization activities on better understanding the rate and variability of surface water infiltration, and what actions influence these processes. In addition, focused field studies to estimate the physical values of associated model parameters, such as the streambed hydraulic conductivity for groundwater and surface water exchange, are valuable.

Uncertainty analysis can provide useful input in the following areas:

- Prioritization of data collection efforts to target key basin characteristics driving the potential for undesirable results with the goal of reducing the level of remaining uncertainty.

- The selection of a reasonable margin of operational flexibility in specifying measurable objectives, minimum thresholds, and proposed projects and management actions (allowable surface water diversions, pumping quantities, etc.).
- A platform for integrating the uncertainty of the effects of climate change and sea-level rise on sustainable basin operations.

Assessing Impacts on Adjacent Basins

Coordination of modeling efforts between adjacent basins is critical in assessing the current understanding of the basin inflows and outflows, and evaluating the potential effects from projects and management actions in one basin on adjacent basins. For example, boundary heads and flows computed by different models need to be checked for consistency. Boundary conditions and general parameter values for adjacent models are expected to be consistent. Interagency *coordination agreements*, as required under the GSP Regulations (§357.4), stress the importance of basin-wide planning and modeling. Interbasin agreements are optional, but are recommended in the GSP Regulations (§357.2) to help with establishing a consistent understanding of basin conditions across adjacent basins, and to aid in development of models with consistent assumed properties and boundary conditions. Items that may be affected and need to be coordinated among adjacent basins relate to existing undesirable results, basin sustainability goals, water budgets, minimum thresholds and measurable objectives, and general land use plans.

Model Adaptability

Modeling to support sustainable groundwater management is an ongoing effort. The initial model developed to support a sustainability assessment must be based on the best available information, the level of expert knowledge about the basin, and the *best available science* at the time of model development. As new data are collected and an improved understanding of the basin is developed over time, through either additional characterization, monitoring efforts, or both, the predictive accuracy of the model (or models) should be improved through a refinement of the underlying model assumptions (aquifer properties, stratigraphy, boundary conditions, etc.), as well as more robust calibration due to a larger database of calibration targets (groundwater levels, surface water flows, a more robust climatic dataset, etc.). The model selected to provide long-term support of a groundwater basin should be able to adapt to refined hydrogeologic interpretations and incorporate additional data.

Incorporating model adaptability allows a GSP to start with relatively simple models, and add complexity over time. It may be beneficial to initially defer to simple yet adaptable models. As the amount of information and expert knowledge about a basin increases, complexity can be added to these simple models to reduce the amount of predictive uncertainty.

Spatial Extent of the Model and Model Boundaries

A single GSP or multiple GSPs with a coordination agreement must be developed for an entire basin. Therefore, to predict whether undesirable results currently exist or may occur in the future, the model should at a minimum cover the entire basin. For some sustainability indicators, such as changing groundwater levels causing depletions of interconnected surface water, the model boundaries may need to extend beyond the basin boundary to accurately simulate the effects of pumping. Additionally, the model must be capable of evaluating whether the basin's projects and management actions adversely affect the ability of adjacent basins to implement their Plan or achieve and maintain their sustainability goals over the planning and implementation horizon. Important areas of consideration that may call for an expanded model domain are: 1) the ability to simulate the magnitude and variability in the exchange of groundwater and surface water systems between a basin of interest and adjacent groundwater basins; and 2) the ability to simulate boundary conditions that may lie outside of the basin of interest, but still have an influence on the water budget of the basin under consideration. In many cases, the model needs to be large enough to encompass the entire area affected by the GSA's groundwater activities such as pumping and recharge projects that the model is intended to assess.

Regional scale models may not always be appropriate for basin management because the model grid might be too coarse to accurately assess local sustainability indicators. However, in these cases regional scale models can be used as a basis for basin-wide models. Regional models can provide boundary conditions that can be implemented into basin-wide models. Alternatively, fine grid models can be nested into regional models. This can be done by either locally refining the mesh structure of a regional model, or using tools such as the Telescopic Mesh Refinement (TMR) or Local Grid Refinement (LGR) packages.

Data Availability

The availability of basin-specific information may influence model selection and construction. Basins with a large amount of data may support a more complex modeling platform than a basin with a paucity of available data. However, the complexity of the model should be based on the surface water and groundwater use and potential issues in the basin. Hydrologic processes that may affect SGMA undesirable results also need to be considered for model development.

Importance of Land Use Practices in Agricultural Basins

It is important that models developed for basins with significant agricultural water use be responsive to changes in agricultural practices. These changes may entail changes in crop types, irrigation practices, irrigation water source, or other changes related to land use practices. Some model codes, such as the Department Integrated Water Flow Model (IWFM) and the USGS' One Water Hydrologic Model (OWHM) explicitly simulate the effects of changing agricultural practices and surface water uses. Agricultural practices may also be addressed in model pre-processors such as GIS tools or spreadsheets for other model codes.

Model Results Presentation

Models are important tools that can aid with stakeholder engagement and common understanding of the basin, as well as the establishment of sustainable management criteria, and projects and management actions, through the presentation of outputs in graphical and mapping formats. Using model results in coordination with HCM graphical representations provides a means of communication with interested parties in the basin by providing detailed basin information. Where multiple models exist, an informed comparison to results from other models may be useful to confirm results or identify potential additional uncertainties.

Models developed for management support should provide clear information to decision makers, and must be capable of efficiently and effectively conveying simulation output in a format that is understandable by a wide variety of stakeholders with varying levels of technical expertise.

GUIs are commercially available for different types of model codes. These GUIs, in addition to other commonly used software, such as Microsoft Excel and ESRIs software, are powerful tools to help with processing data into model input formats, more efficiently run models, and provide a platform to visualize model outputs and create figures for stakeholder communication and reporting needs. These GUIs are not part of the model code itself, but are an external software that can be used to make the modeling process more streamlined. Therefore, GUIs do not fall under the "public domain and open source" definition that the model codes need to adhere to per the GSP Regulations.

THE GROUNDWATER MODELING PROCESS

Modeling depends on and reflects the judgement and experience of the groundwater modeler(s). There is no formula or discrete set of steps that will ensure that a model is accurate or reliable. However, there are recommended steps and protocols that groundwater modelers should follow. The general steps are shown graphically in **Figure 3**, and discussed below.

1. **Establish the model's purpose and objectives**. Models generally cannot reliably answer all questions about groundwater behavior. For the purposes of SGMA, the GSA should assess which sustainability indicators need to be simulated by the model (or models), and develop the model purpose to address these. GSAs should also establish protocols at this stage for where the model will be housed, how the model will be updated, and the terms of model use by various GSA members. Stakeholder input is an important component of model development; specifically, during the early planning phase of model development when the purpose and objectives of the model are being considered and near the end of the modeling process when various modeling scenarios are being considered.

2. **Collect and organize hydrogeologic data**. The amount of available data and accuracy of available data will drive the complexity and detail included in both the conceptual model and mathematical model. All GSA members should, to the degree possible, provide data of similar accuracy and completeness to ensure that the entire model reflects a similar level of data density and integrity. Raw data collected as part of the basin setting and HCM development should be organized at this stage. Once these data are organized into a database, they are processed into input files for modeling, with specific file formats as required by the chosen code. As an example, the Central Valley Hydrologic Model (CVHM) website has a framework for the organization of the raw data with links to the data sources, as well as related GIS shapefiles and CVHM input files of the processed data (http://ca.water.usgs.gov/projects/central-valley/central-valley-spatial-database.html).

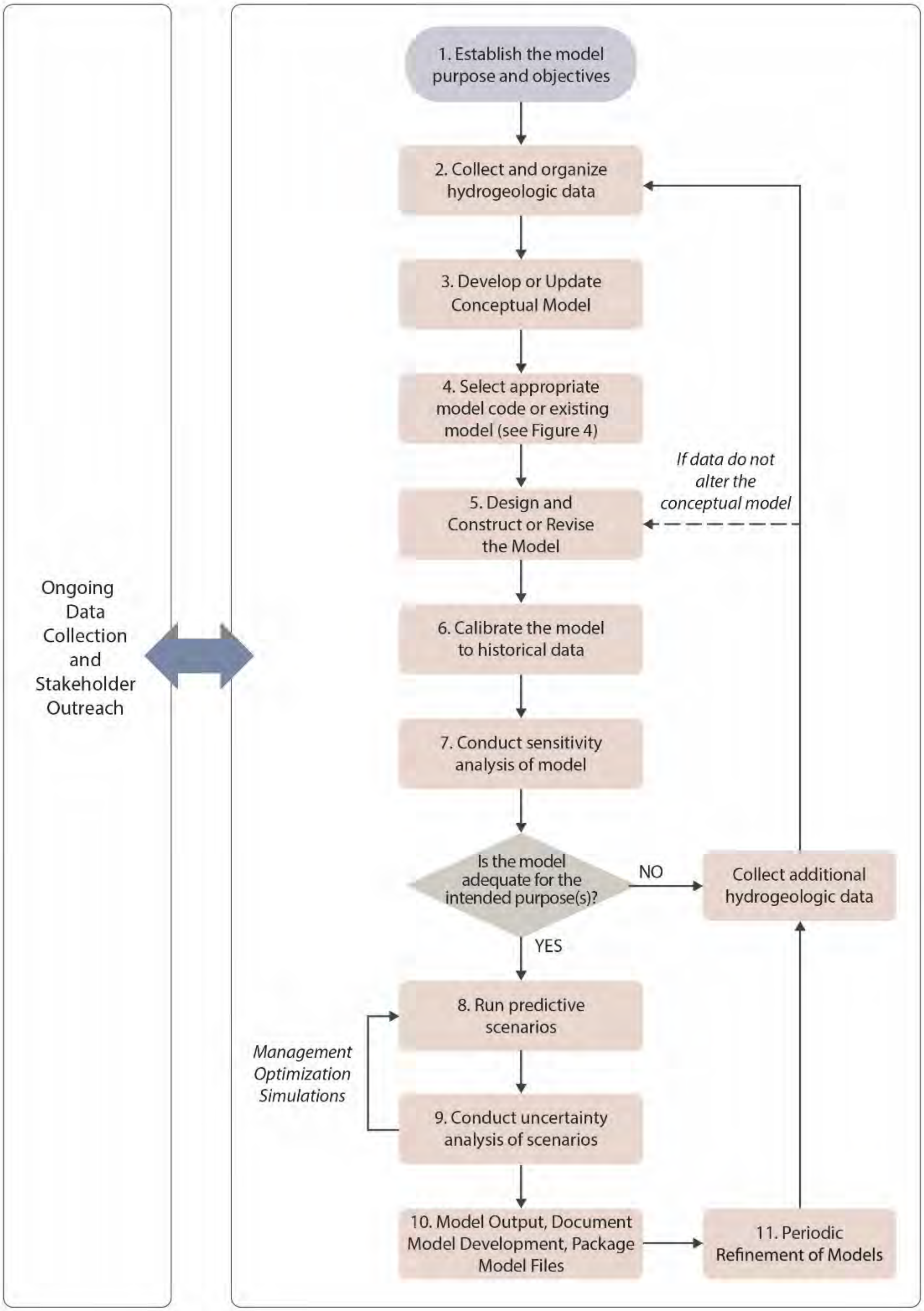

Figure 3: General Modeling Process

3. **Develop a conceptual model of the basin**. The conceptual model forms the structural, hydrogeologic, and hydrologic basis of the mathematical (analytical or numerical) model. The conceptual model identifies the key parameters of physical setting, aquifer structure and range of aquifer parameters, hydrologic processes, and boundary conditions that govern groundwater and surface water occurrence within the basin. The conceptual model provides the technical foundation of the model and an initial interpretation of a basin based on known characteristics and current management actions. In addition to aquifer characteristics and groundwater management activities, the conceptual model includes a conceptual understanding of the surface features, water uses, land uses, water management activities, and any other processes in the basin that affect surface and groundwater uses. Although a conceptual model does not necessarily include quantitative values, it should identify the range of reasonable parameter values for the aquifer materials that occur in the basin and that reflect the scale of the model. A sound and well-developed conceptual model is essential to the development of a reliable mathematical model. For more details on developing a *hydrogeologic conceptual model*, please refer to the HCM BMP.

   4. Select the appropriate model code or existing model. The selected model code or existing model must be able to simulate all the processes that might significantly influence the various sustainability indicators. However, modelers should practice pragmatism and avoid unnecessary model complexity. In many basins, there may be one or multiple existing models already in use. It is preferable to avoid competing models that perform similar functions in a single basin. The GSA should compare existing models and decide if one of these models is better suited for GSP development and implementation. If multiple models are used in a basin, GSAs should consider the potential overlap and differences between the models, and how the different model results could inform management uncertainty.

   Figure 4 provides a flowchart that may aid in the comparison and selection of an appropriate model if multiple models exist in a basin and GSAs opt to use a single model. In addition, two interactive maps of a select number of existing, available, model applications in California are available at the following links (DWR – http://www.water.ca.gov/groundwater/MAP_APP/index.cfm ; USGS – http://ca.water.usgs.gov/sustainable-groundwater-management/california-groundwater-modeling.html).

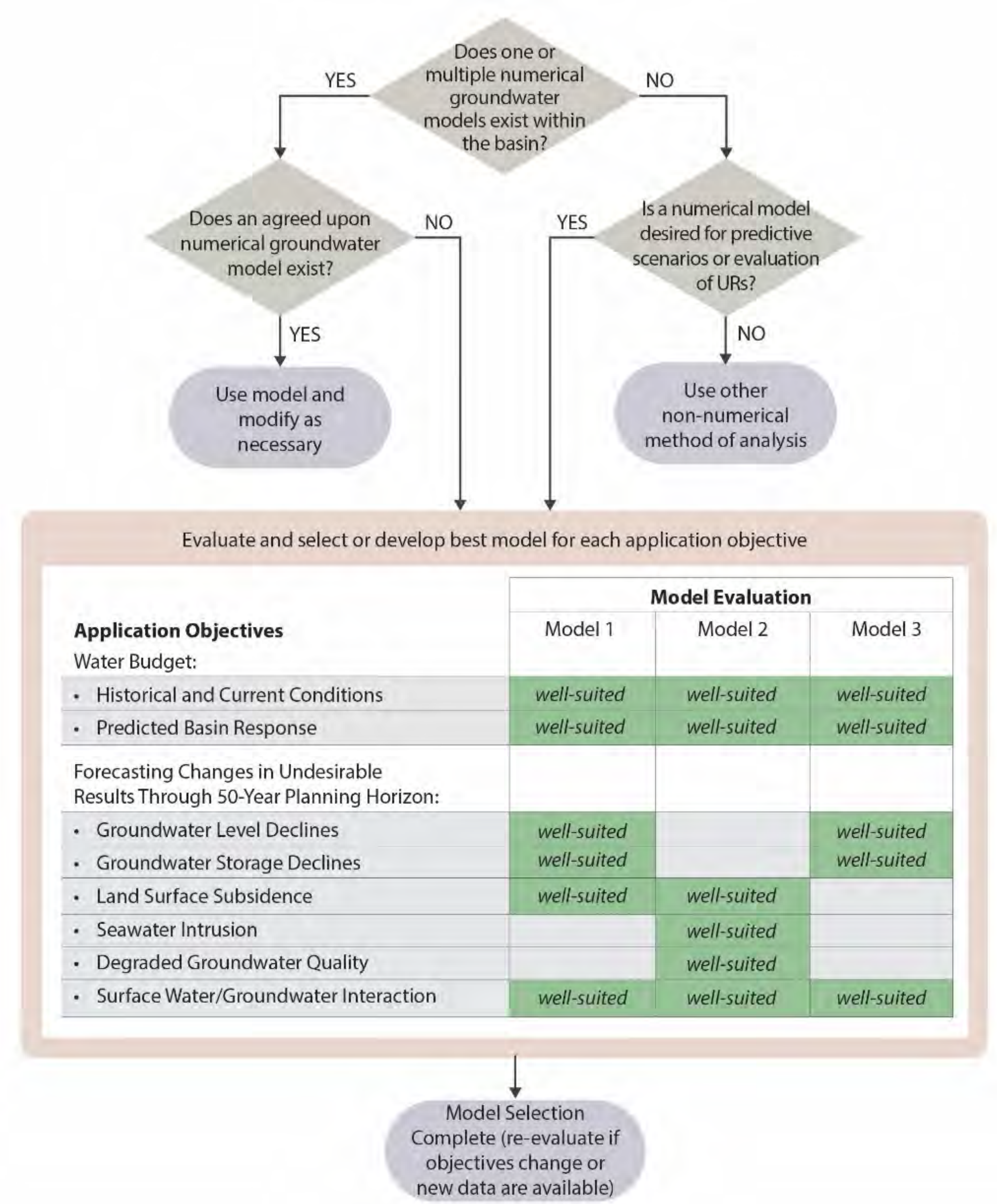

Figure 4: Generalized Model Selection Process

Note: Selected model needs to adhere to the public domain open source requirements.

5. **Design and construct (or revise) the model**. In this step, the conceptual model developed in step three is implemented in the selected model code. This step includes constructing the model grid, populating the model with hydrogeologic parameters, assigning boundary conditions, and adding water budget components to the model. Models should maintain simplicity and parsimony of hydrogeologic parameters, while simultaneously simulating the important hydrogeologic details that will drive basin sustainability.

6. **Calibrate the numerical model to historical data**. Model calibration is required by the GSP Regulations (§352.4(f)(2)). Calibration is performed to demonstrate that the model reasonably simulates known, historical conditions. Calibration generally involves iterative adjustments of various model aspects until the model results match historical observations within an agreed-to tolerance. Hydrogeologic parameters such as hydraulic conductivity, specific yield and leakance coefficients are often modified during model calibration. However, adjustment of parameter values must be constrained within the range of reasonable values for the aquifer materials identified in the conceptual model. Aspects of the water budget, such as recharge rate or private pumping rate, may also be modified during calibration.

   One of the primary values of model calibration is to identify problems in the hydrogeologic conceptual model. If a model fails to reproduce observed data, then the representation of the conceptual model in the numerical model contains inaccuracies. While the ability to achieve an acceptable calibration does not necessarily prove that a model is a good representation of the physical system, difficulties encountered during calibration can help identify areas where the conceptualization of the physical system is lacking and more data may be needed to improve the model conceptualization.

   No model is perfectly calibrated, and establishing desired calibration accuracy *a priori* is difficult. One criteria that could be considered is whether additional calibration would change a GSA's approach to achieving sustainability. If a more accurate model does not change the decision a GSA would make, then additional calibration is not necessary. The USGS has published calibration guidelines (Reilly and Harbaugh, 2004), and other modeling guidelines exist to help estimate calibration adequacy. For example, the correlation coefficient between the simulated and observed groundwater elevations, for instance, can be used as a statistic to determine how well a model is calibrated. "Generally, a value of R that is greater than 0.90 indicates that the trends in the weighted simulated values closely match those of the weighted observations" (Hill and Tiedeman, 2007).

7. **Conduct sensitivity analysis of the model.** The model calibration process typically includes or is followed by a sensitivity analysis to identify parameters or boundary conditions to which model forecasts are particularly sensitive. Parameters that are both highly sensitive and poorly constrained may be good candidates for future data collection. Sensitivity analysis provides a measure of the influence of parameter uncertainty on model predictions. By systematically varying parameter values within reasonable ranges, GSAs can assess how sensitive the calibrated model is to uncertainty in these parameters, and where future data collection efforts could be focused. This step of the modeling process can also help to determine whether the calibrated model can conduct required simulations with the desired level of accuracy.

8. **Develop and run predictive scenarios** that establish expected future conditions under varying climatic conditions, and implementing various projects and management actions. Predictive scenarios should be designed to assess whether the GSP's projects and management actions will achieve the sustainability goal, and the anticipated conditions at five-year *interim milestones*. Predictive scenarios for the GSP should demonstrate that the sustainability goal will be maintained over the 50-year planning and implementation horizon.

9. **Conduct an uncertainty analysis of the scenarios.** This is to identify the impact of parameter uncertainty on the use of the model's ability to effectively support management decisions and use the results of these analyses to identify high priority locations for expansion of monitoring networks. Predictive uncertainty analysis provides a measure of the likelihood that a reasonably constructed and calibrated model can still yield uncertain results that drive critical decisions. It is important that decision makers understand the implications of these uncertainties when developing long-term basin management strategies. As discussed in other sections of this BMP, this type of analysis can also identify high-value data gaps that should be prioritized to improve confidence in model outputs, and yield a tool that has an increased probability of providing useful information to support effective basin management decisions. A formal optimization simulation of management options may be employed, taking advantage of the predictive uncertainty analysis to minimize economic costs of future actions, while meeting regulatory requirements at an acceptable risk level.

10. **Model output, document model code and model application development, and package model files**. Model data outputs are used for GSP development and analysis of sustainability indicators and inform proposed management actions. The GSP needs to include documentation on the modeling tools used for GSP development. This documentation can be provided in the form of a technical appendix to the GSP and should include both information on the model code (i.e., referenced from user manuals) and detailed descriptions of the model application development. Model code information should include an explanation of the model code, associated mathematical equations, and assumptions, which are typically found in publicly available theoretical documentation, user instructions or manuals. This information should be referenced by the model user in their documentation of the model application. The description of the model application should include detailed information on the model conceptualization, assumptions, data inputs, boundary conditions, calibration, sensitivity and uncertainty analysis, and other applicable modeling elements such as model limitations. In addition, final model files used for decision making in the GSP should be packaged for release to the Department.

11. **Revise and refine model regularly during implementation**. After GSP development and during the implementation of the GSP, new data will be available through monitoring and collection from local agencies. As new data are made available through annual updates and the 5-year review process, models can be updated and refined. These new data will be useful for regular model updates and recalibration to reduce model uncertainties and better assess the future effects of management actions on the basin's sustainability indicators.

6. KEY DEFINITIONS

The key definitions related to surface water and groundwater modeling outlined in this BMP are provided below for reference.

SGMA Definitions (California Water Code §10721)

- "Basin" refers to a groundwater basin or subbasin identified and defined in Bulletin 118 or as modified pursuant to Chapter 3 (commencing with Section 10722).

- "Coordination agreement" means a legal agreement adopted between two or more groundwater sustainability agencies that provides the basis for coordinating multiple agencies or groundwater sustainability plans within a basin pursuant to this part.

- "Condition of long-term overdraft": The condition of a groundwater basin where the average annual amount of water extracted for a long-term period, generally 10 years or more, exceeds the long-term average annual supply of water to the basin, plus any temporary surplus. Overdraft during a period of drought is not sufficient to establish a condition of long-term overdraft if extractions and recharge are managed as necessary to ensure that reductions in groundwater levels or storage during a period of drought are offset by increases in groundwater levels or storage during other periods.

- "Groundwater" refers to water beneath the surface of the earth within the zone below the water table in which the soil is completely saturated with water, but does not include water that flows in known and definite channels.

- "Groundwater recharge" refers to the augmentation of groundwater, by natural or artificial means.

- "Planning and implementation horizon" means a 50-year time period over which a groundwater sustainability agency determines that plans and measures will be implemented in a basin to ensure that the basin is operated within its sustainable yield.

- "Sustainability goal" means the existence and implementation of one or more groundwater sustainability plans that achieve sustainable groundwater management by identifying and causing the implementation of measures targeted to ensure that the applicable basin is operated within its sustainable yield.

- "Sustainable groundwater management" means the management and use of groundwater in a manner that can be maintained during the planning and implementation horizon without causing undesirable results.

- "Sustainable yield" means the maximum quantity of water, calculated over a base period representative of long-term conditions in the basin and including any temporary surplus, that can be withdrawn annually from a groundwater supply without causing an undesirable result.

- "Undesirable result" refers to: One or more of the following effects caused by groundwater conditions occurring throughout the basin:

    1. Chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply if continued over the planning and implementation horizon. Overdraft during a period of drought is not sufficient to establish a chronic lowering of groundwater levels if extractions and recharge are managed as necessary to ensure that reductions in groundwater levels or storage during a period of drought are offset by increases in groundwater levels or storage during other periods.

    2. Significant and unreasonable reduction of groundwater storage.

    3. Significant and unreasonable seawater intrusion.

    4. Significant and unreasonable degraded water quality, including the migration of contaminant plumes that impair water supplies.

    5. Significant and unreasonable land subsidence that substantially interferes with surface land uses.

    6. Depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water.

- "Water budget" is an accounting of the total groundwater and surface water entering and leaving a basin including the changes in the amount of water stored.

- "Water year" refers to the period from October 1 through the following September 30, inclusive.

Groundwater Basin Boundaries Regulations (California Code of Regulations §341)

- "Hydrogeologic conceptual model" is a description of the geologic and hydrologic framework governing groundwater flow through and across the boundaries of a basin and the general groundwater conditions in a basin.

Groundwater Sustainability Plan Regulations (California Code of Regulations §351)

- "Basin setting" refers to the information about the physical setting, characteristics, and current conditions of the basin as described by the Agency in the hydrogeologic conceptual model, the groundwater conditions, and the water budget, pursuant to Subarticle 2 of Article 5.

- "Best available science" means the use of sufficient and credible information and data, specific to the decision being made and the time frame available for making that decision that is consistent with scientific and engineering professional standards of practice.

- "Best management practice" refers to a practice, or combination of practices, that are designed to achieve sustainable groundwater management and have been determined to be technologically and economically effective, practicable, and based on best available science.

- "Data gap" refers to a lack of information that significantly affects the understanding of the basin setting or evaluation of the efficacy of *Plan implementation*, and could limit the ability to assess whether a basin is being sustainably managed.

- "Groundwater flow" refers to the volume and direction of groundwater movement into, out of, or throughout a basin.

- "Interconnected surface water" refers to surface water that is hydraulically connected at any point by a continuous saturated zone to the underlying aquifer and the overlying surface water is not completely depleted.

- "Interim milestone" refers to a target value representing measurable groundwater conditions, in increments of five years, set by an Agency as part of a Plan.

- "Measurable objectives" refer to specific, quantifiable goals for the maintenance or improvement of specified groundwater conditions that have been included in an adopted Plan to achieve the sustainability goal for the basin.

- "Minimum threshold" refers to a numeric value for each sustainability indicator used to define undesirable results.

- "Plan implementation" refers to an Agency's exercise of the powers and authorities described in the Act, which commences after an Agency adopts and submits a Plan or Alternative to the Department and begins exercising such powers and authorities.

- "Sustainability indicator" refers to any of the effects caused by groundwater conditions occurring throughout the basin that, when significant and unreasonable, cause undesirable results, as described in Water Code Section 10721(x).

- "Uncertainty" refers to a lack of understanding of the basin setting that significantly affects an Agency's ability to develop sustainable management criteria and appropriate projects and management actions in a Plan, or to evaluate the efficacy of Plan implementation, and therefore may limit the ability to assess whether a basin is being sustainably managed.

7. Related Materials

The following links provide examples, standards, and guidance related to modeling. By providing these links, the Department neither implies approval, nor expressly approves of these documents.

STANDARDS

- ASTM D5718-95: Standard Guide for Documenting a Groundwater Flow Model Application.
- ASTM D5880-95: Standard Guide for Subsurface Flow and Transport Modelling.
- ASTM D5981-96: Standard Guide for Calibrating a Groundwater Flow Model Application.

REFERENCES FOR FURTHER GUIDANCE

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Moran, T., 2016. Projecting Forward, A framework for Groundwater Model Development Under the Sustainable Groundwater Management Act. Final Report, Stanford, Water in the West, November 2016. http://waterinthewest.stanford.edu/publications/groundwater-model-report

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Reilly, T.E., 2001. System and boundary conceptualization in groundwater flow simulation: Techniques of water resource investigations of the United States geological survey, book 3, applications of hydraulics, Chapter B8, Reston, VA, 38 p. http://pubs.usgs.gov/twri/twri-3_B8/

Reilly, T.E., and A.W. Harbaugh, 2004. Guidelines for evaluating ground-water flow models: USGS scientific investigations report 2004-5038, Reston, VA, 30 p. http://pubs.usgs.gov/sir/2004/5038/PDF.htm

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APPENDIX A - EXISTING MODEL CODES AND MODEL APPLICATIONS

There are many existing model codes and model applications being used in basins throughout the state. The Department and USGS have coordinated and compiled a table of available model codes (see Appendix A) and interactive maps displaying a select number of existing model applications in California.

- DWR: http://www.water.ca.gov/groundwater/MAP_APP/index.cfm
- USGS: http://ca.water.usgs.gov/sustainable-groundwater-management/california-groundwater-modeling.html

Currently, there are two existing, calibrated, and actively updated and maintained model applications that cover the Central Valley aquifer system. These models can be a great source of data and provide a good starting point for basins within the Central Valley that currently do not have a model. A brief description of these models is provided below. Other regional applications of these models have also been developed for specific purposes.

California Central Valley Groundwater-Surface Water Simulation Model (C2VSim)

The Department developed, maintains, and regularly updates C2VSim. It has been used for several large-scale Central Valley studies. C2VSim is an integrated numerical model based on the finite element grid IWFM that simulates the movement of water through a linked land surface, groundwater, and surface water flow systems. The C2VSim model includes monthly historical stream inflows, surface water diversions, precipitation, land use, and crop acreage data from October 1921 through September 2009. The model simulates the historical response of the Central Valley's groundwater and surface water flow system to historical stresses, and can also be used to simulate response to projected future stresses (DWR, 2016).
http://baydeltaoffice.water.ca.gov/modeling/hydrology/C2VSim/index_C2VSIM.cfm

Central Valley Hydrologic Model (CVHM)

CVHM is a three-dimensional numerical groundwater flow model developed by USGS and documented in Groundwater Availability of the Central Valley Aquifer, California (USGS, 2009). CVHM simulates groundwater and surface water flow, irrigated agriculture, and other key hydrologic processes over the Central Valley at a uniform grid-cell spacing of 1 mile on a monthly basis using data from April 1961 to September 2003. CVHM simulates surface water flows, groundwater flows, and land subsidence in response to stresses from water use and climate variability throughout the Central

Valley. It uses the MODFLOW-2000 (USGS, 2000) finite-difference groundwater flow model code combined with a module called the farm process (FMP) (USGS, 2006) to simulate irrigated agriculture. It can be used in a similar manner to C2VSim to simulate response to projected future stresses.
http://ca.water.usgs.gov/projects/central-valley/central-valley-hydrologic-model.html

Summary of Commonly Used Groundwater Model Codes in California.					
Model Code	**Description**	**Download**	**Documentation**	**Maintained by**	**Applicability to SGMA Sustainability Indicator**
IWFM	Finite-element code for integrated water resources modeling.	http://baydeltaoffice.water.ca.gov/modeling/hydrology/IWFM/	DWR, 2016. *Integrated Water Flow Model: IWFM -2015, Theoretical Documentation*, Central Valley Modeling Unit Support Branch Bay-Delta Office	DWR	Groundwater levels Storage Interconnected SW/GW Subsidence
IDC	Stand-alone executable version of IWFM root zone component (IWFM Demand Calculator).	http://baydeltaoffice.water.ca.gov/modeling/hydrology/IDC/index_IDC.cfm	DWR, 2016. *IWFM Demand Calculator: IDC-2015, Theoretical Documentation and User's Manual*, Central Valley Modeling Unit Support Branch Bay-Delta Office	DWR	Land use water budget
MODFLOW	Finite-difference groundwater flow code; several versions available with related modules.	http://water.usgs.gov/ogw/modflow/	Current core version is MODFLOW -2005: *USGS. 2005. MODFLOW-2005, The U.S. Geological Survey Modular Ground-Water Model—the Ground-Water Flow Process. USGS Techniques and Methods 6–A16*	USGS	Groundwater levels Storage Interconnected SW/GW Subsidence Seawater intrusion
MODFLOW - OWHM	MODFLOW based integrated hydrologic flow model (One Water Hydrologic Flow Model).	http://water.usgs.gov/ogw/modflow-owhm/	*USGS. 2014, One-Water Hydrologic Flow Model (MODFLOW-OWHM). U.S. Geological Survey Techniques and Methods 6-A51.*	USGS	Groundwater levels Storage Interconnected SW/GW Subsidence Seawater Intrusion

Summary of Commonly Used Groundwater Model Codes in California.					
Model Code	**Description**	**Download**	**Documentation**	**Maintained by**	**Applicability to SGMA Sustainability Indicator**
MODFLOW-USG	MODFLOW-USG: An Unstructured Grid Version of MODFLOW for Simulating Groundwater Flow and Tightly Coupled Processes Using a Control Volume Finite-Difference Formulation	http://water.usgs.gov/ogw/mfusg/	*Panday, Sorab, Langevin, C.D., Niswonger, R.G., Ibaraki, Motomu, and Hughes, J.D., 2015, MODFLOW-USG version 1.3.00: An unstructured grid version of MODFLOW for simulating groundwater flow and tightly coupled processes using a control volume finite-difference formulation: U.S. Geological Survey Software Release, 01 December 2015, http://dx.doi.org/10.5066/F7R20ZFJ*	USGS	Groundwater levels Storage Interconnected SW/GW Subsidence
GSFLOW	GSFLOW: coupled groundwater and surface-water flow model	http://water.usgs.gov/ogw/gsflow/	*Regan, R.S., Niswonger, R.G., Markstrom, S.L., Maples, S.R., and Barlow, P.M., 2016, GSFLOW version 1.2.1: Coupled Groundwater and Surface-water FLOW model: U.S. Geological Survey Software Release, 01 October 2016, http://dx.doi.org/10.5066/F7WW7FS0*	USGS	Groundwater levels Storage Interconnected SW/GW
MT3D[1]	Modular 3-D Multi-Species Transport Model for Simulation of Advection, Dispersion, and Chemical Reactions of Contaminants in Groundwater Systems. Post-processing code to MODFLOW for transport modeling.	http://hydro.geo.ua.edu/mt3d/	Zheng, Chunmiao, 2010, *MT3DMS v5.3 Supplemental User's Guide*, Technical Report to the U.S. Army Engineer Research and Development Center, Department of Geological Sciences, University of Alabama, 51 p	University of Alabama	Water quality/contaminant plumes

[1] The USGS recently updated this code and released a newer version, *MT3D-USGS: Groundwater Solute Transport Simulator for MODFLOW*. More information can be found at: http://water.usgs.gov/ogw/mt3d-usgs/

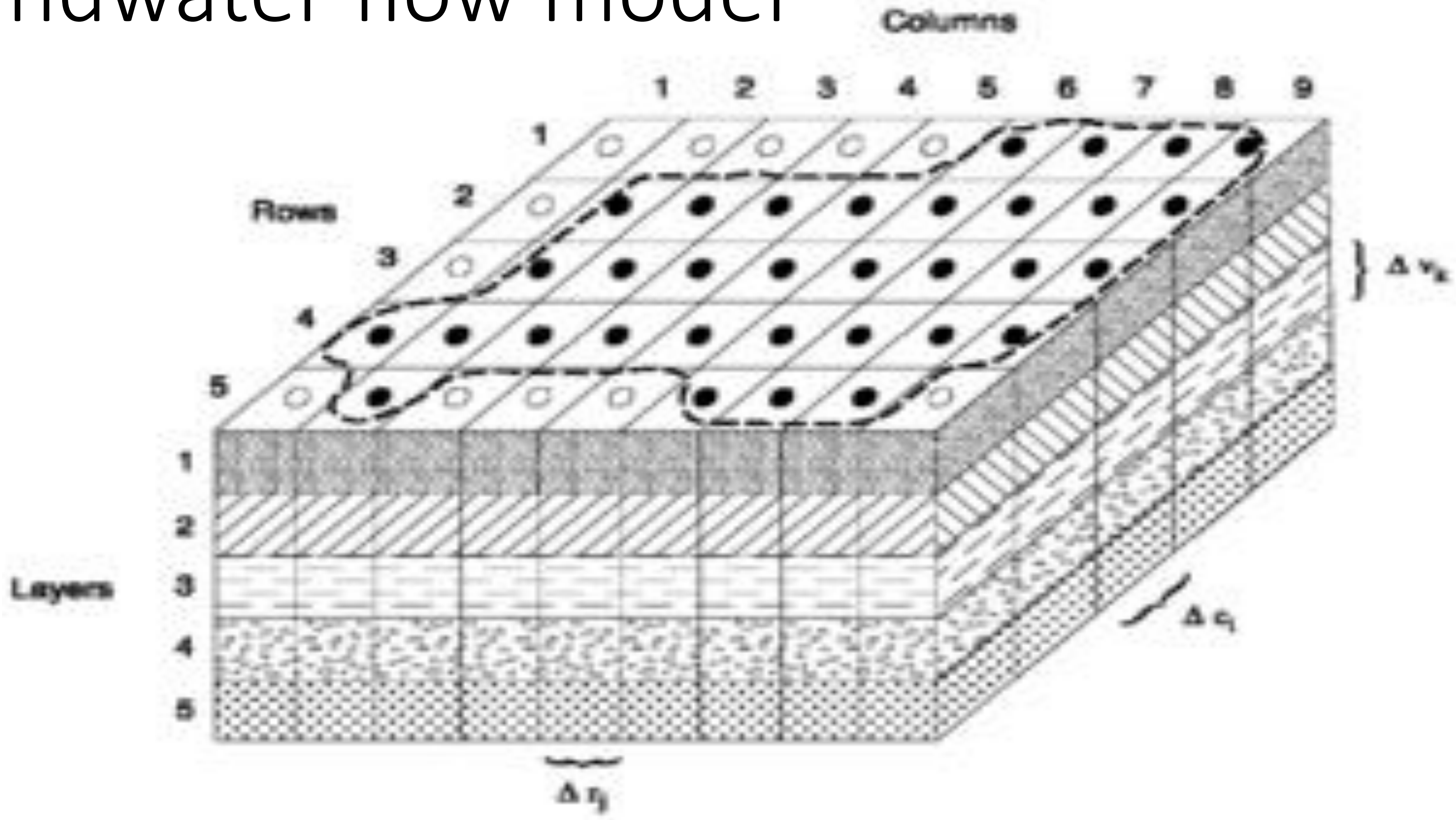
Summary of Commonly Used Groundwater Model Codes in California.					
Model Code	**Description**	**Download**	**Documentation**	**Maintained by**	**Applicability to SGMA Sustainability Indicator**
RT3D	Modular Code for Simulating Reactive Multi-species Transport in 3-Dimensional Groundwater Systems. Post-processing code to MODFLOW for transport modeling.	http://bioprocess.pnnl.gov/rt3d.downloads.htm#doc	Clement, P. T, 1997, *A Modular Computer Code for Simulating Reactive Multi-species Transport in 3-Dimensional Groundwater Systems*, Pacific Northwest National Laboratory	Pacific Northwest National Laboratory	Water quality/contaminant plumes
Path3D	A particle-tracking program for MODFLOW that can simulate advective transport	http://www.sspa.com/software/path3d	Zheng, C., 1992, *Path3D, a groundwater pass and travel time simulator*, S.S. Papadopulos & Associates, Inc..	S.S. Papadopulos & Associates	Water quality/contaminant plumes
MOD-PATH3DU	Groundwater path and travel time simulator for unstructured model grids	http://www.sspa.com/software/mod-path3du	Muffles, C, M. Tonkin, M. Ramadhan, X. Wang, C. Neville, and J.R. Craig, 2016, *Users guide for mod-PATH3DU*; a groundwater pass and travel time simulator, S.S. Papadopulos & Assoc. Inc, and the University of Waterloo.	S.S. Papadopulos & Associates	Water quality/contaminant plumes
SEAWAT	MODFLOW MT3D based model designed to simulate three-dimensional variable-density groundwater flow.	http://water.usgs.gov/ogw/seawat/	Langevin, C.D., *SEAWAT: a computer program for simulation of variable-density groundwater flow and multi-species solute and heat transport:* U.S. Geological Survey Fact Sheet FS 2009-3047, 2 p.	USGS	Seawater intrusion

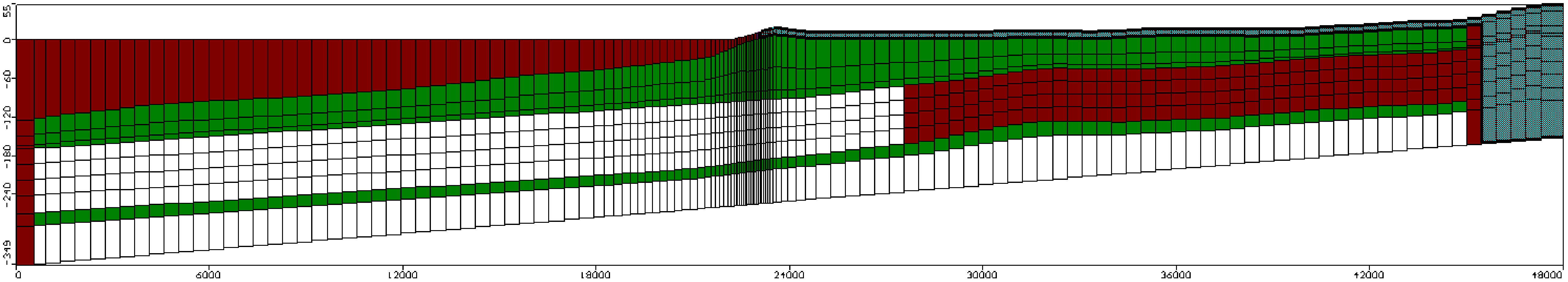
Summary of Commonly Used Groundwater Model Codes in California.					
Model Code	**Description**	**Download**	**Documentation**	**Maintained by**	**Applicability to SGMA Sustainability Indicator**
MODPATH	Particle-Tracking post-processing tool for MODFLOW.	http://water.usgs.gov/ogw/modpath/	*USGS. 2012, User guide for MODPATH version 6—A particle-tracking model for MODFLOW: U.S. Geological Survey Techniques and Methods, book 6, chap. A41*	USGS	Groundwater flow path tracking for groundwater quality, Seawater intrusion, and other flow-related processes
INFIL 3.0	Watershed model to estimate net infiltration below the root zone.	http://water.usgs.gov/nrp/gwsoftware/Infil/Infil.html	U.S. Geological Survey, 2008, Documentation of computer program INFIL3.0-A distributed-parameter watershed model to estimate net infiltration below the root zone: U.S. Geological Survey Scientific Investigations Report 2008-5006.	USGS	

Notes:

- Additional DWR modeling tools and resources are available at: http://www.water.ca.gov/groundwater/sgm/index.cfm and http://baydeltaoffice.water.ca.gov/modeling/
- Additional USGS modeling tools and resources are available at: http://water.usgs.gov/software/lists/groundwater
- This list does not contain all available models in California and there are model codes in use in California that are currently proprietary (such as MicroFem, MODFLOW-Surfact, MODHMS) but may be allowed if the model applications were developed and used prior to the effective date of the GSP Regulations.

Groundwater flow model





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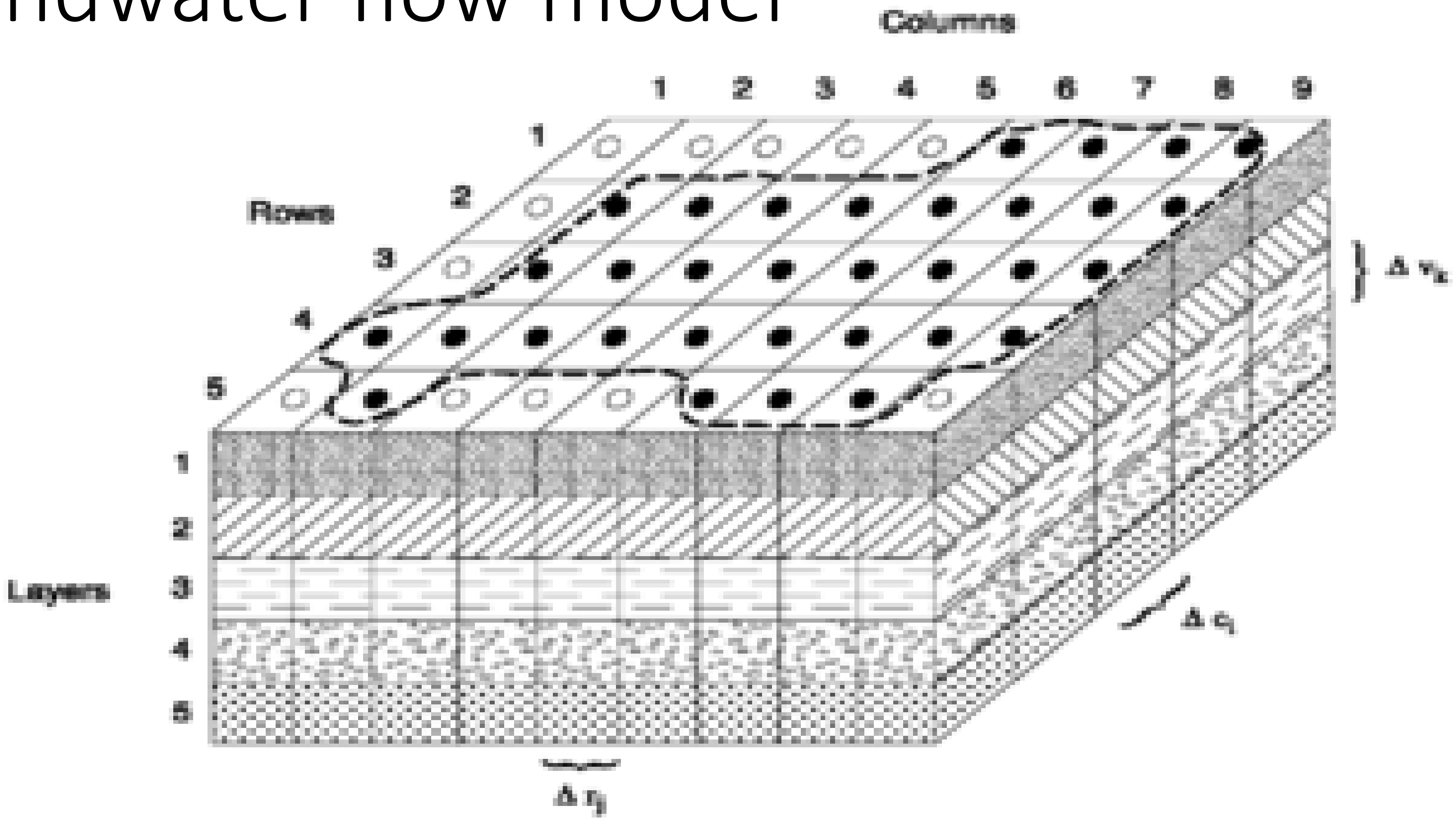
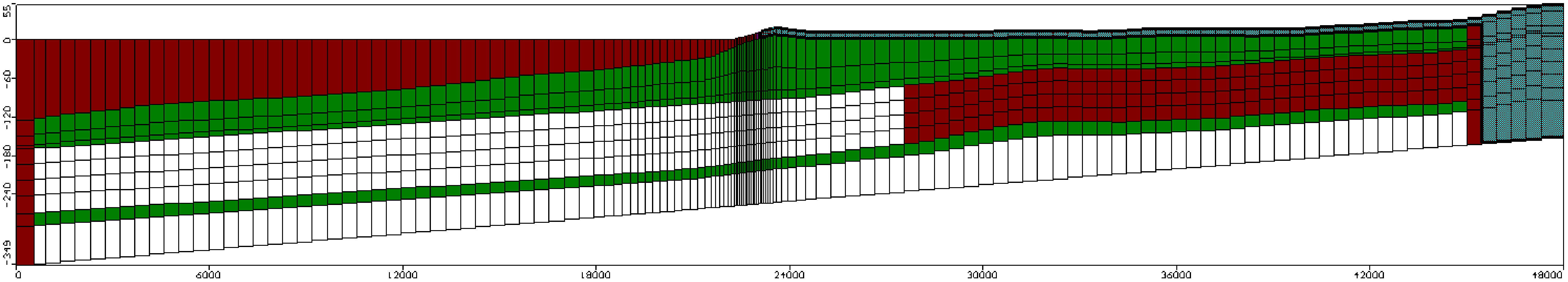
Scientific Process

- Question – feasible?

- Model -> hypothesis
- Test hypothesis – collect data

Groundwater flow model

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Scientific Process

- Question – feasible?

- Model -> hypothesis
- Test hypothesis – collect data

AN ASSESSMENT OF THE REPORTS ON THE PROPOSED HUNTINGTON-POSEIDON SEAWATER DESALINATION PROJECT PREPARED BY THE INDEPENDENT SCIENTIFIC TECHNICAL ADVISORY PANEL

PROFESSOR MICHAEL HANEMANN

University of California, Berkeley

Arizona State University

June 16, 2018

EXECUTIVE SUMMARY

I was asked by California Coastkeeper Alliance to review reports prepared by the Independent Scientific Technical Advisory Panel (ISTAP) convened by CONCUR, Inc. to analyze the technical and economic feasibility of sub-surface intakes for the proposed Huntington-Poseidon Seawater Desalination project. The purpose of this report is to comment on whether or not the ISTAP reports are satisfactory for meeting California regulations for new seawater desalination facilities.

While the ISTAP panels indicated that their analyses were not intended to constitute a regulatory compliance report, the Phase 1 and Phase 2 reports were included in the project permit application. The ISTAP reports are being relied upon by the Applicant as evidence that sub-surface intakes are neither technically nor economically feasible, making the Poseidon project eligible for an exemption to the regulatory preference compelling the use of sub-surface intakes. Hence the need for an independent review.

After reviewing the relevant regulations and policies, as well as the ISTAP reports and other relevant studies, I have concluded as follows:

- The ISTAP Phase 1 report erred in finding that slant wells are not technically feasible for the proposed facility;

- The ISTAP Phase 2 report did not adequately demonstrate that sub-surface intakes are not economically feasible for the proposed facility;

- Further, because the Phase 1 report erred in dismissing slant wells, the Phase 2 report lacked any analysis of the economic feasibility of slant wells and or similar subsurface technologies. The lack of an economic analyses of slant wells is a significant flaw because the construction cost of slant wells is lower than that of the Seawater Infiltration Galleries analyzed in the ISTAP Phase 2 report. Other desalination projects in California proposing to use slant wells have shown that technical risks with slant wells can potentially be mitigated and that there would be significant savings in the costs of operation and maintenance compared to the screened open ocean intakes proposed for the Huntington-Poseidon project.

I have concluded that the ISTAP Phase 1 and Phase 2 reports are inadequate for showing that slant wells are neither technically nor economically feasible according to the requirements set forth in the Ocean Desalination Amendment to the California Water Quality Control Plan for Ocean Water.

1. INTRODUCTION

I was asked by the California Coastkeeper Alliance to review the Phase 1 and Phase 2 reports produced by the Independent Scientific Technical Advisory Panel (ISTAP) convened and facilitated by CONCUR, Inc. with regard to the feasibility of subsurface intake designs for the proposed Poseidon Water Desalination Facility at Huntington Beach, California (the Poseidon plant). Those reports were prepared between June and September 2014 (Phase 1 Report) and between December 2014 and August 2015 (Phase 2 Report). While the ISTAP reports were being prepared, the California State Water Resources Control Board (SWRCB, State Water Board) was in the process of preparing an amendment to the California Water Quality Control Plan for Ocean Water to address desalination facilities. SWRCB staff released a Draft Amendment and Staff Report/Substitute Environmental Document (SR/SED) on July 3, 2014 and a Draft Final Amendment and SR/SED on April 24, 2015. SWRCB adopted the Ocean Desalination Amendment on May 6, 2015.

As an economist with experience in the analysis of water projects and water policy, I have assessed how well the ISTAP analysis comports with the requirements set forth in the Ocean Desalination Amendment.

Among other items, III.M.2.d.(1)(a) of the Amendment states that "the regional [water quality control] board in consultation with State Water Board staff shall require subsurface intakes unless it determines that subsurface intakes are not feasible based upon a comparative analysis of the factors listed below for surface and subsurface intakes." Taken in combination, the ISTAP reports concluded that subsurface intakes are not feasible for the Poseidon plant.

I was asked to assess whether the ISTAP analysis adequately demonstrates that the Poseidon plant should be exempted from SWRCB's stated preference for a subsurface intake for a new ocean desalination facility to meet State law requiring these facilities to minimize the intake and mortality of marine life. This report sets forth my conclusions and the reasons for them.

In preparing this report, I read both ISTAP reports[1] and both the 2014 and 2015 SWRCB SR/SED reports,[2] as well as the final adopted Ocean Desalination Amendment.[3] I reviewed numerous reports detailing the technical and economic viability of subsurface intakes. I also read three appendices prepared for me by California Coastkeeper Alliance.[4]

2. BEST AVAILABLE SITE, BEST AVAILABLE DESIGN, BEST AVAILABLE TECHNOLOGY

Article III.M.2.a(2) of the 2015 Ocean Amendment states: "The regional water board shall conduct a Water Code section 13142.5(b) analysis of all new and expanded desalination facilities. … The regional water board shall first analyze separately as independent considerations a range of feasible alternatives for the best available site, the best available design, the best available technology, and the best available mitigation measures to minimize intake and mortality of all forms of marine life. Then, the regional water board shall consider all four factors collectively and determine the best combination of feasible alternatives to minimize intake and mortality of all forms of marine life."

Another article, III.M.2.b(2), requires the owner or operator of a new facility to: "Consider whether the identified need for desalinated water is consistent with an applicable adopted urban water management plan prepared in accordance with Water Code section 10631, or if no urban water management plan is available, other water planning documents such as a county general plan or integrated regional water management plan." Furthermore, article III.M.2.d.(1)(a) states in part: "A design capacity in excess of the identified regional water need for desalinated water shall not be used by itself to declare subsurface intakes as infeasible."

Based on my understanding of the history of the Poseidon project as recounted in the ISTAP Phase I (pp. 5-9), it does not appear that the site and size of the Poseidon facility were subjected in either ISTAP Phase 1 or Phase 2 reviews to the analysis called for in the 2015 Ocean Amendment.

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[1] *Final Report: Technical Feasibility of Subsurface Intake Designs for the Proposed Poseidon Water Desalination Facility at Huntington Beach, California*, October 8, 2014 (ISTAP 1). *Phase 2 Report: Feasibility of Subsurface Intake Designs for the Proposed Poseidon Water Desalination Facility at Huntington Beach, California*, November 9, 2015 (ISTAP 2).

[2] *Draft Staff Report Including the Draft Substitute Environmental Documentation, Amendment to the Water Quality Control Plan for Ocean Waters of California Addressing Desalination Facility Intakes, Brine Discharge, and the Incorporation of other Non-Substantive Changes,* July 3, 2014 (Draft Staff Report). *Final Staff Report Including the Draft Substitute Environmental Documentation, Amendment to the Water Quality Control Plan for Ocean Waters of California Addressing Desalination Facility Intakes, Brine Discharge, and the Incorporation of other Non-Substantive Changes,* May 6, 2015 (Final Staff Report).

[3] State Water Resources Control Board, *Water Quality Control Plan Ocean Waters of California 2015* (2015 Ocean Amendment).

[4] The appendices are: *Cost Savings from Avoiding Pretreatment*; *Flawed Reliability Premium*; and *Cost of Slant Wells*.

In 1998, around the time that it had put together the proposal to Tampa Bay Water for a 25 mgd desalination facility in Florida, Poseidon developed a proposal for two 50 mgd desalination plants at Carlsbad, in San Diego County,[5] and at Huntington Beach.[6] Both projects were sited with the expressed purpose of co-locating with coastal power plants in order to take advantage of the cooling water intake and discharge systems – systems that are now being abandoned to minimize the intake and mortality of marine life for cooling purposes. A lease of the property on the power plant site for the proposed Huntington Beach project was acquired in 2001, and Poseidon submitted a coastal development permit application in 2002.

Thus, rather than emerging as the outcome of a selection process which identified them as the best alternative in order to minimize the intake and mortality of marine life, the site and scale of the Huntington Beach proposal have been a fixed datum since the project's inception twenty years ago.

Moreover, the scale was not justified on the basis of analysis in an urban water management plan. The 50 mgd scale of the Huntington Beach facility was not chosen because the need for expensive, drought-proof water in Orange County is exactly the same as the need in San Diego County where Poseidon's other 50 mgd plant is located. In fact, Orange County overlies a large groundwater basin allowing the water agencies many alternatives for reliable water supplies that are not available in San Diego County where there is limited groundwater storage availability. Moreover, since 2002 when Poseidon first applied for Coastal Development Permit, total demand for water in Orange County has gone down[7] and alternative sources of water supply have become available.

In short, the 50 mgd scale of the Huntington Beach facility was a pre-determined decision made without the identification of any discrete need for 50 mgd of supplemental water in any Urban Water Management Plan from 2002 through the most recent plan adopted for 2015.

The Draft Staff report for the Ocean Plan Amendment contained an earlier version of article III.M.2.b(2). The earlier version required the owner or operator of a new desalination facility to:[8] "Consider whether the identified regional need for desalinated water identified is consistent with any applicable general or coordinated plan for the development, utilization or conservation of the water resources of the state, such as a county general plan, an integrated regional water management plan or an urban water management plan. A design capacity in excess of the identified regional water need for desalinated water shall not be used by itself to declare subsurface intakes as infeasible."

In comments submitted on August 15, 2014, the Municipal Water District of Orange County (MWDOC) objected to this provision, stating:[9] "This determination is beyond the scope of the

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[5] https://www.water-technology.net/projects/carlsbaddesalination/

[6] https://www.water-technology.net/projects/huntington-beach-desalination-california/

[7] *See* James Fryer, A Review of Water Demand Forecasts for the Orange County Water District (July 2016).

[8] Article 2.b.(1).

[9] Final Staff Report, Appendix H, Comment 6.3, page H-12, 13.

statutory requirement under Section 13142.5 and is not part of the determination of the best available site. We don't see a need for this in the Ocean Plan. …. We are recommending that this provision be deleted since it is not a specified part of a Water Quality Control Plan and is not relevant to the regulation of intakes and brine disposal."

That argument was rejected by SWRCB staff. The staff responded:[10] "Subsurface intakes should be used to the maximum extent feasible. The intent of the language is to ensure that if there is a situation where an Urban Water Management Plan identified a need for 10 MGD of desalinated water, but only 9 MGD could be acquired through subsurface intakes, the regional water board would not automatically reject subsurface intakes as an option. Instead, the regional water board could require the use of subsurface intakes for the 9 MGD and find an alternative means for acquiring the other 1 MGD. The alternative means that 1 MGD could include withdrawing water through a screened surface intake or seeking out other water supply options like recycled water."

The staff went on to observe that: "several parties have commented that large infiltration galleries may not be technically feasible to operate. Some parties have expressed concern that facilities will be proposed that far exceed the reasonable water supply needs of a community in order to "game" the results of the feasibility analysis to allow the project proponent to reject the amendment's preferred intake technology of subsurface intakes in order to avoid potential construction costs."

Whether intentionally or not, the a priori specification of a 50 mgd scale facility without consideration of alternative, smaller scales, may indeed have performed the function of "gaming" the Ocean Amendment amendment process by providing an excuse to declare an otherwise feasible subsurface intake technology as not feasible for the Huntington Beach facility.

To summarize, prior to adoption of the Ocean Plan Amendment sections III.M.2.b(2) and III.M.2.d.(1)(a), there was no requirement for a permit applicant to document a need for the volume of seawater withdrawn and potable water produced. As explained in the Final Staff Report response to comments, this remains true if the applicant is requesting a permit to construct and operate a facility using a subsurface intake. But, if the applicant is requesting a permit for a facility using an open ocean intake, the applicant must document a demand for the volume of product water that could not be met with alternative sources (eg, "other water supply options like recycled water") and/or a combination of subsurface and open ocean intakes.[11] The ISTAP reports did not meet this requirement. They did not address the question of whether there was a documented need for 50 mgd of water from a seawater desalination facility that could not be met with alternative sources.

[10] Final Staff Report, p. H-13.

[11] Final Staff Report, pp. H-12 and H-13.

3. TECHNICAL FEASIBILITY

The ISTAP Phase 1 report was intended to assess the technical feasibility of alternative subsurface intake designs for the Huntington Beach facility. That report evaluated nine types of subsurface intakes for technical feasibility at the Huntington Beach site. It concluded that only two of the nine designs -- seabed infiltration gallery and beach infiltration gallery -- were technically feasible.

However, the definition of technical feasibility employed in ISTAP Phase 1 differs in two significant ways from that used in the 2015 Ocean Amendment.

In article 2.d.(1)(a)(i), the Draft Staff Report specified the following criteria for determining the feasibility of subsurface intakes:

geotechnical data,
hydrogeology,
benthic topography,
oceanographic conditions,
presence of sensitive habitats,
presence of sensitive species,
energy use,
impact on freshwater aquifers,
local water supply, and existing water users,
desalinated water conveyance,
existing infrastructure,
co-location with sources of dilution water,
design constraints (engineering, constructability), and
project life cycle cost.

These criteria were modified in the Final Staff Report and the 2015 Ocean Amendment as adopted. The final list, article 2.d.(1)(a)(i), specifies the criteria for determining the feasibility of subsurface intake as:

geotechnical data,
hydrogeology,
benthic topography,
oceanographic conditions,
presence of sensitive habitats,
presence of sensitive species,
energy use for the entire facility,
design constraints (engineering, constructability), and
project life cycle cost.

The criteria relating to impact on freshwater aquifers, local water supply, and existing water users, desalinated water conveyance, existing infrastructure, and co-location with sources of dilution water were omitted in the final Amendment.

The criteria for technical feasibility used by ISTAP Phase 1 differ from those in the final Amendment in two important ways.

First, ISTAP Phase 1 included impact on freshwater aquifers as a criterion of technical feasibility. The factors considered in ISTAP Phase 1 were given (pp. 23-24) as:

geotechnical data,
hydrogeology,
benthic topography,
oceanographic conditions,
impact on freshwater aquifers, and
design constraints (engineering, constructability).

Thus, for example, ISTAP Phase 1 rejects slant wells as an option because they "would draw large volumes of water from the Orange County Groundwater Basin, which in itself is considered a fatal flaw" (p. 56).

From my perspective as an economist, this is not a valid criterion of technical feasibility – it is an economic consideration. Suppose, for the sake of argument, that a desalination facility with subsurface slant-wells pumps 100 mgd for a usable supply of 50 mgd of desalinated water, and suppose that a fraction, θ, of the amount pumped actually originates from the freshwater aquifer. Then, when 100 mgd of seawater is pumped, the *net* additional supply of usable water obtained is $(0.5-\theta)*100$ mgd instead of $0.5*100 = 50$ mgd. Suppose that 5% of the amount pumped with the slant-wells originates from the freshwater aquifer ($\theta = 0.05$).[12] Then each mgd of water seawater pumped for "source water" generates a net "product water" supply of 0.45 mgd instead of 0.5 mgd. The main significance of this adjustment is that it raises the unit cost of the water supplied.

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[12] An independent report by Hydrofocus, *Huntington Beach Seawater Desalination Facility Groundwater Model Evaluation*, September 23, 2016 presents a preliminary estimate that $\theta = 0.04$. The Hydrofocus report found that a wide range of potential drawdown volumes were dependent upon the variables used in computer modeling.It recommended utilizing test wells to verify the computer modeling. The report "identified model limitations and uncertainty that affect the ability of the model to accurately predict impacts of project pumping. The model was not calibrated or verified using observed water level data." The report went on to recommend "(1) aquifer tests to determine properties of the Talbert Aquifer, the overlying sediments, and the wetland sediments; (2) an assessment of the effects of the lateral model boundaries; (3) correction of inconsistencies in model construction; (4) calibration/verification using water level data; and (5) incorporation of the US Geological Survey MODFLOW Subsidence Package to preliminarily evaluate the subsidence potential due to slant well pumping." Only then can the improved model "be used to more effectively simulate potential impacts and project feasibility."

The unit cost of the deasalinated water supply needs to be adjusted to reflect the drawdown of aquifer water. Suppose the cost had been estimated at $2,000 per acre-foot ignoring the drawdown of aquifer water. With the drawdown of aquifer water, the true cost per acre-foot of additional supply from desalination becomes $2000*\frac{0.5}{0.5-\theta}=2000*\frac{0.5}{0.45}=2222.$

The drawdown of aquifer water is a factor that increases the effective cost per mgd supplied via desalination using a slant-well intake but, by itself, it does not constitute a "fatal flaw." This may be why SWRCB dropped "impact on freshwater aquifer" from its criteria for technical feasibility.

Further, ISTAP Phase 1 applies a second criterion for technical feasibility that is also not endorsed by SWRCB. The report states (p. 11): "For the Phase 1 Report, the working definition of "Technical Feasibility" was specified in the expert contract documents as: "Able to be built and operated using currently available methods." Thus, an additional reason adduced by the report for declaring a slant-well subsurface intake to be technically infeasible was the following (p. 56):

"The performance risk is considered medium, as the dual-rotary drilling method used to construct the wells is a long-established technology, but there is very little data on the long-term reliability of the wells. Maintainability is also a critical unknown issue."

That argument is questionable. The 2015 Ocean Amendment declares a policy preference for the use of a subsurface intake for desalination, a requirement that did not previously exist.[13] It is not a valid response to say, in effect: "There is not a lot of experience with this technology therefore it should be declared infeasible." A correct response, instead, is to conduct the appropriate testing – as has been done elsewhere in California.

In fact, as evidenced by the CalAm-Monterey and Doheny desalination project proposals, slant well intakes *are* considered "technically feasible" regardless of the potential drawdown of inland waters.[14] Clearly the industry disagrees with the ISTAP finding on the feasibility of slant wells based on performance risks, as witnessed by designed and tested proposals to use slant wells for the Doheny and CalAm-Monterey projects.

4. ECONOMIC FEASIBILITY

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[13] As the SWRCB staff notes in the *Final Staff Report* (p. H-287), the proposed Desalination Amendment "does not take a technology neutral approach for intakes."

[14] See *Hydrogeologic Working Group, Monterey Peninsula Water Supply Project – HWG Hydrogeologic Investigation Technical Report* (Nov. 6, 2017); available at https://docs.wixstatic.com/ugd/28b094_e3255ac3069c4b6b83bce80604ae6703.pdf; see Municipal Water District of Orange County, *Final Summary Report Doheny Ocean Desalination Project Phase 3 Investigation* (January 2014); available at http://docplayer.net/46522220-Final-summary-report-doheny-ocean-desalination-project-phase-3-investigation.html; and see http://www.mwdh2o.com/FAF%20PDFs/10_MWDOC_SlantWell_FactSheet.pdf.

The 2015 Ocean Amendment defines *feasible* thus: “For the purposes of Chapter III.M, [feasible] shall mean capable of being accomplished in a successful manner within a reasonable period of time, taking into account economic, environmental, social and technological factors” (p. 54).

Article III.M.2.d.(1)(a)I of the Amendment states: “Subsurface intakes shall not be determined to be economically infeasible solely because subsurface intakes may be more expensive than surface intakes. Subsurface intakes may be determined to be economically infeasible if the additional costs or lost profitability associated with subsurface intakes, as compared to surface intakes, would render the desalination facility not economically viable.”

In their response to comments received, the SWRCB noted: “The fact that an alternative may be more expensive or less profitable is not sufficient to show that the alternative is financially infeasible. What is required is evidence that the additional costs or lost profitability are sufficiently severe as to render it impractical to proceed with the project.”[15]

As an economist, I would argue that reasonableness in a water purchase agreement requires some form of a cost-benefit test. Whether or not an item is economically practical surely can be determined only by reference to the benefit that it generates, and by how those who receive the benefit value it. One cannot meaningfully decide that an item is too costly without also considering its benefit. Too costly relative to what? $20,000 may be an unreasonably high cost for a skate-board, but not for an SUV. A purely cost-based determination without reference to benefit is neither rational nor reasonable.

The ISTAP Phase 2 Report interprets the criterion for the economic viability of an intake technology as an amount “that OCWD might be willing to pay for the water supplied” by the proposed Poseidon facility.[16] From an economic perspective, that interpretation is very problematic.

The mere fact that OCWD states it is unwilling to pay for a subsurface intake for the proposed Huntington Beach facility is not, by itself, a meaningful demonstration of economic non-viability. One has to know what factors were being taken into consideration when the economic viability was being assessed by OCWD.

Two factors are surely relevant: (1) The reliability premium -- the economic value of the heightened reliability associated with desalinated water compared to other sources of water supply for Orange County. And (2) the economic value of the environmental damage avoided when a subsurface intake is used instead of an open ocean intake. There is no evidence that either factor was properly considered by OCWD or by the ISTAP reviews.

[15] Final Staff Report, p. H-241, comment 15.92; p. J-70, comment 12.7.

[16] ISTAP 2, p. 13.

The ISTAP Phase 2 Report states (p. 13) that it evaluated the price that OCWD might be willing to pay for water from the Poseidon facility "using OCWD's Water Purchase Agreement Term Sheet with Poseidon … as a starting point and assessing the change in that price over time with appropriate escalation factors." It elaborates: "We based the OCWD water price on the amount that OCWD will likely have to pay for water supplied by the Metropolitan Water District (MWD) of Southern California in the future (which OCWD would rely on in the absence of the desalination facility). On top of this price, we have factored in a subsidy that MWD provides local communities for developing local water supplies, as well as a premium that OCWD has indicated it is willing to pay for the increased water supply reliability that the desalination plant will provide."

The ISTAP Phase 2 Report states (p. 60): "Consistent with our understanding of the ongoing contract discussions, in our projections we assume that the reliability premium amounts to 20% of MWD's Tier 1 water price for 10 years after construction. The premium drops to 15% of the Tier 1 price for the next 10 years, to 10% for 10 more years, to 5% for ten years, and then finally to 0%."

I have two comments on this calculation.

First, if this calculation were intended as an estimate of the reliability premium associated with a drought-proof water supply from desalination, it entirely lacks foundation. Where does the 20% premium come from? Why is the premium not 40%? Or, 17%? The value used for the reliability premium appears to be an after-the-fact justification for the cost of seawater desalination, not a meaningful analysis of the final customers' willingness to pay for additional reliability.

Secondly, these estimates have no credibility as a reliability premium. Why would the economic value of increased reliability for water supply in Southern California *decline* over time, having a lower value in 2030-2039 than in 2020-2029, a lower value still in 2040-2049, etc., and zero value from 2060 onwards? The population of Southern California will be growing over time, and global warming will be reducing Southern California's effective surface water supply in 2040 or 2060 compared to the present. It is implausible to presume the projected economic value of increased reliability in Orange County's water supply will decline over the next 40 years and will be zero from 2060 onwards.

There is a technically correct way to estimate the value of a more reliable source of water supply for OCWD as compared to a less reliable source of supply. It would involve three general components.

First, one has to measure the change in the overall reliability of OCWD's water supply portfolio with desalinated water from Huntington Beach versus without it. This would be based on (i) assumptions as to the composition of OCWD's water supply portfolio in 2020-2029, 2030-2039, 2040-2049, etc., with and without the supply from Poseidon, and (ii) probabilistic forecasts of the changed occurrence of shortage (i.e., projected annual demand exceeds projected annual supply) during those time periods, with desalinated water in the supply portfolio versus without.

Second, one has to calculate the loss of economic value associated with the occurrence of shortages in the time periods.

Third, one has to estimate the risk aversion premium that water users potentially affected by the shortage (e.g., water users subjected to rationing) would be willing to pay to reduce or avoid this risk.

I myself conducted the first two elements of this type of analysis in a study for the California Energy Commission in 2006. That study assessed the economic loss for urban water users in Southern California under a climate change scenario.[17] In a paper published in 2016, I conducted all three elements of this type of analysis, including forming an estimate of the risk aversion premium for Central Valley agricultural water users (i.e., estimating what they might be willing to pay to avoid the increased risk of economic loss due the reduction in their water supply under a scenario of climate change).[18]

In the case of Huntington Beach, Peer Swan has presented an example of the type of economic analysis that needs to be conducted.[19] By contrast, the ISTAP Phase 2 Report is deficient precisely because it failed to perform any such an analysis.[20] Because it did not perform a correct economic analysis of the reliability value, the ISTAP Phase 2 analysis cannot be taken as evidence that a subsurface intake would not be economically feasible for the proposed facility.

If the Poseidon facility at Huntington Beach had a subsurface intake it would likely provide water at a lower cost than one with an open ocean intake. But, would it be economically viable? Because the necessary economic analysis is lacking in the ISTAP reports, it is an open question in my mind whether such a facility would be economically viable, let alone optimal. There are too many unanswered questions.

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[17] Michael Hanemann et al., *The Economic Cost of Climate Change Impacts on California Water: A Scenario Analysis*. California Climate Change Center at U.C. Berkeley, Working Paper 06-01, January 2006.

[18] Michael Hanemann et al., The Downside Risk of Climate Change in California's Central Valley Agricultural Sector, *Climatic Change* (2016) 137: 15-27.

[19] For further details of Swan's analysis see California Coastkeeper Alliance's *Appendix 2 Flawed Reliability Premium*. Swan's analysis lacks the third element noted above -- the possible risk aversion premium that water users in Orange County might be willing to pay.

[20] In a memorandum *Reliability Benefits in OC from the Poseidon Project*, dated July 7, 2015, MWDOC staff implicitly acknowledged the validity of the type of analysis conducted by Per Swan and recommended here. The memo stated:"If [MWD] is reliable, say 8 or 9 years out of 10, this means OC [Orange County] would only need Poseidon water 1 or 2 years out of 10. However, ocean desalination projects generally cannot be effectively operated only a few years out of 10 as the financial allocaiton of capital costs to the smaller volume of water produced yields extremely expensive water. … However, if [MWD] is much less reliable, maybe only 1 or 2 years out of 10, the argument in support of the Poseidon Project makes better sense and OC would receive a greater return on investment" (page 8).

It is not obvious just how much a 50 mgd facility, rather than a smaller one, is needed. There are other potential sources of supply for Orange County that would be cheaper. It is not clear just how much the facility as planned with OCWD would actually improve the reliability of Orange County's water supply. It is not obvious whether it is economically sensible to have OCWD as the entity that contracts for the desalinated water.

It is likely that there are many cheaper sources of water for Orange County, including water from the reuse of treated wastewater, or water market purchases, or conservation. For example, I understand that Irvine Ranch Water District (IRWD) has purchased farmland in Palo Verde Irrigation District (PVID) possibly with the purpose of transferring the water directly or indirectly into Orange County. I understand that this water was acquired for a one-time, up-front cost of approximately $3,400/AF, which will turn out to be significantly cheaper than the ultimate cost of water from Poseidon. Other water districts in Orange County, too, are pursuing efforts to obtain water. Thus, Santa Margarita Water Distric has committed to purchase at least 5,000 AF/year from the Cadiz Project.

With regard to the increased reuse of treated wastewater, MWD in partnership with the Los Angeles Sanitation Districts is building an 0.5mgd demonstration plant, the Carson Project, that should start up by the end of this year. If it proves successful, the plan is to scale the program up to as much as 150 mgd. [21]

it is unclear how the desalinated water from the Poseidon facility would actually be put to use. My understanding is that this has not yet been determined by OCWD. The water might be sold directly to water providers or used in some manner for groundwater recharge. The different options may have different implications both for the final cost of the water to users and also for the ultimate impact on supply reliability. MWD allocates water to member agencies during times when there is a shortage of imported surface water in such a way the cumulative water supply in the Orange County region would increase by *less* than the capacity of the desalination facility: it would *not* become more reliable by 50 mgd per year. [22] In fact, "if OC can store the Poseidon water in years when it is not being used to meet demands directly, it becomes a question as to whether the water would result in a <u>significantly</u> higher reliability for OC. … OC would likely be better off by only a small percentage."[23]

One solution might be for MWD pursue the project rather than OCWD. MWD is better positioned to distribute the incremental supply as widely as possible though the entire Southern California area. This might avoid the expense of having OCWD store the bulk of the water in the Orange County groundwater basin and pump it back up intermittently when there

[21] *See* http://www.mwdh2o.com/DocSvcsPubs/rrwp/assets/mwd_board_item_6-b_staff_presentation_march_2018.pdf. Slide 18 suggests that 60 mgd would be delivered for spreading to the Orange County basin.
[22] "MWDOC: Reliability Benefits in OC from the Poseidon Project", page 4.
[23] Ibid, pp. 6-7.

is a shortage. But, “the problem with this is that MWD has historically evaluated that they have sufficient other supply options, costing less than $1800 per AF.” [24]

The questions that should have been addressed by the ISTAP Phase 2 Report, but have not yet been answered, are these: What is the value added for Orange County by obtaining 56,000 AF every year from Poseidon at a cost of $2,200/AF? What is the economic cost to Orange County of intermittent supply shortages? What is the economic value to water users in Orange County of mitigating the risk of these shortages? Does it actually justify the scale, location, and cost of the Poseidon facility?

In short, the ISTAP Phase 2 analysis fails to demonstrate that a subsurface intake is not economically viable compared to the screened open ocean intake proposed for the Poseidon facility. It also fails to demonstrate that the Poseidon facility with any type of intake is economically justified.

5. SLANT WELL INTAKE - POTENTIAL LIFE-CYCLE COST SAVINGS

The ISTAP Phase 2 Report considered only one type of subsurface intake, namely a seafloor infiltration gallery (SIG). The ISTAP Phase 2 team had started out with the two subsurface intake options that ISTAP Phase 1 had determined – inadequately, in my view – to be technically feasible, namely SIG and BIG, a beach (or surf zone) infiltration gallery. However, early in its work, the ISTAP Phase 2 team determined that the BIG option analysis “would not be feasible.” Along with open ocean option, it focused simply on the SIG option using two possible methods of construction, a trestle (SIG-Trestle) or a float-in construction (SIG-Float In).

A striking inconsistency with the ISTAP Phase 1 Report is that the ISTAP Phase 2 analysis considered alternative scales of plant production capacity for the intake options being considered – open-ocean, SIG-Trestle, and SIG-Float In. Three alternative scales were considered in addition to the 50 mgd of production proposed by Poseidon and analyzed in ISTAP Phase 1 Report; these were production levels of 100 mgd, 25 mgd, and 15 mgd. The per unit cost of delivered water for a 25 mgd facility was estimated to be about only 7.6% to 10.1% higher than for a 50 mgd facility.

As noted above, the ISTAP Phase 1 team was unwilling to consider alternative scales besides Poseidon’s 50 mgd design. But, as also noted above, ISTAP Phase 1 rejected slant wells as a subsurface intake technologically because of uncertainty about this technology’s ability to provide “the required volume of water” – i.e., 50 mgd. The implication is that, had a smaller scale been permitted, slant wells would have been deemed an acceptable technology. Whether intentionally or not, the inconsistency in the production scale assumed by ISTAP Phase 1 and

[24] Ibid, p. 7.

ISTAP Phase 2 had the effect of eliminating slant well as a technology to be costed and compared alongside open ocean intake.

Also as noted above, the other reason why the ISTAP Phase 1 Team rejected slant wells as a subsurface intake technology relied on a consideration that the SWRCB explicitly rejected – namely the mere existence of some impact on freshwater aquifers.

Together, the reasons why ISTAP Phases 1 and 2 rejected the alternative of a slant well intake lack credibility.

That is an unfortunate omission because there are reasons to believe that slant wells are a cheaper technology than the subsurface intake gallery considered by ISTAP Phase 2 and, quite possibly, a cheaper technology than the ocean intake proposed by Poseidon.

First, information summarized in California Coastkeeper Alliance *Appendix 3 Cost of Slant Wells*, suggests that the construction cost for slant wells might be as much as an order of magnitude lower than the cost of the subsurface infiltration gallery considered by ISTAP 2. Second, as the Abt Associates economic analysis commissioned by the SWRCB suggests, [25] there could be significant cost savings for slant wells because they would not need the full conventional pretreatment that is required for the open ocean intake proposed by Poseidon. The ISTAP 2 Report did not consider the cost savings of subsurface intakes when the need for conventional pretreatment is reduced or eliminated, a surprising omission. Information presented in California Coastkeeper Alliance *Appendix 1 Cost Savings from Avoiding Pretreatment* suggests that subsurface intakes have cheaper life cycle costs compared to open ocean intakes and may produce water cheaper than the proposed Poseidon plant.

6. CONCLUSION

In summary, as an economist with extensive experience in the analysis of water projects and water policy, including having served as the SWRCB's economic staff, I do not believe that the analysis contained in the ISTAP Phase 1 and Phase 2 Reports meets the standards laid down by the SWRCB to determine that a subsurface intake at the Huntington Beach desalination facility is technically or economically infeasible.

The 50 mgd scale of the facility has not been justified as required by the 2015 Ocean Plan Amendment.

The assertion that it is a "fatal flaw" for a slant well intake because it would draw some volume of groundwater does not comport with the assessment criteria specified in the 2015 Ocean Plan Amendment and, by itself, is not a valid reason to reject a slant well intake.

The second reason adduced by the ISTAP Phase 1 Report to reject the option of a slant well intake – that it is not a well established technology – is unpersuasive, given that slant well

[25] Abt Associates, Economic Analysis of the Proposed Desalination Amendment to the Water Quality Control Plan for Ocean Waters of California, Appendix G, Final Staff Report, pp. 4-5, Exhibit 12-4, and Exhibits A-14 and A-15.

intakes are incorporated in both the CalAm-Monterey and Doheny desalination project proposals.

The finding by the ISTAP Phase 2 Report that a subsurface intake at Huntington Beach would not be economically viable lacks foundation. The quantity offered as a measure of the economic value of the increased reliability provided by desalination – the time-varying premium that OCWD is willing to pay to Poseidon – is flawed and does not in any way measure the (likely increasing) economic value of supply reliability in Orange County.

The economic calculation provided by Peer Swan is a sound starting point for the type of economic analysis that should be performed, although it lacks an allowance for a possible risk aversion premium that water users in Orange County might be willing to pay.

Thus, the question that needs to be answered – what is the value added for Orange County by obtaining 56,000 AF of additional supply every year from Poseidon at a cost of $2,200/AF – has not yet been answered.

There are reasons to believe that slant wells are a cheaper technology than the subsurface intake gallery considered by ISTAP 2 and, quite possibly, a cheaper technology than the ocean intake proposed by Poseidon. This option needs to receive a proper consideration.

If the ISTAP analyses were to be corrected, several questions need to be addressed more transparently:

(1) How is the water from the Huntington Beach desalination facility to be used, and priced? Will it be held in reserve primarily for use at times of shortage, and will it be priced specially on those occasions so as to capture the higher value of an increment in water supply during a shortage? Or will it serve mainly as additional baseload supply, and will it be priced no differently than other water sold for baseload supply?
(2) Who will contract with Poseidon? It is not obvious to me that OCWD is the party best placed to be the buyer of this water since it is a groundwater management agency. To maximize the economic value of water obtained by desalination, namely as insurance against disruption of regular surface water supplies, you would want to connect it to as extensive a surface water distribution network as possible. Groundwater injection seems like a sub-optimal solution. Perhaps MWD would be a better fit as the party that contracts with Poseidon and would be better placed to maximize the economic value of this water.
(3) What should the scale be? Alternatives smaller than 50 mgd should be considered. It could be that a smaller scale desalination plant would have greater economic value as substitute source of water when the conventional surface water sources of supply are disrupted.
(4) There is also the question of timing. Why build now – or rather, why build 50 mgd now? Desalination is a relatively modular source of supply. It may not be optimal to invest now to build out the full desalination supply that will be needed in, say, 2060.

APPENDICES

EVIDENCE AS TO WHY THE ISTAP REPORTS DO NOT ADEQUATELY EVALUATE SUBSURFACE INTAKE FEASIBILITY AS REQUIRED BY THE DESALINATION OCEAN PLAN AMENDMENT

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CALIFORNIA COASTKEEPER. ALLIANCE

COST SAVINGS FROM AVOIDING PRETREATMENT

SUMMARY

The question presented is whether the Regional Water Board can rely on the ISTAP conclusions that subsurface intakes are not feasible when the ISTAP never considered the cost savings of slant wells from the avoided need for full conventional pretreatment. Subsurface intake systems use the natural geological properties of sediments and rocks to strain and biologically remove organic matter, suspended sediment, and dissolved organic compounds before they enter the treatment processes. The use of subsurface intake systems improves water quality, increases operational reliability, reduces the pretreatment train complexity, and reduces operating costs – all factors to be considered when determining "feasibility" under the Desalination Ocean Plan Amendment.

The ISTAP did not consider the cost savings of subsurface intakes by avoiding full conventional pretreatment that is required for the proposed open ocean intake. The ISTAP failed to consider life-cycle costs as required by the Desalination Ocean Plan Amendment. Studies have concluded that life-cycle cost analyses show significant cost saving over operating periods of 10 to 30 years. California pilot studies have demonstrated subsurface intakes do not require full conventional pretreatment, have cheaper life-cycle costs compared to open ocean intakes, and that subsurface intakes may produce water cheaper than the proposed Poseidon-Huntington Beach proposal. While cost savings may vary based on site specific characteristics, the ISTAP Report is void of any consideration of this critical information in their analysis.

SUBSURFACE INTAKES DO NOT REQUIRE COSTLY PRETREATMENT

Natural seawater contains a variety of macro- and micro-organic components that affect the ocean desalination treatment process. Open-ocean intakes are seasonally clogged in some regions by seaweed and some pretreatment systems are periodically fouled by influx of jellyfish.[1] Natural environmental events, such as harmful algal blooms and red tides, can overwhelm full conventional pretreatment systems and cause temporary shut-downs of ocean desalination plants.[2] In comparison, when subsurface intakes are used, improvements in the raw water quality can lead to reduction in the complexity of pretreatment systems, thereby reducing the need for physical cleaning and amount of chemicals used, and increasing the operational reliability of facilities (e.g., avoid loss of production during algal blooms).[3] Commonly, feeding higher quality raw water into the primary membrane process leads to a reduction in the rate of organic biofouling, reduced capital cost for construction of pretreatment processes, and reduced operating costs for maintenance, chemical use, and accessory operations. Further, eliminating the use of chemicals required for full conventional pretreatment also eliminates the discharge of these chemicals into the municipal wastewater treatment facilities or direct ocean discharges.

A key issue in assessing the economic feasibility of slant wells and other subsurface intakes is how to improve the quality of the feedwater and, as a result, decrease the life-cycle cost of desalination or total cost per unit volume of product water. The use of subsurface intake systems is one method to improve water quality, to increase operational reliability, to reduce the pretreatment train complexity, and to reduce operating costs.[4] Subsurface

[1] *See* Attachment One: T.M. Missimer et al., Subsurface Intakes for Seawater Reverse Osmosis Facilities: Capacity Limitation, Water Quality Improvement, and Economics; Desalination 322 (2013) 37–51, pg. 37.

[2] *See* Ry Rivard, Desal Plant Is Producing Less Water Than Promised, Voice of San Diego (August 29, 2017); available at https://www.voiceofsandiego.org/topics/science-environment/desal-plant-producing-less-water-promised/; In April, for instance, the plant shut down for 15 days when an algal bloom along the coast soured the water. The plant was unable to treat any water without fouling up the expensive filters it uses to remove salt and other impurities from water; Loreen O.Villacorte et al., Seawater Reverse Osmosis Desalination and (Harmful) Algal Blooms, Elsevier, Volume 360, 16 March 2015, Pages 61-80; The potential issues in SWRO plants during HABs are particulate/organic fouling of pretreatment systems and biological fouling of RO membranes, mainly due to accumulation of algal organic matter (AOM).

[3] *Supra* Note 1 at 39.

[4] *Id*.

intake systems use the natural geological properties of sediments and rocks to strain and biologically remove organic matter, suspended sediment, and dissolved organic compounds before they enter the treatment processes.[5]

The State Water Board's CEQA documentation for the Desalination Ocean Plan concludes subsurface intakes eliminates the need for conventional pretreatment, thus reducing capital and operational costs. The natural filtration process of a subsurface intake significantly reduces or eliminates the need for pretreatment requirements.[6] For instance, subsurface intakes typically allow for higher quality raw water to be fed into the intake system, minimizing pretreatment and significantly lowering operation and maintenance costs.[7] Surface intakes have lower capital costs relative to subsurface intakes, although a life-cycle analysis shows that surface intakes result in higher operational costs compared to subsurface intakes.[8] The higher quality of feed water with a subsurface intake reduces capital costs for construction of pretreatment processes.[9] Furthermore, subsurface intakes collect water through sand sediment, which acts as a natural barrier to organisms and thus eliminates impingement and entrainment.[10] This gives subsurface intakes a significant environmental advantage over surface water intakes because mitigation for surface intake entrainment will have to occur throughout the operational lifetime of the facility.[11] Overall, subsurface intakes can lower desalination operational plant costs and minimize associated environmental impacts.[12]

LIFE-CYCLE COST ANALYSIS

The Regional Water Board cannot rely upon the ISTAP's findings that subsurface intakes at Huntington Beach are not feasible. The ISTAP Report noted "that the Phase 2 ISTAP was not asked to assess the feasibility of the other components of the SWRO Plant including the pretreatment systems, the membrane system or the brine disposal system."[13] The exclusion of these components in the ISTAP Report is not an acceptable feasibility analysis under the Desalination Ocean Plan Amendment. The Amendment requires regional water boards to consider numerous factors when determining feasibility of subsurface intakes, including "energy use for the entire facility…and project life cycle cost."[14] According to the Desalination Ocean Plan Amendment's Final Substitute Environmental Document, "[p]retreatment increases costs and energy requirements, and is an additional step that is often not necessary when using subsurface intakes."[15] Both factors were intentionally omitted from the ISTAP Phase 2 Report, but are pertinent to an economic feasibility analysis and are required by a regional board to consider. Furthermore, the Ocean Plan Amendment requires project life cycle cost to "be determined by evaluating the total cost of planning, design, land acquisition, construction, operations, maintenance, mitigation,

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[5] *Supra* note 1 at 38.
[6] State Water Resources Control Board, Final Staff Report Including the Final Substitute Environmental Documentation, Pg. 51 (May 6, 2015); *available at* https://www.waterboards.ca.gov/board_decisions/adopted_orders/resolutions/2015/rs2015_0033_sr_apx.pdf.
[7] *Id*; Pacific Institute. 2013a. Key Issues in Seawater Desalination in California: Marine Impacts; National Research Council (NRC). 2008. Desalination: A National Perspective. Washington, DC: The National Academic Press; Bartak, R., T. Grischek, K. Ghodeif and C. Ray. 2012. Beach Sand Filtration as Pre-Treatment for RO Desalination. International Journal of Water Sciences; San Diego Water Authority Camp Pendleton. December 2009. Seawater Desalination Project Feasibility Study Report Executive Summary.
[8] *Supra* Note 6 at 51.
[9] *Id*; San Diego Water Authority Camp Pendleton. December 2009. Seawater Desalination Project Feasibility Study Report Executive Summary.
[10] *Supra* Note 6 at 64; Municipal Water District of Orange County (MWDOC). 2010. Memorandum to B. Richard from N. Davis; Supra Note 4; Hogan, T. 2008. Impingement and Entrainment: Biological Efficacy of Intake Alternatives. Presented at the Desalination Intake Solutions Workshop. 16-17 Oct. 2008. Alden Research Laboratory, Holden, MA; Pankratz, T. 2004. An overview of Seawater Intake Facilities for Seawater Desalination, The Future of Desalination in Texas. CH2M Hill, Inc. Vol 2: Biennial Report on Water Desalination, Texas Water Development Board. Water Research Foundation. 2011. Assessing Seawater Intake Systems for Desalination Plants [Project #4080] http://www.waterrf.org/ExecutiveSummaryLibrary/4080_ExecutiveSummary.pdf.
[11] *Supra* Note 6 at 64.
[12] *Id*.
[13] Independent Scientific Technical Advisory Panel, Phase II Report: Feasibility of Subsurface Intake Designs for the Proposed Poseidon Water Desalination Facility at Huntington Beach, California, pg. 9 (November 9, 2015).
[14] State Water Resources Control Board, California Ocean Plan, pg. 39 (2015); *available at* https://www.waterboards.ca.gov/water_issues/programs/ocean/docs/cop2015.pdf.
[15] *Supra* Note 6 at 51.

equipment replacement and disposal over the lifetime of the facility, in addition to the cost of decommissioning the facility." The ISTAP Report did not adequately analyze all these factors when determining whether subsurface intakes are feasible.

More importantly, the ISTAP did not consider the cost saving of subsurface intakes not needing full conventional pretreatment. The use of subsurface intake systems for seawater desalination plants significantly improves raw water quality, reduces chemical usage and environmental impacts, decreases the carbon footprint, and reduces cost of treated water to consumers.[16] Subsurface intakes act both as intakes and as part of the pretreatment system by providing filtration and active biological treatment of the raw seawater. Recent investigations of the improvement in water quality made by subsurface intakes show lowering of the silt density index by 75 to 90 percent, removal of nearly all algae, removal of over 90 percent of bacteria, reduction in the concentrations of TOC and DOC, and virtual elimination of biopolymers and polysaccharides that cause organic biofouling of membranes.[17] Economic analyses show that overall seawater desalination plants operating costs can be reduced by 5 to 30 percent by using subsurface intake systems.[18] These important factors in life cycle costs were not included into the ISTAP Report, as required by the Desalination Ocean Plan Amendment. Studies have concluded that "a preliminary life-cycle cost analysis shows significant cost saving over operating periods of 10 to 30 years."[19] The Regional Board should conduct a new independent study of subsurface intakes at Huntington Beach to consider all factors of a project-life cycle cost, as defined by the Ocean Plan Amendment, including the cost savings over the lifetime of the project from not needing pretreatment for subsurface intakes.

DOHENY DESALINATION PROJECT AS A REAL-WORLD EXAMPLE

The Municipal Water District of Orange County (MWDOC) in partnership with five participating agencies, investigated the feasibility of slant wells to extract ocean water for the planned Doheny Ocean Desalination Project. In 2003/04, MWDOC undertook preliminary studies to assess alternative approaches to produce ocean water in the vicinity where San Juan Creek discharges to the ocean in Dana Point. Options included a conventional open intake, a subsurface infiltration gallery, and various types of beach wells. To investigate the feasibility of a subsurface slant well intake, a phased hydrogeology and subsurface well technology investigation was undertaken. In 2004/05, four exploratory boreholes were drilled along the beach to a depth of 188 feet below the ground surface. In 2005/06, after a thorough review of several technologies it was determined that the most cost-effective approach for this location was the use of slant beach wells constructed with a dual rotary drill rig from the beach out under the ocean.

The Doheny Project demonstrates that conventional pretreatment is not necessary for subsurface intakes, leading to additional capital and operational savings. From the four exploratory boreholes it was discovered that "…[t]he produced water showed a very low silt density index (average around 0.5 units) and turbidity (averaged around 0.1 NTU), indicating excellent filtration by the aquifer which eliminates the need for conventional pretreatment filtration and saves costs."[20] Furthermore, "…the produced water showed no presence of bacterial indicator organisms which were found to be present in high concentrations in the ocean and seasonal lagoon," and that "[b]iofilm growths by the end of the test were found to be less than 10 μ in thickness, a level of no concern for biofouling."[21] Pumped well water was run directly to the test RO units continuously for over four months. No fouling or performance deterioration was observed during the test or in the post-membrane autopsy as all the

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[16] *Supra* Note 1.
[17] *Id* at 37.
[18] *Id*.
[19] *Id*; *Supra* Note 6 at 64.
[20] *See* Attachment Two: Municipal Water District of Orange County, Final Summary Report Doheny Ocean Desalination Project Phase 3 Investigation, pg. 14 (January 2014).
[21] *Id*.

dissolved iron and manganese was easily removed as anoxic conditions were maintained throughout the test period.[22]

The MWDOC study concluded that for the Doheny Desal Project, "slant wells are less expensive than open intakes which also require pretreatment systems to remove sediments and organic materials."[23] This conclusion was due to the finding that "slant wells provide highly filtered water via the natural filtration process provided by the marine aquifer, thus avoiding the cost of having to construct and operate conventional pretreatment strainers, filtration and solids handling/disposal facilities."[24] MWDOC "determined from the results of the extended pumping test that the use of a slant well intake system will avoid the need for conventional pretreatment costs estimated at $56 million in capital and about $1 million in O&M costs, thus reducing the costs compared to other sites by more than $300 per AF."[25] The ISTAP failed to do any of this type of analysis demonstrated by the MWDOC study. As such, the Regional Water Board cannot rely on the ISTAP's conclusions.

The MWDOC study also compared the total cost of the Doheny Project using subsurface intakes, verse the cost estimates of the Poseidon- Huntington Beach project. MWDOC concluded that the:

> "Poseidon Huntington Beach project unit cost as of February 2013 is around $1,800 per AF, including all costs and assuming a contribution from MET of $250 per AF. The Doheny Desal Project cost, assuming an escalation of debt repayment similar to the Huntington Beach Project at 2.5%, is currently estimated around $1,200/AF including all costs and assuming a contribution from MET of $250 per AF."[26]

MWDOC's Doheny study concluded that subsurface intakes do not need full conventional pretreatment – the natural filtration by the aquifer eliminates the need for conventional pretreatment filtration. The Doheny study further demonstrated that the use of subsurface intakes – and the avoidance of full pretreatment – resulted in significant cost savings, including $56 million in capital costs and $1 million annually in O&M costs. And finally, the Doheny study determined that the Doheny project using subsurface intakes would produce water for $600 per AF cheaper than that of the Poseidon-Huntington Beach open ocean intake proposal.

The intentional omission of pretreatment considerations in the ISTAP Phase 2 Report, and the requirement to include them expressly stated in the Ocean Plan Amendment, renders the ISTAP Phase 2 report inadequate for granting an exception to the stated preference for subsurface intakes.

CONCLUSION

It is clear in the Ocean Plan Amendment that before the Regional Water Board can consider an exemption to the preference for subsurface intakes, there must be a thorough consideration of life-cycle costs. Further, as documented in the Ocean Plan Amendment SED, it is clear that there are significant life-cycle cost savings from the use of subsurface intakes, as well as avoided discharges of chemicals from the use of conventional pretreatment.[27]

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[22] *Id*.
[23] *Id* at 42.
[24] *Id*.
[25] *Id*.
[26] *Id* at 43.
[27] *Supra* Note 6 at 64; Pacific Institute. 2013a. Key Issues in Seawater Desalination in California: Marine Impacts; National Research Council (NRC). 2008. Desalination: A National Perspective. Washington, DC: The National Academic Press; Bartak, R., T. Grischek, K. Ghodeif and C. Ray. 2012. Beach Sand Filtration as Pre-Treatment for RO Desalination. International Journal of Water Sciences; San Diego Water Authority Camp Pendleton. December 2009. Seawater Desalination Project Feasibility Study Report Executive Summary.

The Regional Water Board cannot rely on the ISTAP conclusions that subsurface intakes are not feasible because the ISTAP never considered the cost savings of slant wells from avoiding the construction and operating costs of full conventional pretreatment required for surface intakes. As compared to open ocean intakes with screens, the use of subsurface intakes likely improves water quality, increases operational reliability, reduces the pretreatment train complexity, and reduces operating costs. The ISTAP failed to consider life-cycle costs of subsurface intakes where studies show significant cost saving over operating periods of 10 to 30 years. While the benefits and costs of using subsurface intakes may be site-specific, the Doheny study demonstrates that subsurface intakes in Huntington may not require full conventional pretreatment, have cheaper life-cycle costs compared to open ocean intakes, and that subsurface intakes may produce water cheaper than the proposed Poseidon-Huntington Beach proposal. The ISTAP Report fails to factor any of this critical information into their economic feasibility analysis because of an intentional decision not to consider pre-treatment, membrane system and discharge components of the proposal – all of which are critical considerations of life-cycle costs.

FLAWED RELIABILITY PREMIUM

SUMMARY
The Regional Water Board needs to determine whether the Independent Scientific Technical Advisory Panel (ISTAP) reports are an adequate justification for allowing Poseidon an exemption to the regulatory preference to use subsurface intakes. The economic analysis of the "reliability premium" in the ISTAP report fails to adequately describe the risk of water shortage, the economic cost of mitigating the risk, and the alternatives for risk mitigation. Further, the ISTAP reports failed to document and analyze the quality of risk mitigation given Metropolitan Water District's (MWD) "allocation formula."

The perceived risk is a function of the intermittent shortages of available imported water to supplement Orange County Water District's (OCWD) basin recharge programs. But the proposed "reliability premium" from the Poseidon proposal is a constant cost in a "take or pay" contract, regardless of intermittent allocations of imported water during times of limited availability. Further, an economic analysis of a particular project should compare marginal costs and benefits of the project to the marginal cost and benefits of alternatives.

ISTAP and OCWD should not have simply accepted the higher cost of the proposed project's product water and characterized the excess cost to consumers of the melded rate increase as a "reliability premium." ISTAP should have factored in the variables below.

RISK
As part of the economic analysis of the "risk premium", ISTAP should have more thoroughly considered the nature of the risk. For example, in Attachment One, the Swan presentation assumes the risk of water shortages is primarily a function of interruptions to imported water deliveries from MWD to help replenish the basin – what is called a MWD "period of allocation."[1]

The Swan presentation used a conservative assumption, based on the historical record, that MWD will allocate deliveries based on interruptions to imported water deliveries 2 out of every 10 years.[2] That means that in 8 out of 10 years, the assumption is that there will ample imported water available to meet the demands of OCWD to safely maintain reliable levels in the basin. But, for the project to mitigate the risk of shortages, it is assumed the 50,000 ac/ft/yr from the project will make up the difference in the 2 years of allocation every 10 years. In short, ISTAP failed to consider what Swan rightly characterized as a risk of interrupted imported water deliveries occurring 2 out of 10 years, with a project that charged a "risk premium" for every year regardless of the reasonably foreseeable intermittent risk.

COST OF RISK MITIGATION
Swan then calculated the marginal cost of reliability as 8 years of unnecessary purchases of 50,000 ac/ft of the project water, minus the cost of un-purchased imported water from MWD:

8 years * 50,000 * (2200 – 800) = $560 million.

If you apply that to the 2 years of interruption (divide total by 2), the risk premium is calculated at:

$280,000,00 / 50,000 & $2200 = $7800 ac/ft.[3]

[1] *See* Attachment Three: Peer Swan Presentation.
[2] *Id* at Slide 10.
[3] *Id* at Slide 11.

Regardless of whether Swan's numbers are precise for this circumstance, ISTAP failed to use any assumptions and calculations to monetize the "reliability premium." Instead, the panel simply relied on OCWD's stated willingness to pay the difference between what imported water costs and the negotiated cost of Poseidon's product water in a "take or pay" contract. In short, ISTAP failed to offer any meaningful context or analysis of the marginal cost of a "risk premium" from purchasing water from the proposed project.

VALUE OF RISK MITIGATION

Importantly, MWD applies an "allocation formula" to each of the member agencies during interruptions in deliveries of imported water. The policy behind the formula is an attempt to disperse risks in a manner that reflects a member agency's reliance on MWD deliveries. Simply put, the more a member agency relies on MWD deliveries (the greater the proportion of the supply portfolio), the lower a percentage of reduced deliveries during an allocation period.

As shown in a presentation by Municipal Water District of Orange County (MWDOC) staff, the "allocation formula" results in a smaller amount of imported water delivered to Orange County during a shortage if the region is less dependent on MWD deliveries after inclusion of the Poseidon water in the portfolio.[4] While the MWD "allocation formula" is somewhat complicated and dependent on real-life variables, the MWDOC report summarizes the impact of the formula on "reliability" as: *"The average person might expect OC to be more reliable by 56,000 AF per year with the Poseidon Project. This is not the case under either of these definitions."*[5] But the ISTAP report failed to consider the actual value of paying for 56,000 ac/ft/yr of Poseidon water as risk mitigation, given that inclusion of the water into the local portfolio will reduce imported water available to local agencies from MWD during periods of interruptions.

BEST-FIT ALTERNATIVES

The ISTAP reports failed to compare the "reliability premium" of water purchased from Poseidon to water management and/or supply augmentation alternatives.

ISTAP should have started with an examination of the "elasticity" of water demand. Some water consumption is necessary for people to stay alive – a perfectly "inelastic" demand. But some customers may use water to wash dirt from the street in front of their house – an arguably low-value and extremely "elastic" demand. Conserving water by eliminating low-value uses, either through regulation or by customer response to higher prices, is an important alternative to current usage and must be factored into the consideration of a reasonable "reliability premium." If consumers were compelled to use less water, they would likely eliminate the low value uses and the "reliability premium" would decrease to a better benefit-cost fit. On the other hand, if consumers conserve in response to the higher price of the Poseidon project's "reliability premium", there is either a risk of "stranding the asset" and/or otherwise not maximizing the benefit-cost fit.

Even assuming demand would remain constant, or even increase with the introduction of supply, there are alternatives to increasing reliability in the local supply portfolio that must be considered in an economic analysis. In brief, economists must answer the question: "Is it a prudent investment – compared to what?"

As noted in the most recent MWDOC Urban Water Management Plan and Reliability Study, there are several projects in planning that may offer similar or better reliability in the region at a lower reliability premium. For example, the Carson Wastewater Recycling Project, a partnership between MWD and LA County Sanitation District, may deliver 65,000 ac/ft/yr for injection into the Orange County basin at the same price as imported water – the volume of reliable water would be greater than the proposed Poseidon project and the "reliability premium" would be zero. It is unclear what this alternative would mean to the portfolio when the MWD

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[4] *See* Attachment 4: Robert Hunter, Municipal Water District of Orange County, Reliability Benefits in OC from the Poseidon Project: P&O Committee presentation at page 3.

[5] *Id* at page 4.

"allocation formula" is applied, but it would certainly be a preferable economic alternative compared to the proposed Poseidon alternative.

Swan also suggests groundwater management changes that could provide the same reliability as the Poseidon project, but at a much lower cost. These alternatives would seem to avoid the complications and limited local benefits of increased reliability inherent in the MWD allocation formula. Swan suggests purchasing more "untreated" water from MWD when it is readily available and storing it in the basin to ensure ample supply during interruptions to MWD supplies.[6] Of course, there is a risk of purchasing that additional water only to discover that the basin may have recharged through natural rainfall – something akin to purchasing auto insurance and never needing it. Another method would be to have OCWD member agencies purchase "treated water" in lieu of pumping their allotment from the basin – again, allowing the basin to recharge during times when imported water is readily available, and storing that water for times of interruptions to imported water deliveries.[7] Again, there are risks and costs associated with that management change.

ISTAP erred in simply assuming that because OCWD Board members signaled a willingness to pay excess costs for Poseidon water, it is an economically valid "reliability premium." Economics is fundamentally about choices and maximizing efficiency in the allocation of scarce resources. Therefore, an economic analysis must consider alternatives before concluding what is or is not feasible.

CONCLUSION

The question presented is whether the ISTAP reports are an adequate justification for allowing Poseidon an exemption to the regulatory preference to use subsurface intakes. The ISTAP report's economic analysis of the "reliability premium" fails to adequately describe the risk of water shortage, the economic cost of mitigating the risk, and the alternatives for risk mitigation. Without these considerations adequately analyzed, the ISTAP reports did not provide the necessary background for analyzing the feasibility of the Poseidon project either with or without subsurface intakes.

[6] *Supra* Note 1, Swan at Slide 12.
[7] *Id* at 13.

COST OF SLANT WELLS

SUMMARY
The Regional Water Board needs to determine whether slant wells are economically feasible as defined by the Desalination Ocean Plan. Due to the ISTAP's determination that slant wells were not technically feasible, the ISTAP did not perform an economic analysis of whether slant wells are economically feasible. The Regional Board cannot rely upon the ISTAP's determination that slant wells are infeasible because it incorrectly dismissed slant wells as technically infeasible, and because a proper economic feasibility analysis was never conducted.

Before the Regional Board can approve an exemption to the Ocean Plan's preference for subsurface intakes to minimize the intake and mortality of marine life, an independent analysis of whether slant wells are feasible under the Ocean Plan Amendment is necessary.

Below we use real world slant well cost estimates to demonstrate the significant cost savings of constructing and operating slant wells as compared to the infiltration galleries. The existing slant well cost estimates demonstrate that slant well construction cost about $120 to $150 million per MGD as compared to the ISTAP's cost estimate for infiltration galleries at $1,000 to $15,000 million per MGD. The Cal Am cost estimate also demonstrates that economies of scale may provide additional unit cost savings from higher production capacity.

CONSTRUCTION COSTS
Estimating the cost of developing slant wells is arguably a site-specific task. The cost of mitigating for freshwater drawdown, contaminated water, and potential well performance varies by site characteristics. However, developing slant wells is clearly a lower cost alternative compared to the estimates for developing a SIG in the ISTAP Phase 2 report. Therefore, the ISTAP conclusion that subsurface intakes are not economically feasible is inadequate for an exemption to the Ocean Plan's preference for subsurface intakes.

First, a report on the feasibility of slant wells for the proposed Doheny project was finalized in January 2014.[1] The proposal was a facility producing 15mgd of potable water based on a 30mgd withdrawal of source water through slant wells. The estimated cost of constructing the intake and raw water conveyance system was $44,759,000.[2] For purposes of rough cost comparisons, that cost estimate is approximately $1.5 million for each million gallons per day (mgd) of water withdrawn. Extrapolating that cost estimate to the proposed 100mgd intake for the Poseidon project results in an estimated construction cost of $150 million.

Second, cost estimates for developing slant wells for Monterey-CalAm project were prepared in 2015.[3] The winning bid estimated the cost of constructing slant wells at a lower per unit cost than the Doheny estimate:

[1] *See* Municipal Water District of Orange County, Final Summary Report Doheny Ocean Desalination Project Phase 3 Investigation (January 2014).
[2] *Id* at 33.
[3] *See* Monterey Peninsula Water Supply Project website: https://www.watersupplyproject.org/about1.

No. of Wells	Total Well Production Capacity (MGD)	Well Construction[4]	Design and Construction Management[5]	Wellhead Completion and Equipping[6]	Total	Cost Per Well	$/MGD of Intake Capacity
7	22.2	$ 19,424,000	$ 2,136,640	$ 5,250,000	$ 26,810,640	$ 3,830,091	$ 1,208,994
9	28.5	$ 24,746,000	$ 2,227,140	$ 6,750,000	$ 33,723,140	$ 3,747,016	$ 1,182,770

This cost estimate of approximately $1.2 million per million gallon of intake volume is marginally lower than the Doheny per unit cost estimate for constructing slant wells. Also, importantly, this bid shows that there are potential "scale economies" for drilling more wells at a site to withdraw increased volumes.

Regardless of which estimate for slant well construction (Doheny or Monterey), the cost is a small fraction of the ISTAP cost estimate of $1 billion to $1.5 billion for constructing galleries. While a site-specific analysis is required, a rough estimate for developing slant wells for a 100 MGD withdrawal and conveyance to the treatment plant would be in the range of $118,277,000 (CalAm 1MGD estimate times 100) to approximately $150,000,000 (approximate Doheny 1MGD estimate times 100). While these are admittedly rough estimates, and actual cost estimates and any economies of scale would be site-specific, the ISTAP Phase 2 report is void of any cost and economic analysis of a system of slant wells compared to a seawater infiltration gallery and/or the proposed addition of screens to the existing open ocean intake.

In conclusion, the ISTAP Phase 1 report erred in concluding slant wells were not technically feasible. This in turn resulted in an inadequate analysis of all available subsurface intakes for economic feasibility. Therefore, the implication that all subsurface intakes are not economically feasible is inadequate as evidence that the Poseidon proposal should be exempted from the stated regulatory preference mandating subsurface intakes to minimize the intake and mortality of marine life.

AVOIDED COSTS OF SLANT WELLS COMPARED TO SCREENED OPEN OCEAN INTAKES
Studies show that slant wells may have significant life-cycle cost savings compared to open ocean intakes.[7] For example, there are cost savings from eliminating the need to construct full conventional pre-treatment required for open ocean intakes, as well as operation and maintenance cost savings from not including full conventional pre-treatment.[8] For example, the Doheny report estimated that annual savings from operation and maintenance costs by avoiding the need for full conventional pretreatment were approximately $1 million for a 30mgd intake system. Arguably, the annual savings from avoided operation and maintenance costs for the proposed Huntington-Poseidon project would be approximately 3 times the savings for the proposed Doheny facility.

However, slant wells may have additional operating costs. For example, if the slant wells withdraw some inland freshwater, that adds to the unit cost of the product water to replace the lost freshwater. Further, there may be costs for mitigating the risk of source water contamination and/or partial well failures to produce the intended volume of 100mgd intake. These potential additional costs need to be identified and included in the economic feasibility analysis.

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[4] From Boart Longear Bids on Monterey.
[5] Estimate Based on Monterey Test Well Costs.
[6] Estimate Based on Monterey Test Well Costs.
[7] State Water Resources Control Board, Final Staff Report Including the Final Substitute Environmental Documentation, Pg. 51 (May 6, 2015); *available at* https://www.waterboards.ca.gov/board_decisions/adopted_orders/resolutions/2015/rs2015_0033_sr_apx.pdf; National Research Council (NRC). 2008. Desalination: A National Perspective. Washington, DC: The National Academic Press; San Diego Water Authority Camp Pendleton. December 2009. Seawater Desalination Project Feasibility Study Report Executive Summary.
[8] *Ibid.*

In conclusion, the ISTAP Phase One report erred in excluding slant wells as technically infeasible, and the ISTAP Phase 2 findings compounded the error by failing to consider all the associated costs and cost savings from constructing and operating slant wells.

AVOIDED RISKS

Scientific papers recognized in the Ocean Plan Amendment SED found that subsurface intakes have a benefit of eliminating risks of damage to the RO treatment train and/or the risk of having to shut down the plant during natural occurrences like algal blooms.[9] And experience with unplanned shut-downs at the recently opened Carlsbad-Poseidon facility shows the papers' analysis of risks from using open ocean intakes are valid and have been confirmed in Southern California.

Again, because the ISTAP Phase One report erred in excluding slant wells from further consideration, the ISTAP Phase Two report failed to document the reliability benefits of subsurface intakes protecting against unplanned shutdowns of the project. This is a critical omission given that the economic feasibility of the project itself is dependent on showing a rationale for the so-called "reliability premium." That is, arguably, paying the "reliability premium" is only a sound economic choice if the project actually produces the reliability it claims – so the added benefit of insurance against plant shutdowns provided by slant wells, especially during times when imported water is in short supply, is an important consideration in determining whether or not a project is economically feasible.

CONCLUSION

The questions presented are whether slant wells are economically feasible as defined by the Desalination Ocean Plan. The ISTAP did not perform an economic analysis of whether slant wells are economically feasible. The Regional Board cannot rely upon the ISTAP's determination that slant wells are infeasible because it incorrectly dismissed slant wells as technically infeasible, and because a proper economic feasibility analysis was never conducted.

Real world cost estimates demonstrate the significant cost savings of constructing and operating slant wells as compared to infiltration galleries. The existing slant well cost estimates demonstrate that slant wells cost about $120 to $150 million per MGD as compared to the ISTAP's cost estimate for infiltration galleries at $1,000 to $15,000 million per MGD. The Cal Am cost estimates also demonstrates that economies of scale provide additional cost savings from higher production capacity. The Regional Board must produce an independent new technical and economic feasibility study prior to considering an exemption to the Ocean Plan preference for subsurface intakes.

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[9] See Ry Rivard, Desal Plant Is Producing Less Water Than Promised, Voice of San Diego (August 29, 2017); available at https://www.voiceofsandiego.org/topics/science-environment/desal-plant-producing-less-water-promised/; In April, for instance, the plant shut down for 15 days when an algal bloom along the coast soured the water. The plant was unable to treat any water without fouling up the expensive filters it uses to remove salt and other impurities from water; Loreen O.Villacorte et al., Seawater Reverse Osmosis Desalination and (Harmful) Algal Blooms, Elsevier, Volume 360, 16 March 2015, Pages 61-80; The potential issues in SWRO plants during HABs are particulate/organic fouling of pretreatment systems and biological fouling of RO membranes, mainly due to accumulation of algal organic matter (AOM).

ATTACHMENT ONE

Subsurface Intakes for Seawater Reverse Osmosis Facilities: Capacity Limitation, Water Quality Improvement, and Economics

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Subsurface intakes for seawater reverse osmosis facilities: Capacity limitation, water quality improvement, and economics

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HIGHLIGHTS

- The use of subsurface intake types for seawater RO facilities was documented.
- Feedwater quality improvements by using subsurface intakes were demonstrated.
- Reduced environmental impacts using subsurface intakes were discussed.
- Capacity limits on various subsurface intake types were assessed.
- Life-cycle cost savings using subsurface intakes were preliminarily analyzed.

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ABSTRACT

The use of subsurface intake systems for seawater reverse osmosis (SWRO) desalination plants significantly improves raw water quality, reduces chemical usage and environmental impacts, decreases the carbon footprint, and reduces cost of treated water to consumers. These intakes include wells (vertical, angle, and radial type) and galleries, which can be located either on the beach or in the seabed. Subsurface intakes act both as intakes and as part of the pretreatment system by providing filtration and active biological treatment of the raw seawater. Recent investigations of the improvement in water quality made by subsurface intakes show lowering of the silt density index by 75 to 90%, removal of nearly all algae, removal of over 90% of bacteria, reduction in the concentrations of TOC and DOC, and virtual elimination of biopolymers and polysaccharides that cause organic biofouling of membranes. Economic analyses show that overall SWRO operating costs can be reduced by 5 to 30% by using subsurface intake systems. Although capital costs can be slightly to significantly higher compared to open-ocean intake system costs, a preliminary life-cycle cost analysis shows significant cost saving over operating periods of 10 to 30 years.

1. Introduction

Seawater desalination is an energy-intensive and costly means of treating water to potable standards and has some environmental impacts. With the development of advanced membrane technology and energy recovery systems, the energy consumption and cost of seawater desalination have been significantly reduced over the past several decades [1]. However, membrane fouling is still a major problem at most seawater reverse osmosis (SWRO) facilities, which reduces operational efficiency and the life-expectancy of the membranes [2]. Complex and expensive pretreatment processes are commonly required to reduce the rate of biofouling and the frequency of membrane cleaning (Fig. 1). Possible environmental impacts associated with conventional open-ocean intakes, such as impingement and entrainment of marine biota, can also create large permitting costs and construction delays [3,4]. There are also environmental impacts associated with the use of chemicals to keep the intakes and associated piping clean of organic growth, disposal of coagulants required in the pretreatment processes (e.g., ferric chloride), and disposal of macro-organic debris that accumulates on the traveling screens (seaweed, fish, jellyfish, etc.) and other parts of the pretreatment train [5].

Natural seawater contains a variety of macro- and micro-organic components that affect the treatment process [6]. Open-ocean intakes are seasonally clogged in some regions by seaweed [7] and some pretreatment systems are periodically fouled by influx of jellyfish. Also, natural environmental events, such as harmful algal blooms and red tides, can overwhelm pretreatment systems and cause temporary shut-downs of SWRO plants [8,9]. Improvements in the raw water quality can lead to reduction in the complexity of pretreatment systems,

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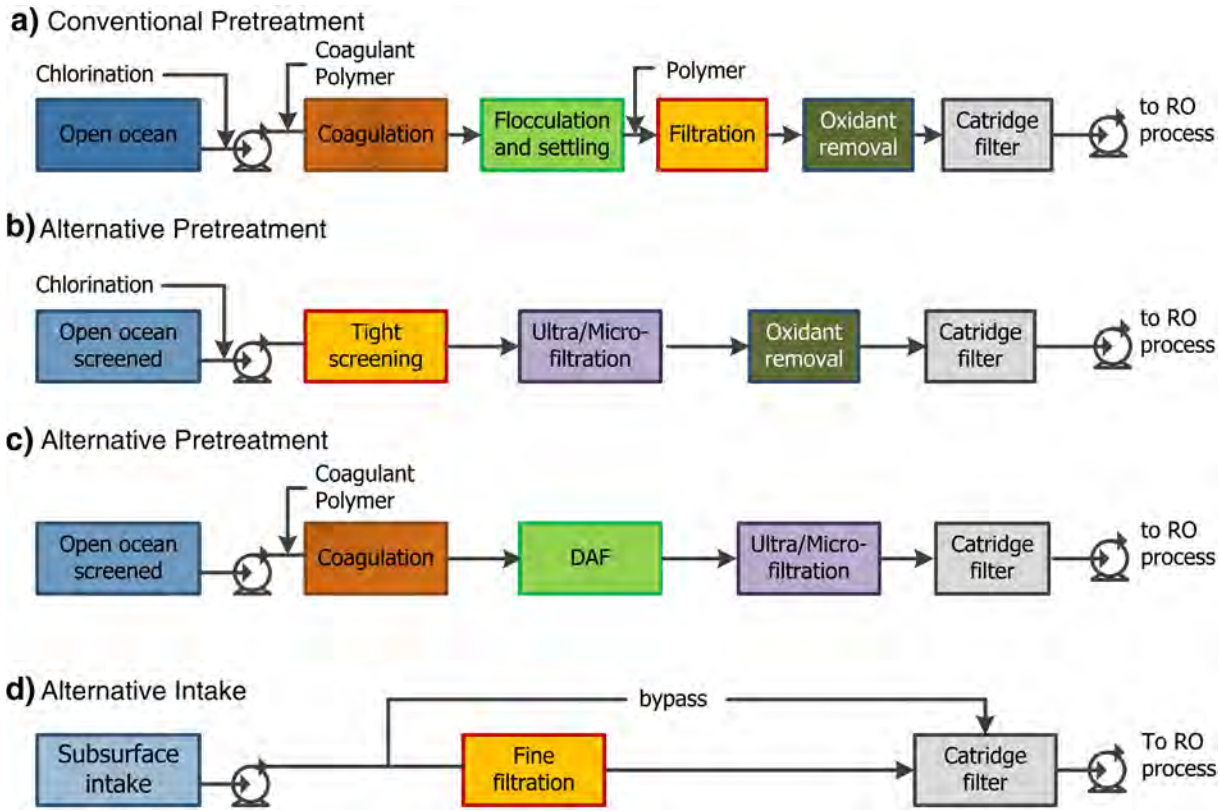

Fig. 1. Diagram showing typical pretreatment process trains for a SWRO plant (a, b, c) with the desired simplified system using a subsurface intake (d). A subsurface intake may be any to produce feedwater that can bypass the pretreatment system and flow directly to the cartridge filters.

thereby reducing the need for physical cleaning and amount of chemicals used, and increasing the operational reliability of facilities (e.g., avoid loss of production during algal blooms). Commonly, feeding higher quality raw water into the primary membrane process leads to a reduction in the rate of organic biofouling, reduced capital cost for construction of pretreatment processes, and reduced operating costs for maintenance, chemical use, and accessory operations. A key issue is how to improve the quality of the feedwater and, as a result, decrease the life-cycle cost of desalination or total cost per unit volume of product water.

The use of subsurface intake systems is one method to improve water quality, to increase operational reliability, to reduce the pretreatment train complexity, and to reduce operating costs [10,11]. Subsurface intake systems use the natural geological properties of sediments and rocks to strain and biologically remove organic matter, suspended sediment, and dissolved organic compounds before they enter the treatment processes [11]. Most of the subsurface processes function in a similar manner to river bank filtration (RBF) or bank filtration systems used to treat freshwaters in Europe and the United States for over a century [12,13]. Investigations of RBF systems have conclusively demonstrated that they are very effective in reduction or elimination of pathogens in the filtered water [14–18] and also reduce the concentration of suspended solids and organic matter entering the primary treatment processes [19]. RBF systems have also been effective at reducing algal toxin concentrations [20]. In Europe, RBF commonly is the primary treatment for many potable water systems with little or no subsequent additional treatment.

There are a number of different types of subsurface filtration systems that can be used depending upon the local geology and environmental conditions. Subsurface intake types can be grouped into two categories which include wells and galleries [11]. Wells can be subdivided into conventional vertical wells, horizontal wells or drains, angle/slant wells, and Ranney wells or collectors. Gallery-type intakes include seabed filters or galleries and beach galleries. It is the purpose of this paper to thoroughly review these subsurface intake types in terms of feasibility, design, function, and applicability to various capacity seawater desalination facilities and include an overview of facility economics.

2. Materials and methods

A general survey was conducted of SWRO plants located globally to ascertain the types and capacities of subsurface intake systems currently being used. Information was obtained from databases, books, and peer-reviewed publications on desalination. Design information was also collected on construction methods, materials, and pump types. At locations where the facility operators could be contacted, data were collected on the raw seawater, the inflow stream before pre-treatment, and after pretreatment. Information was obtained on the degree of membrane fouling experienced and on the frequency of cleaning required at the plant.

Water quality data were also collected from the literature and from some field surveys to assess the impact of subsurface intakes on removal of algae, bacteria, and organic compounds that tend to produce biofouling of membranes. These data were compiled to assess the effectiveness of subsurface intakes on improving overall feedwater quality.

3. Results

3.1. Feasibility of subsurface intakes under various natural geological conditions

Local hydrogeological conditions and the proposed capacity of SWRO plants control the feasibility of subsurface intakes and the specific choice concerning the type of system that best matches the facility requirements [10,11]. Many locations worldwide have local hydrogeological conditions sufficient to develop one or more different types of subsurface intakes while other locations do not have subsurface intake feasibility. A key issue is the pre-design technical assessment of the hydrogeological conditions before the facility design and bid process begin [10,11,21–26]. The pre-design geological and geotechnical investigations should be phased with a preliminary investigation scope developed to assess "fatal flaws" that would eliminate the use of any subsurface intake type and a primary investigation that would provide sufficient data upon which to base at least a preliminary design. In most cases the failure to conduct these investigations would effectively eliminate the use of a subsurface design in the bid process because of the perceived risk factor. The scope of the primary investigation should be developed within the preliminary study report and should contain a minimum amount of field data collection, some groundwater modeling assessment, and some preliminary economic assessments (Table 1). Should a subsurface intake be deemed to be infeasible, then the need for the primary investigation would be eliminated with associated savings in project cost.

There are some general coastal and nearshore characteristics that tend to favor the feasibility of subsurface intake development. The occurrence of permeable rock adjacent to the shoreline is a good indication that a subsurface intake may be feasible. Coastal carbonate aquifers (limestones and/or dolomites) have been commonly used for feedwater supply systems [27,28] (Fig. 2a). Coastal regions underlain by thick deposits of permeable sand, gravel, or a combination of these lithologies also have a high probability of successful development. Sandy beaches that are relatively stable and have adequate wave activity also have a good probability of being useful (Fig. 2b). Unvegetated offshore marine bottom areas that contain quartz or carbonate sands with a low percentage of mud are also acceptable for the development of subsurface intake systems provided that they are not environmentally sensitive (e.g., coral reefs or important marine grass beds are not present) (Fig. 2c). Areas having a high-energy, rocky shoreline containing low permeability rocks are likely not feasible. Low-energy shorelines with associated high-mud content in offshore sediments are also not likely to be feasible.

Table 1
Scope of preliminary and permitting investigations for subsurface intake feasibility to be provided to project bidders.

Regional investigation of coastal characteristics
1. Provide a detailed description of site for the desalination facility and coastal areas available for development of a subsurface intake system
2. Provide historical aerial photographs of the shoreline to assess shoreline stability
3. Provide geologic maps of the coastal area under consideration
4. Provide a copy of any oceanographic investigations conducted for permitting
5. Provide a bathymetric map of the offshore area adjacent to the coastal area of interest
6. Provide bidders with the overall coastal conditions package and give them a maximum distance from the plant in which they could develop a subsurface intake system
Site-specific investigation of surface and subsurface conditions
1. Drill test borings on the beach area at the proposed intake site
2. Construct detailed geologic logs
3. Collect sand samples from the beach and have the grain size distribution of the samples analyzed
4. Construct at least one observation well in any aquifer found to have high hydraulic conductivity, collect a water sample, and provide a chemical analysis of the inorganic chemistry, including analyses of all major cations and anions with alkalinity, hardness silica, strontium, barium, boron, arsenic, and any trace metals of concern (with some organic analyses such as TOC, DOC, TEP, biopolymers, and others)
5. Optional — if an aquifer is found in the test drilling that has a possibility of producing the desired quantity of water, an aquifer performance test should be conducted to measure aquifer hydraulic coefficients.
6. For gallery type intakes — obtain sediment samples from the beach offshore to a distance of up to 500 m and a water depth up to 10 m and have the samples analyzed for grain size properties and hydraulic properties. The sample grid should contain the entire area in which the galleries would be constructed and perhaps some additional areas from which sediment could be transported.
7. Produce a site-specific report containing the test data and any potential recommendations for subsurface intake feasibility.

Fig. 2. Typical coastal characteristics acceptable for the use of subsurface intake systems, a. Limestone shoreline at Sur, Oman, that has a high productivity limestone aquifer, b. Sandy beach in the northern Red Sea Coastline of Saudi Arabia which could support a number of subsurface intake types based on lithology, geology, and wave action, c. Shallow limestone and clean sand area of the Red Sea that could be used for seabed gallery development.

3.2. Well systems

3.2.1. Conventional vertical wells

There are many different types of wells that can be designed and constructed to provide feedwater [11]. The term "beach well" is commonly used to describe the most common type of subsurface intake, but this term is a misnomer that applies to only one class of wells that are directly recharged by seawater close to the beach area. Many well systems used to supply SWRO facilities are located inland away from beaches or even in interior areas of continents where high salinity waters occur at great distance from the sea or in deep regional aquifer systems that contain seawater (Fig. 3) (e.g., New Providence Island systems, Bahamas, the Bolson Aquifer of New Mexico).

The site geology must be adequate to allow individual well yields to be high enough so that the number of production wells needed to meet the required raw water supply is reasonable or cost-competitive with other supply options. In some cases the aquifer hydraulic conductivity found during a preliminary site investigation is insufficient to produce the necessary well yield requirements based on the site size or overall economic considerations. The type and design of a well system should be coordinated with the local hydrogeology and the required capacity needed to supply the facility. Key issues include maximization of the efficiency to withdraw water while meeting the plant capacity requirements as well as improving water quality. The well yields should be designed to match the plant design configuration (e.g., one well per train or two wells per train). Well intake system should have some reserve or emergency standby capacity to meet demands caused by pump failures or scheduled maintenance.

Well intake systems have been successfully used at hundreds of SWRO facilities worldwide with capacities up to 160,000 m^3/d (Table 2). Well intake systems have proven to be a reliable means of providing feedwater with positive impacts on water quality [27–35]. A key issue when a well system is contemplated is to obtain sufficient hydrogeologic information to predict well yields and to reduce operational risk to the facility operator [36]. Technical evaluation methods have been used that allow local groundwater system hydraulics to be evaluated prior to construction with positive operational experience as a result [37]. Well design and construction should follow industry standards with strong consideration of materials because of the highly corrosive nature of seawater (non-metallic casings and conveyance pipe should be used) [38].

Comparative analyses of seawater quality between open-ocean intakes and wells show that well intakes produce significantly lower concentrations of particulate matter, algae, bacteria, and organic compounds that promote membrane biofouling [39–46] (Table 3). While conventional vertical wells do significantly reduce organic carbon and bacterial concentrations, care must be taken to maintain the wells to avoid bacterial growth within the wellbore and periodic disinfection of the wells may be necessary to lower bacterial concentrations if regrowth occurs [47,48]. Based on operation of RBF systems, travel distance and residence time influence water quality changes. All conventional vertical wells used for SWRO intakes will require periodic maintenance to remove any buildup of calcium carbonate scale or a biofilm on the "skin" of the well in open-hole designs or the well screens.

The location of true beach wells is important because they must be recharged primarily by direct recharge with seawater or otherwise seaward movement of freshwater could occur. Induced seaward movement of water has been known to draw contaminated groundwater or water

Table 2
Selected seawater RO facilities using well intake systems.

Facility name	Location	Capacity[1] (m^3/d)	No. of wells
Sur	Oman	160,000	28
Alicante (combined for two facilities)	Spain	130,000	30
Tordera	Blanes, Spain	128,000	10
Pembroke	Malta	120,000	–
Bajo Almanzora	Almeria, Spain	120,000	14
Bay of Palma	Mallorca, Spain	89,600	16
WEB	Aruba	80,000	10
Lanzarote IV	Canary Islands, Spain	60,000	11
Sureste	Canary Islands, Spain	60,000	–
Blue Hills	New Providence I., Bahamas	54,600	12 (?)
Santa Cruz de Tenerife	Canary Islands, Spain	50,000	8
Ghar Lapsi	Malta	45,000	18
Cirkewwa	Malta	42,000	–
CR Aguilas, Murcia	Spain	41,600	–
SAWACO	Jeddah, Saudi Arabia	31,250	10
Dahab	Red Sea, Egypt	25,000	15
Turks & Caicos Water Company	Providenciales, Turks & Caicos Islands	23,260	6
Windsor Field	Bahamas	20,000	–
North Side Water Works	Grand Cayman	18,000	–
Ibiza	Spain	15,000	8
North Sound	Grand Cayman	12,000	–
Red Gate	Grand Cayman	10,000	–
Abel Castillo	Grand Cayman	9000	–
Al-Birk	Saudi Arabia	5100–8700	3
Lower Valley	Grand Cayman	8000	3
West Bay	Grand Cayman	7000	–
Britannia	Grand Cayman	5400	4
Bar Bay	Tortola, B.V.I.	5400	–
Morro Bay	California, USA	4500	5
Ambergris Caye	Belize	3600	–

[1] Capacity is for the well intake (approximated based on published reports or estimated based on the reported capacity of the plant divided by the reported recovery rate or a maximum of a 50% recovery rate where it is not reported).

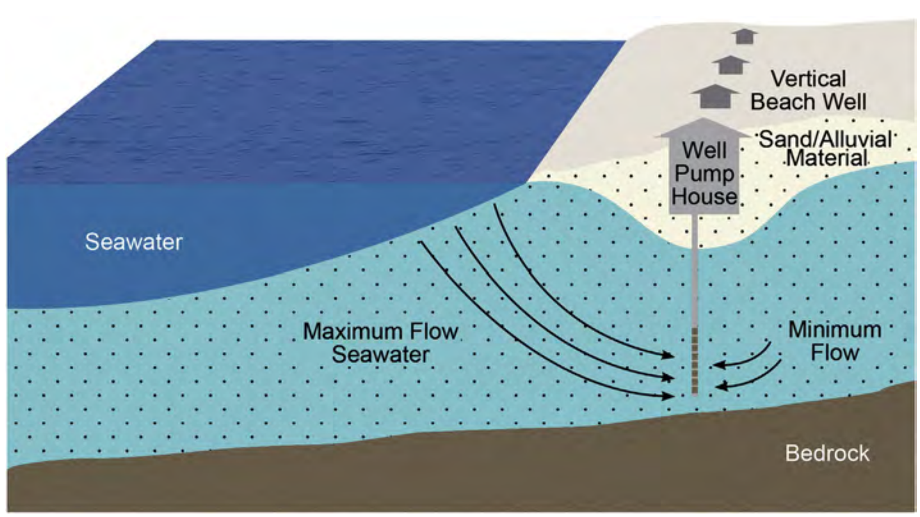

Fig. 3. Well intake system located along a shoreline. This is truly a "beach well" system that promotes direct recharge from the sea and minimizes capture of landward water resources. Minimal flow should come from the shoreline direction to avoid aquifer impacts and entry of poor quality water.

Table 3
Comparison between bacteria, algae, organic carbon compound concentrations in natural seawater verses well intakes from select sites.

Location	Parameter	Seawater	Well 1	Well 2	Well 3	Well 4
Dahab, Egypt [40]	DOC (mg/L)	1.6	1.2	2.3	0.6	0.8
	UV-254 (m^{-1})	1.4	0.8	0.9	0.8	0.6
Fuerteventura Island, Spain [41]	TOC (mg/l)	0.5	0.7			
	UV-254 (m^{-1})	0.36	0.55			
	Phytoplancton, cell/L	57,720	0			
Al-Birk, Saudi Arabia [42]	Dissolved protein (mg/L)	2.73 ± 0.78	0.75 ± 0.08	ND	ND	
	Dissolved carbohydrates (mg/L)	1.57 ± 0.23	0.52 ± 0.15	0.77 ± 0.10	0.50 ± 0.14	
SWCC Al-Jubail test sites [43]	TOC (mg/L)	2	1.2–2			
	Bacteria (CFU/mL), 0, 24, and 72 h	1.8×10^3	1.3×10^3			
		1.1×10^5	3.3×10^5			
		5.6×10^4	4.0×10^6			
Dahab beach well system, Egypt [44]	DOC (mg/L)	1.6	1.2	2.3	0.6	0.8
	UV-254 (m^{-1})	1.4	0.8	0.9	0.8	0.6
Mediterranean location-spring [45]	Total picophyto-plankton (cells/mL)	1.6×10^3	1.3×10^2			
	Synechococcus (cells/mL)	1.3×10^3	1.0×10^2			
	Picoeukaryote (cells/mL)	1.1×10^3	1.9×10^1			
	Nanoeukaryote (cells/mL)	1.2×10^2	1.7×10^0			
Site 1 [46]	TOC (mg/L)	1.2	0.9			
	Polysaccharides (mg/L)	0.12	0.01			
	Humic substances + building blocks (mg/L)	0.5	0.4			
	Low-molar mass acids & neutrals (mg/L)	0.25	0.16			
	Low molar mass compounds (mg/L)	0.33	0.29			
Site 2 [46]	TOC (mg/L)	0.9	0.6			
	Polysaccharides (mg/L)	0.4	ND			
	Humic substances + building blocks (mg/L)	0.26	0.16			
	Low-molar mass acids & neutrals (mg/L)	0.22	0.13			
	Low molar mass compounds (mg/L)	0.38	0.3			

with high concentrations of dissolved iron or manganese into beach wells (e.g., Morro Beach, California beach well system) [29]. High concentrations of dissolved iron or manganese, greater than those found in normal seawater, can create scaling problems in SWRO membranes. Wells located at significant distances from the shoreline can also cause adverse impacts to wetlands or produce water that has salinity higher than that in the adjacent sea (Flagler County, Florida) [49] or as in the case of Morro Beach, California can have high concentrations of dissolved iron or manganese that is common in the mixing zone between terrestrial freshwater aquifers and seawater.

While conventional wells can meet the feedwater requirements of small to intermediate capacity SWRO facilities, there is a limit on the use of wells for large-capacity facilities. When the number of wells and associated infrastructure is too large and costly, another intake system may be required. The issue of well pump replacement and maintenance, even with the use of special-order duplex stainless steel, is an important consideration because of the very corrosive nature of seawater. The ratio of well yield to overall feedwater requirement will dictate the feasibility of using wells as intakes. Also, the use of large numbers of beach wells can raise the issue of unacceptable aesthetic appearance which can adversely influence public opinion and make the permitting of well intakes difficult or impossible.

3.2.2. Angle wells

Angle wells can be drilled from a position near the shoreline with an extension under the seabed or close to it (Fig. 4). Angle-well intakes are currently being evaluated in field and general research investigations [50,51]. One advantage of using angle well technology is that the wells can be set back further from the shoreline compared to conventional vertical wells. This tends to induce primarily vertical recharge through the seabed, produces water that is stable and of similar quality to the seawater in the area, may have a lesser tendency

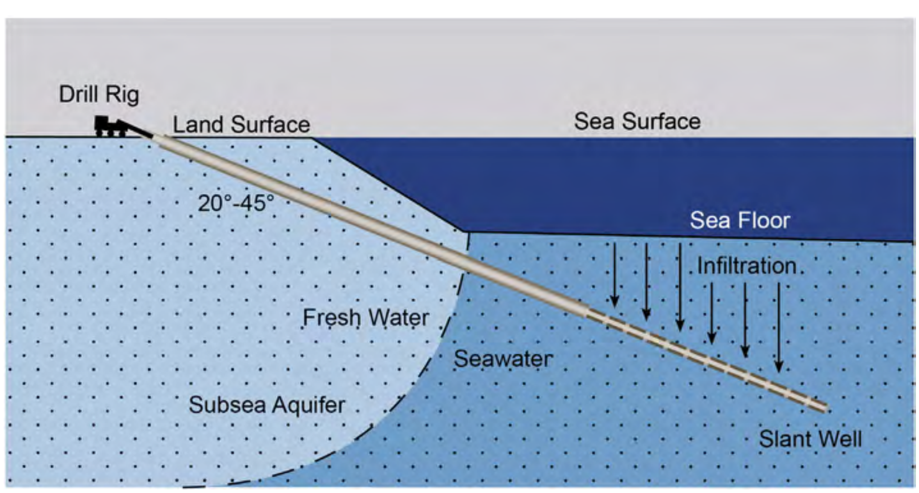

Fig. 4. Diagram showing an angle well intake system. Note that the recharge direction is vertical compared to the typical vertical well intake system and the issue of impacts to coastal aquifers can be avoided.

to induce landward to seaward flow that can cause water quality problems, and better protects pumps and associated infrastructure from storm damage. Also, several wells can be drilled from a single location to create clusters [50] (Fig. 4), thereby reducing the land area necessary for construction and infrastructure development.

Construction of angle wells is more complex compared to conventional vertical wells and requires the use of specialized equipment necessitating corresponding skilled operators. In coastal aquifers consisting of lithified rock, angle well construction is essentially no more complex than conventional well construction, but within unconsolidated sediments, dual-rotary drilling equipment may be required so that a filter pack can be installed with screens inside of a temporary steel casing that is subsequently withdrawn before well development [50]. The dual-rotary drilling method does have some limitations regarding the maximum length (or depth) of the well that can be constructed. This length is dependent on the geological materials penetrated and the diameter of the well. Within unlithified sediments it is likely a maximum of about 150 m for a casing diameter of 30.48 cm [50] or greater, but may be up to 400 m depending on the size of the rig and geologic conditions. Angle wells may also be more difficult to maintain, especially where specialized equipment is not locally available.

Although no large-scale seawater desalination facility currently utilizes an angle well intake system, several facilities are being evaluated in terms of feasibility [51]. It is likely that medium capacity SWRO facilities will be constructed using this type of well intake design. There will always be some limit on the overall yield of angle wells to meet very large-scale capacity SWRO facilities. Angle wells may have greater yields then vertical wells. However, a site-specific economic analysis is required to determine whether the potential greater yield per well (and thus less number of wells) offsets the greater construction and maintenance costs of angle wells.

3.2.3. Horizontal wells or drains

Horizontal well construction has rarely been used in the water industry, but has a variety of potential applications. A key issue is matching the technology to the specific geologic conditions at a given site to maximize the efficiency of withdrawal within the framework of the fundamental groundwater hydraulics. Most unlithified sediments are deposited in horizontal layers that make vertical wells very effective because the screens can be placed perpendicular to the bedding planes and tend to take advantage of the generally high horizontal to vertical ratio of hydraulic conductivity. If it is the purpose of a horizontal well to induce vertical flow, such as in the case of drilling beneath the seabed, then use of the technology does have the advantage of producing high yields per individual well. If the aquifer to be used is semi-confined or not well connected vertically to the overlying sea, then the wells may not be effective in producing high, sustainable yields. Also, great care must be taken in use of horizontal wells beneath the seafloor in terms of water quality because the well may pass through zones of sediments containing varying oxidation conditions along the axis of the well. Mixing of oxygenated seawater with anoxic seawater within the well, especially where hydrogen sulfide is present, can lead to the precipitation of elemental sulfur that would require removal before entry into the membrane treatment process. Also, the oxidation issue can also cause precipitation of ferric hydroxide or manganese dioxide. The configuration of using horizontal wells as intakes for SWRO plants appears to have considerable advantages [52].

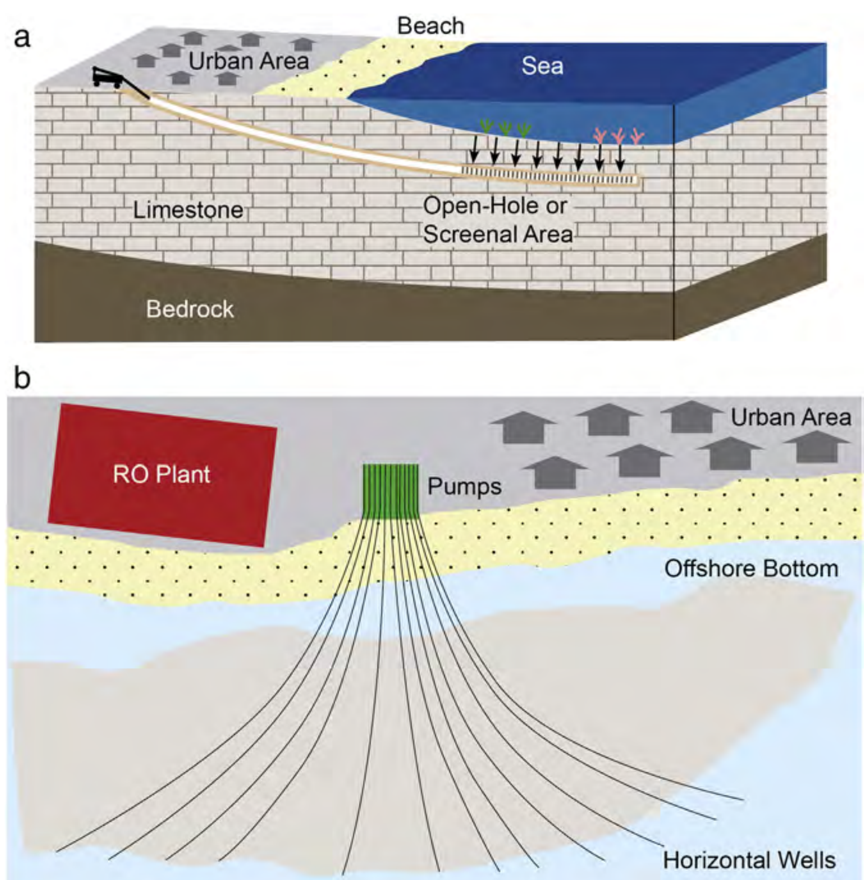

Fig. 5. Horizontal wells can be drilled from the shoreline using older mature technology or the Neodren™ system. a. General configuration of a horizontal system. b. Horizontal well systems can be configured to allow multiple wells to be drilled from a compact location, saving land cost and allowing pumps to be housed in a single building.

In recent years horizontal well intakes have been installed in several facilities in Spain with the highest capacity reported at 172,800 m^3/d [52–57] (Fig. 5a). The Neodren™ horizontal well system has been touted as being a state-of-the-art technology with potential widespread application [55]. Unfortunately, there have been few operating data reported from the larger capacity SWRO facilities currently using this intake type. Data on silt density index (SDI) for a Neodren™ system compared to multi-media filtration and ultrafiltration show a value of 5.1 compared to 3.4 and 3.2, respectively, on one system and 4.6 compared to 2.6 and 2.4, respectively, on another system with the locations of the systems not given [57]. Typical seawater SDI values commonly are greater than 10 (both SDI_{10} and SD_{I5}), which suggest that the horizontal well system does improve water quality. However, no data on organic carbon or bacteria removal are presented in the literature touting this technology.

An issue requiring consideration in the selection of a horizontal well intake is the elimination of feasibility and operational risk. While the assessment of groundwater sources adjacent to the shoreline is rather well established, the hydrogeologic characterization of the offshore sub-bottom requires specialized equipment and methods which are expensive and may still leave questions that cannot be easily answered, such as on sub-bottom oxidation state of the water and horizontal geological variations that could reduce or eliminate productivity of the well(s). The drilling of test borings and obtaining accurate water quality samples can be difficult if not impossible under some conditions, where the offshore bottom slope is very steep or where wave action is intense, not allowing use of barge-mounted drilling equipment.

Another important issue concerning the long-term operation of any horizontal well system is the ability to adequately clean the well when it becomes partially clogged [11]. All well types require periodic maintenance and cleaning which can be easily accomplished in conventional vertical wells using weak acid and various redevelopment processes, such as air or water surging, sonic disaggregation and redevelopment, or some combination of processes depending on the nature of the clogging, such as calcium carbonate scaling, iron nodule precipitation, or biofouling [11,38]. Maintenance work on a horizontal well can be quite complex because of its long distance from the shoreline and the presence of screen in the well that could be damaged during maintenance due to the cleaning pipe traveling on the lower screen surface of the well.

In the event that all obstacles are resolved with construction and maintenance, the use of horizontal well technology has some compelling advantages. An array of horizontal wells can be drilled from a small construction footprint, as shown in Fig. 5b, which allows considerable savings for land acquisition and a single building can house the pumps and associated electrical equipment. Therefore, horizontal well technology should be evaluated if the geology is adequate to support the required well yields, the seafloor does not have a high rate of muddy sedimentation, and the technical and feasibility risks can be minimized. The potential yield of horizontal beds beneath the seabed can be virtually unlimited if the geology is compatible and the risks can be managed. Also, the need for specialized cleaning equipment is likely to be necessary which may not be available in many locations.

3.2.4. Radial collector wells or Ranney collectors

Radial collector wells are characterized by a central caisson typically having a 3 to 5 m diameter with a series of laterals which are screened to allow water flow to move into the caisson during pumping (Fig. 6). Radial wells are commonly used to provide large-capacity intake capability along rivers in parts of the United States and in some European locations [11,58–60]. Operational radial collector well capacities range from 380 to 51,400 m^3/d [59,60]. The only known operating collector well system used for a SWRO intake is located at the PEMEX Salina Cruz refinery in Mexico [26], which has three wells each with a capacity of 15,000 m^3/d.

The geologic conditions that favor a radial collector well design over a conventional or horizontal well design are the occurrence of thick gravel beds at a relatively shallow depth that have a preferentially high hydraulic conductivity compared to the overlying sediments. High-yield radial collector wells could be successfully developed in the gravel unit by installing the collector laterals in the gravel that extend under the seabed. Collector laterals could be installed only on the seaward side of the well to eliminate impacts to fresh groundwater resources occurring in the landward direction and to also eliminate the potential for drawing contaminated water or water having high concentrations of undesirable metals, such as iron and manganese, into the wellfield (Fig. 6).

Proper aquifer characterization is required in the design of a radial collector well intake system. While the test program to determine potential yield of individual wells and the required space between them is relatively easy to perform (same as conventional wells), the assessment of water quality within the sediments can be more complex. It is quite important to assess the redox state of the water to be pumped because radial wells have a caisson that allows air to come in contact with the water originating in the laterals. If the water flowing into the well from the coastal aquifer contains hydrogen sulfide, iron (Fe^{2+}),

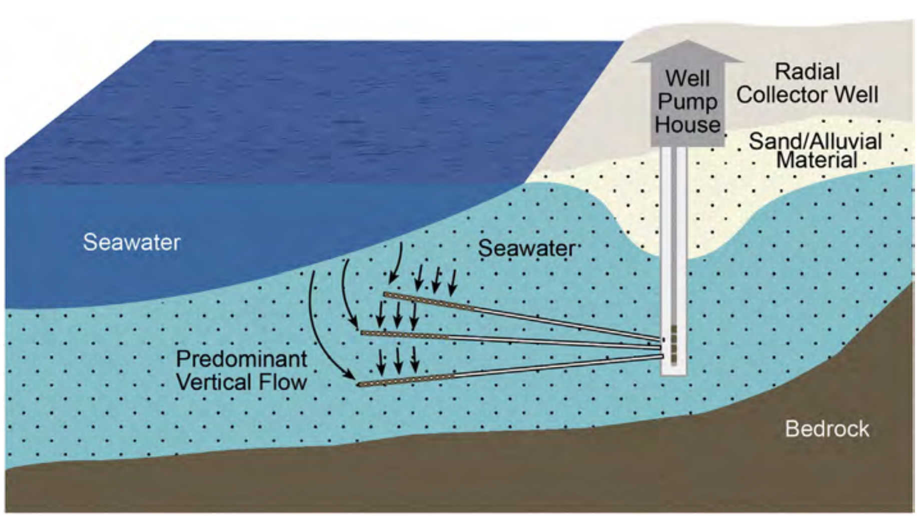

Fig. 6. Typical design from a radial collector or Ranney well. The laterals can be designed to extend beneath the seabed to all only vertical recharge through the seabed, precluding landward impacts. Note that the laterals occur on a single plane and many can be installed.

or manganese (Mn^{2+}), it could react with the dissolved oxygen in the water temporarily stored in the caisson and precipitate elemental sulfur, ferric hydroxide, or manganese dioxide respectively, any of which can foul the cartridge filters and membranes [11,59].

Radial collector wells have an advantage over conventional vertical wells in that the individual well yields can be very high. However, they do require location near the shoreline and are therefore subject to beach erosion and storm wave damage. They could be used to produce large quantities of feedwater in areas where the geology is supportive and the tidal water is relatively calm with low wave action. Since individual wells can yield up to about 50,000 m^3/d, they could be used to supply feedwater to very large capacity SWRO systems. However, no long-term operating data are available on the radial collector wells used for SWRO intakes. There is potentially greater risk associated with radial collector wells because a greater investment in their construction occurs before their performance can be known with certainty.

3.3. Gallery systems

3.3.1. Concept

A gallery intake system design for SWRO intakes is based on the concept of slow sand filtration used in the water industry for more than two centuries [61]. A classical gravity fed slow sand filter, depending on the turbidity of the water being treated, can operate at infiltration rates ranging from 0.1 to 0.4 m/h (2.4 to 9.6 m/d) [61] with minimal need to clean the upper layer of the filter. Modern design criteria for slow and rapid sand filtration tend to have a lower range for the recommended design filtration rate at 0.05 to 0.2 m/h (1.2 to 4.8 m/d which may reflect the treatment of higher turbidity waters [62]).

Gallery intake usage is very applicable to SWRO treatment because sand filters of various designs are commonly used in the pretreatment train in most plants. Slow sand filtration improves water quality by straining and biological activity that can bind or break down many different organic compounds commonly occurring in seawater. Particulate materials are commonly trapped and bound in the upper part of the filter in a layer termed the “schmutzdecke” which is a biologically active layer containing bacteria, bound particulates, and organic carbon compounds. While the entire filter is biologically active, the greatest activity of bacterial treatment occurs in the upper 10 cm of the sand column. Retention time of the water within the filter will tend to increase the assimilation of organic compounds to a greater degree. Therefore, a balance between hydraulic flow rate, which governs the area of the filter footprint, and the retention time that controls the quality of the filtered water, must be achieved. Cleaning a slow sand filter is commonly accomplished by scraping and removing the upper few centimeters of sand with the full sand column being replaced perhaps within a multi-year timeframe.

Testing of slow sand filtration of seawater on a pilot scale has demonstrated significant improvements to feedwater quality [63]. The piloting work was conducted during periods of normal marine bioactivity and during periods of harmful algal blooms. The experimental work on slow sand filtration by Desormeaux et al. [63] showed that the SDI_{15} was reduced to $<$4.0 99% of the time and $<$3.0 90% of the time, the removal of particles $>$2 microns in diameter was greater than or equal to 99%, and the total organic carbon (TOC) concentration was reduced to less than or equal to 2.0 mg/L. The concentration of spiked kainic acid, used as a proxy for algal toxin, was reduced by 89–94%. The operation of the pilot SWRO unit did not require cleaning during the 56-week pilot program and had the lowest amount of foulant observed on the membranes compared to the other pretreatment processes evaluated. The slow sand filter process required no coagulants or other chemicals to be added.

Gallery intakes use the concept of slow sand filtration by creation of an engineered filter that can be located on the beach near or above the high tide line, within the intertidal zone of the beach, or in the seabed. These intake types can be used as part of the pretreatment process, but eliminate the need for a large water treatment plant footprint required by in-plant slow sand filtration and/or dissolved air floatation (DAF).

3.3.2. Seabed galleries

The conceptual design of a seabed gallery or filter has existed since the early 1980's [10,11,64]. To assess the general feasibility and associated operational risks, a marine survey can be conducted to determine the presence of potentially sensitive environmental conditions on the bottom (e.g., marine grass beds or coral reefs), the type of bottom sediment, the general sedimentation rate, and the turbidity of the seawater. At locations where the marine bottom contains clean sand devoid of significant concentrations of mud, there is a high probability that the system is feasible. Since the filter media will be engineered, a key issue is the composition of the naturally-occurring sediment which is an indication of the natural processes acting at a given location. Muddy bottoms have questionable feasibility because mud deposition would clog the top of the gallery. Commonly, muddy bottom areas are associated with river or stream discharges into the sea. Favorable marine processes include currents that keep fine-grained sediment in suspension and move sediment across the bottom, thereby stirring the top of the filter which tends to clean it. Natural macro-scale biological processes, such as bioturbation within the sediment column, can also aid in making the gallery fully functional. Many marine infauna including polychaete worms and mollusks are deposit feeders that ingest sediments to extract nutrients and excrete fecal pellets that act hydraulically similar to sand grains. The deposit feeders act to prevent the building of a biological clogging layer at the sediment–water interface.

Only one large-scale operating SWRO system, the Fukuoka, Japan facility, has been constructed and operated utilizing this type of intake (Fig. 7). The capacity of the Fukuoka gallery is 103,000 m^3/d [65]. It has an infiltration rate of 5.1 m/d with a corresponding retention time of 7 h. Although the gallery infiltration rate is slightly above the normal recommended range for slow sand filtration, it has been operating successfully for 8 years without the need to clean the offshore gallery and with minimal cleaning of the membranes [66]. Monitoring of the feedwater pumped from the gallery shows a very significant improvement in water quality with the SDI being reduced from background levels exceeding 10 to consistently below 2.5 to the beginning of 2010 and mostly below 2.0 thereafter (Fig. 8).

Another seabed gallery has been designed and constructed at the City of Long Beach, California [67,68]. This system has been in the testing phase for a significant time period with infiltration rates ranging from 2.9 to 5.8 m/d [69]. This testing revealed substantial reduction in turbidity, SDI_{15}, total dissolved carbon (TDC), and heterotrophic total plate counts (mHPCs) with some reduction in concentrations of DOC and AOC (Table 4).

The filter media used in slow sand filters in the treatment of freshwater typically consists of graded quartz sand. It has been recently suggested that naturally-occurring carbonate sands may have a greater degree of bioreactivity, thereby potentially causing a greater removal rate of organic compounds [70,71]. Further research will be required to assess this possibility.

Large-scale seabed galleries can be technically complex to construct. In offshore locations where the bottom sediment is unconsolidated, construction requires the use of sheet piling, dredging and temporary dewatering to allow the placement of the bottom intake screens and the filter media (Fig. 9). In locations where the nearshore bottom contains soft rock, the gallery cells can be constructed in the wet using a backhoe resting atop a temporary access road [71]. The development of an artificial filter on the sea floor has been suggested to lessen the difficulty of marine construction [72]. As a greater number of large-capacity systems are constructed, more efficient construction methods will likely be developed to reduce overall construction costs.

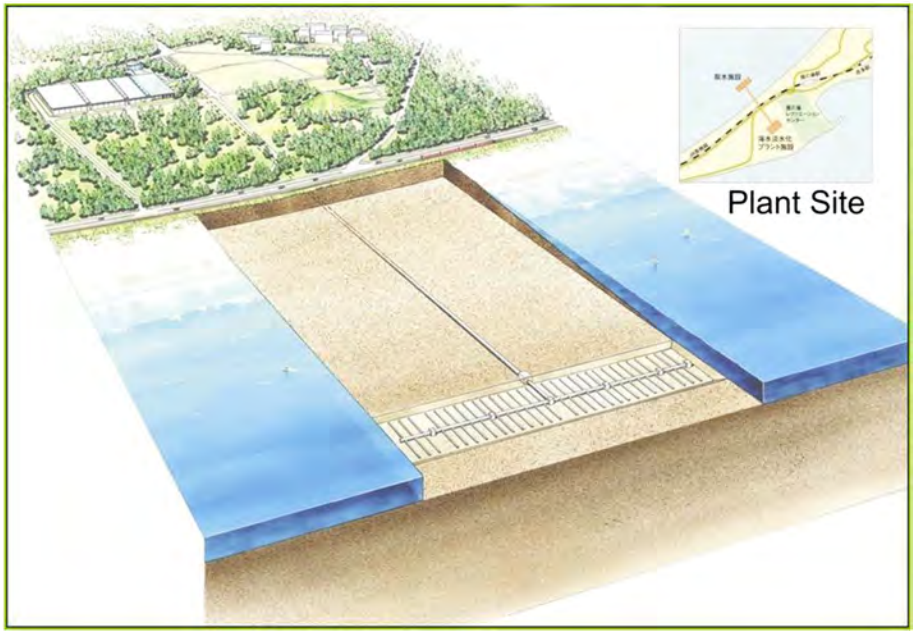

Fig. 7. Seabed gallery at Fukuoka, Japan. This gallery has a capacity of 103,000 m^3/day and has been operating successfully for 8 years [11,23].

Seabed galleries have a minimal environmental impact which occurs only during the initial construction. The major environmental impacts associated with impingement and entrainment of marine organisms in open-ocean intakes are eliminated. The post-construction marine bottom may actually be more productive in terms of infauna due to the increased flux of organic carbon compounds into the filter media over the top of the gallery.

3.3.3. Beach galleries

Another gallery intake type that has very great potential for use in large-capacity SWRO systems is the beach gallery [10,11]. Beach gallery intakes may be preferred over seabed galleries because they can be designed and constructed to be essentially self-cleaning [73]. The gallery is constructed within the intertidal zone of the beach with the mechanical energy of breaking waves being used to continuously clean the face of the filter (Fig. 10).

There are several key criteria that must be met to make beach gallery intakes feasible [74,75]. The shoreline should have significant wave height and a reasonable tidal range to allow the self-cleaning function to work properly. The beach should be relatively stable. While an eroding beach will still allow the gallery to function with the entire gallery continuously submerged, an accreting beach is problematical because the percolating seawater would require a longer flow path and the gallery could dewater if the hydraulic conductively is insufficient to maintain recharge into the gallery at the desired pumping rate. Beach galleries can be constructed successfully only on sandy or gravelly beaches with sufficient thickness of sediment to protect the underlying screens and to eliminate the potential for damage during storms. Care must be taken to design the galleries with sufficient sediment thickness to meet the water quality improvement needs and also to protect the media from storm damage. The thickness of the filter media would be likely greater than that for a seabed gallery.

While no large-scale beach gallery intakes have been constructed to date, several are in design or have been proposed [74]. The use of beach galleries for intakes is compelling because of the potential use for large-capacity systems, the self-cleaning aspect of the design, the lower construction cost compared to seabed galleries, and the minimal environmental impacts.

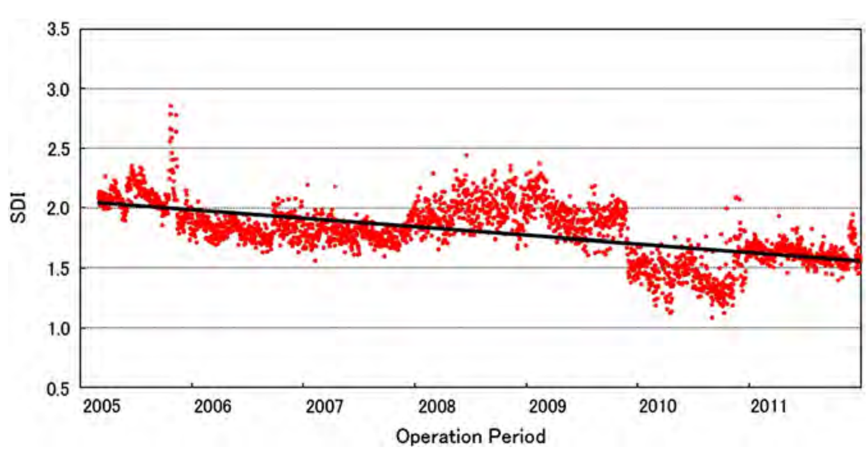

Fig. 8. Long-term variation in the silt SDI of water coming from the seabed gallery at Fukuoka, Japan. The water quality has been consistently good and has improved during the life of the facility [23].

Table 4
City of Long Beach, California seabed gallery water quality test data [68].

Parameter	Infiltration rate (m/d)	Raw seawater (range/mean)	Gallery effluent (range/mean)
Turbidity (NTU)	2.9	1.42–4.8/3.04	0.41–0.70/0.66
Turbidity (NTU)	5.8	1.86–4.56/3.10	0.38–1.23/0.48
SDI_{15}	2.9	Not reported	4.42–5.53/4.56
SDI_{15}	5.8	Not reported	2.74–5.45/4.06
ATP (mg/L)	2.9	1–1000/6.0	1.50–21.0/2.60
TDC (cells/mL)	2.9	3400–1,210,000/54,400	8500–241,000/13,300
mHPC (cfu/100 mL)	2.9	750–470,000/4500	156–5500/1000
DOC (mg/L)	2.9	0.39–0.70/0.41	0.30/0.35/0.35
AOC (mg/L)	2.9	11.0–17.6/12.0/12.0	8.9–11.0/9.8

4. Subsurface intake improvement to feedwater quality

A number of investigations have shown that significant water quality improvements can be achieved by using subsurface intakes instead of open-ocean intakes (Table 3). Recently collected data from the Sur, Oman site demonstrates that subsurface intake systems produce high quality seawater by removing nearly all of the algae, a high percentage of the bacteria, a significant amount of the organic carbon, and a high percentage of the marine biopolymers that are currently believed to facilitate membrane biofouling [76] (Table 5). The removal of virtually all of the turbidity, algae, and the large bacteria allows the use of a simpler, less expensive pretreatment system with a corresponding reduction in operating costs.

Fig. 9. Construction of the City of Long Beach, California seabed gallery system. This gallery required the use of sheet-piling and temporary dewatering to install the gravel and screen system.

In many cases, the water produced from a subsurface intake can be transmitted directly to the cartridge filters, thereby eliminating mixed media filtration, coagulation processes, and the need to use various chemicals (e.g., ferric chloride, chlorine). An example is the Fukuoka, Japan facility that uses a seabed gallery coupled to a membrane filtration pretreatment system, which is likely not needed based on the water quality obtained from the intake. The goal of all subsurface intake systems is to provide seawater that requires no additional pretreatment with the corresponding plant design being similar to brackish-water desalination systems that utilize well intakes and use only cartridge filters (with some chemical additives to prevent scaling) [10,11,77].

5. Economics of subsurface intake systems

Improvement of feedwater quality has a significant impact on the economics of desalination, particularly on operating cost. Therefore, the use of subsurface intakes should reduce the overall cost of desalination. However, the use of subsurface intakes will increase the capital cost for the construction of large-scale desalination facilities in many, but not all cases. While capital cost is important, it is not the major factor determining overall, long-term cost of desalination based on a simple life-cycle analysis. The cost analysis of a SWRO facility is commonly divided into capital or investment cost (CAPEX) and operating cost (OPEX) [78]. Therefore, each type of cost is discussed separately for general input into a preliminary life-cycle cost analysis.

The comparative CAPEX costs of a conventional intake system coupled with pretreatment versus a subsurface intake systems are instructive. For a typical, stand-alone SWRO facility having a capacity of 100,000 m^3/day, the combined cost for the intake, associated pumping station, and outfall is about roughly $30 million USD or about 13.9% of the total facility cost (Table 6). If the intake is separated from this cost, it is about $10 million USD or about 4.6% of total cost. The pretreatment system using conventional gravity filters with coagulation and periodic chlorination/dechlorination has a cost of $25 million USD or constitutes about 11.6% of the total CAPEX. If a dissolved air flotation system and/or a membrane pretreatment system are used, the pretreatment process train cost would be considerably greater. While a subsurface intake system will have a greater CAPEX compared to a conventional open-ocean intake, there will be a corresponding reduction in the pretreatment train cost. If no pretreatment equipment is required, a total of $35 million USD could be used to construct a subsurface intake system without altering the overall project CAPEX. If only polishing filtration is required, the reduction in CAPEX for the subsurface intake system associated pretreatment train would still significantly reduce pretreatment CAPEX cost. Therefore, in some cases the CAPEX cost differential between use of open-ocean and subsurface intakes may be similar and have a minimal impact on overall project cost.

OPEX costs have an overall much greater impact on the net water cost delivered to the consumer compared to CAPEX cost, especially as the useful life expectancy of the facility or the contract duration increases. It is clear that operational cost savings occur as a result of using subsurface intake systems [81–84]. Specific operational cost savings include: 1) reduced cost associated with maintaining an open-ocean intake, such as the use of divers to physically clean it and the periodic or continuous feed of chlorine to control accumulation of biological growth, 2) no need to operate traveling screens with associated removal of debris and disposal of biological waste, 3) no need to operate fish recovery and release programs, 4) no need to add coagulants in the pretreatment system, 5) reduced electrical costs associated with a complex pretreatment system, 6) no use of chlorination/dechlorination, 7) reduction in the frequency of required membrane cleanings, 8) increased life-expectancy of membranes, and 9) reduced labor costs. It is also probable that the higher quality water

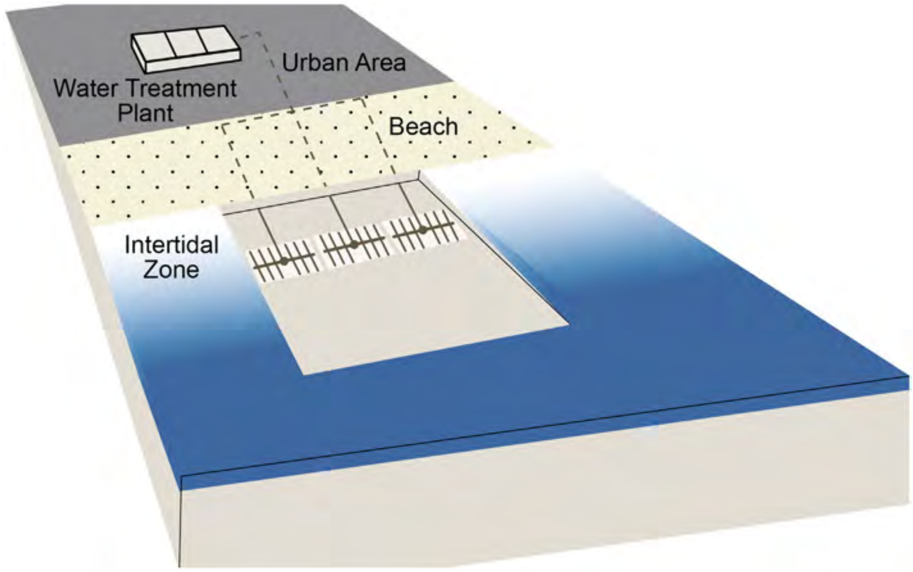

Fig. 10. Beach gallery intake system showing the concept of allowing the breaking waves at the shoreline to mechanically clean the face of the filter, reducing the potential for clogging.

would allow the membrane process to be operated at a higher efficiency by increasing the permeate flux without fear of increasing biofouling. Reverter et al. [85] found at the Palms III plant in the Canary Islands (Spain) that raw water treated from an open-ocean intake required the permeate flux rate to be between 11.8 and 13.4 L/m^2-h, while raw water obtained via beach wells allowed the permeate flux rate to be increased to 16.8 L/m^2-h or an increase of 20 to 30% efficiency. This saves up to 8% in operating cost. Another cost consideration is a reduction in the required environmental monitoring associated with permit special conditions for an open-ocean intake.

Table 5
Comparison of raw seawater and well intake water quality at the Sur, Oman SWRO facility [76].

Parameter	Seawater	Well 1W	Well 9W	Well 12C	Aggregated
Physical					
TDS (mg/L)	55.4	54.3	55.8	55.8	
Turbidity (NTU)	0.91	0.61	0.38	0.30	
SDI_{15}	16.52[a]	0.819	0.996	1.193	
Organics					
DOC (ppm)	0.544	0.101	0.170	0.133	0.128
Biopolymers (ppm)	222	1	8	ND	2
Humic substances (ppm)	520	85	41	91	93
Building blocks (ppm)	425	80	59	77	83
LMW neutrals (ppm)	458	95	150	125	117
LMW acids (ppm)	155	32	49	38	26
Algae					
Prochlorococcus sp. (cells/mL)	4400	<100	<100	<100	<100
Synechococcus sp. (cells/mL)	113,040	<100	<100	<100	<100
Piconanoplankton (cells/mL)	1900	<100	<100	<100	<100
Bacteria					
Total bacteria (cells/mL)	995,310	3270	8540	13,630	11,000
LNA bacteria (cells/mL)	582,750	2270	6110	9520	7540
HNA bacteria (cells/mL)	396,850	940	2230	3900	3266

[a] Seawater SDI was for 5 min instead of 15 min.

There is a large suggested range in potential OPEX savings by using subsurface intakes. If solely pretreatment cost is assessed, the annual savings could be as high as 35% based on a comparison of open-ocean intake versus a beach well system where challenging water quality occurs [81]. A review of relatively small-capacity seawater RO systems showed an OPEX savings range from 10 to 25% [83]. A preliminary analysis of the OPEX savings for all capacities of SWRO facilities using any type of subsurface intake showed a savings range from 10 to 30% based on the plant capacity and the duration of the operating life or contract [84]. A more detailed analysis between plants having open-ocean intakes and conventional pretreatment and those having a beach well system showed a cost reduction of 33.8% [81].

A preliminary life-cycle analysis was conducted to assess how much additional CAPEX cost could be absorbed using a subsurface intake system versus using a conventional intake with a corresponding pretreatment system (Table 7). The cost for a 100,000 m^3/day capacity stand-alone SWRO plant was used as a baseline (Table 6). The cost of a conventional open-ocean intake was assumed to be $10 million USD based on one-third of the line item shown in Table 6. Two scenarios were considered; a facility that would have a subsurface intake with a polishing filtration system with a corresponding reduction in pretreatment CAPEX cost from $25 million USD to $10 million USD and a facility that has a subsurface intake that allows direct discharge of water from the intake to the cartridge filters, which would reduce the pretreatment CAPEX to 0. If it is assumed that there would be zero savings in OPEX for using a subsurface intake, then the maximum CAPEX intake cost that could be induced without increasing the overall cost of water production would be $25 million USD for scenario 1 and $35 million USD for scenario 2. The range of potential OPEX savings using a subsurface intake system was 0 to 30%. The analysis considered OPEX or life-cycle durations of 10, 20, and 30 years. This exercise is significant because there is wide variation in the subsurface intake type that can be used for a specific site, thereby causing extreme variation in intake construction cost. An analysis of the numbers shows that a very large CAPEX investment in the construction of a subsurface intake system can be made without increasing the overall water cost. Considering case 2 with a 30-year operating period, the cost of using a subsurface intake could be as much as 86% of the overall facility CAPEX without increasing the cost of water. In most cases, there will be a clear reduction in cost. Also, this analysis does not consider any cost savings associated with reduction in environmental impacts.

Table 6
CAPEX cost of typical SWRO plant with a capacity of 100,000 m^3/day, including pretreatment [79,80].

Systems	System cost (USD)	Cost partitions (%)	Specific cost (USD/m^3/day)	Supplemental information
Intake, pump station, and outfall	30,000,000	13.9	300.0	
Pretreatment system	25,000,000	11.6	250.00	
–Membranes (MF/UF)		–	–	
–Without membranes	25,000,000	11.6	250.0	
Reverse osmosis part total	80,000,000	37.5	800.0	Isobaric ERD
–Membranes (without vessels)	8,000,000	3.7	80.0	
–Reverse osmosis without membranes	72,000,000	33.4	720.0	
Potabilization plant	10,000,000	4.6	100.0	
Drinking water storage and pumping	10,000,000	4.6	100.0	
Wastewater collection and treatment	5,000,000	2.3	50.0	
Mechanical equipment without membranes	152,000,000	70.6	1520.0	
Auxiliary systems	7,000,000	3.3	70.0	
Civil works	16,000,000	7.4	160.0	
Electrical works	15,000,000	7.0	150.0	
I. & C. Works	7,000,000	3.3	70.0	
Total	205,000,000		2050.0	
Contingencies (5%)	10,250,000	4.8	102.5	
Seawater RO plant total	215,250,000	100.0	2152.5	
	USD/year		USD/year	
Annual capital cost (annuity)	16,838,301		0.46	

Notes: SWRO plant net capacity = 100,000 m^3/day.
Type of pretreatment = gravity filters.
Type of potabilization = lime/CO_2.
Type of intake = open.
Plant lifetime = 25 years.
Interest rate = 6%/year.

Another economic consideration is the location of the RO plant in proximity to an acceptable site on which a subsurface intake could be developed versus using an open-ocean intake at a more proximal location to the distribution system. In locations where seawater quality is challenging, a considerably greater water transmission distance may be cost-effective to locate the plant at a site where treatment cost OPEX would be more favorable, especially where the cost reduction per cubic meter is greater than 20%.

6. Discussion

It is a common misbelief that subsurface intake systems are limited for use on only moderate and small capacity SWRO systems [86,87]. Greenlee et al. [88] stated "Today, as larger and larger RO plants are designed, beach wells cannot always provide enough water, and open seawater intakes are the only feed source option." While these authors may be correct concerning beach wells and their limitations on yield and numbers, beach wells are not the only subsurface intake option available. Horizontal and radial collector wells have the potential to yield very large quantities of water to meet the requirements of a large range of SWRO plant capacities. Beach and seabed gallery systems have the capability under favorable geologic circumstances to meet the requirements of virtually any capacity SWRO system.

Subsurface intake systems are largely a modular design, in which capacity can be increased by the construction of additional wells or galleries. Modular designs thus tend to be more flexible, but have a

Table 7
Economics of subsurface intakes showing the amount capital cost that can be spent on a subsurface intake verses an open ocean intake and not have an impact on the total life-cycle cost based on OPEX savings.

Type of intake	Open ocean intake	Detailed subsurface intake analysis						
Operational period (years)	10 years	10 years						
% of potential saving in operation cost for subsurface		0%	5%	10%	15%	20%	25%	30%
Operation cost ($/$m^3$)	1	1	0.95	0.9	0.85	0.8	0.75	0.7
CAPEX cost	215,250,000	215,250,000						
Annual OPEX cost*	36,500,000	36,500,000	34,675,000	32,850,000	31,025,000	29,200,000	27,375,000	25,550,000
Total OPEX cost along the operational period	365,000,000	365,000,000	346,750,000	328,500,000	310,250,000	292,000,000	273,750,000	255,500,000
Annual capital cost**	29,245,578	29,245,578						
OPEX cost saving	0	0	18,250,000	36,500,000	54,750,000	73,000,000	91,250,000	109,500,000
Annual OPEX cost saving	0	0	1,825,000	3,650,000	5,475,000	7,300,000	9,125,000	10,950,000
Annual capital cost amortization + annual OPEX cost saving**			31,070,578	32,895,578	34,720,578	36,545,578	38,370,578	40,195,578
Principal cost	215,250,000	215,250,000	228,682,159	242,114,318	255,546,477	268,978,635	282,410,794	295,842,953
Capital cost that can be added to the subsurface intake		0	13,432,159	26,864,318	40,296,477	53,728,635	67,160,794	80,592,953
Case 1 (25,000,000): 10 years of operation		25,000,000	38,432,159	51,864,318	65,296,477	78,728,635	92,160,794	105,592,953
Case 2 (35,000,000): 10 years of operation		35,000,000	48,432,159	61,864,318	75,296,477	88,728,635	102,160,794	115,592,953
Case 1 (25,000,000): 20 years of operation		25,000,000	45,932,606	66,865,212	87,797,819	108,730,425	129,663,031	150,595,637
Case 2 (35,000,000): 20 years of operation		35,000,000	55,932,606	76,865,212	97,797,819	118,730,425	139,663,031	160,595,637
Case 1 (25,000,000): 30 years of operation		25,000,000	50,120,817	75,241,634	100,362,451	125,483,267	150,604,084	175,724,901
Case 2 (35,000,000): 30 years of operation		35,000,000	60,120,817	85,241,634	110,362,451	135,483,267	160,604,084	185,724,901

Plant capacity = 100,000 (m^3/day), Interest rate = 6% per year, operation cost = 1($/$m^3$).
* Annual OPEX cost = plant capacity * operation cost * no. of operation days.

** Annual capital cost (annuity cost) = $P\left(i+\frac{i}{(1+i)^n-1}\right)$, where P = amount of principal (Capital), i = interest rate, and n = number of years.

Table 8
Comparative viability of subsurface intake types.

Type	Capacity limit (m^3/d)	Water quality improvement	Technical limitations	Maturity of technology
Conventional wells	<250,000	Major	Local geology, large capacity requirement	Mature
Angle wells	<250,000	Untested	Local geology, large capacity requirement	Immature
Radial collector wells	<500,000	Untested	Local geology, beach stability, large capacity requirement	Mature-non-seawater intake applications
Horizontal wells	Unknown	Minimal testing	Local geology, seabed sedimentation rate, water turbidity	Immature
Seabed galleries	Unlimited	Major	Offshore sedimentation rate, water turbidity	Moderate (one operational system)
Beach galleries	Unlimited	Untested	Shoreline stability	Immature

relatively small economy of scale. Conventional intakes, on the contrary, have a relatively large economy of scale with regard to construction costs. For example, increasing the size (diameter) of a screen and subsea intake pipe can accommodate twice the flow results in a much lower construction cost per unit volume of capacity. Operational costs (e.g., energy and chemical costs) are more proportional to system capacity. Hence for small and mid-sized systems, subsurface intakes can provide both CAPEX and OPEX savings. For large systems, the benefits are predominantly in OPEX costs.

A preliminary life-cycle economic analysis conducted shows that the increased capital cost of using a subsurface intake system is offset by a reduction in capital cost of the pretreatment train (reduced number of processes) and reduced operating costs make subsurface intakes quite attractive. There are a number of specific cost savings in operations which include elimination of traveling screens operation, elimination of solid waste disposal of marine debris, such as fish, jellyfish, and seaweed, reduction or elimination of chemical usage, reduction or elimination of electrical and maintenance costs for the pretreatment systems, and potential increases in the flux rate of seawater across the membranes resulting in increased productivity.

The economic analysis shows that the capital costs for the use of a subsurface intake can be increased by as much as factors of 54, 75, and 86% for corresponding operating periods of 10, 20, and 30 years using the summed life-cycle costs for these timeframes based on a cost reduction factor range of 30% for a SWRO plant with a capacity of 100,000 m^3/day. Therefore, from a purely economic viewpoint, the use of subsurface intake systems is preferred over an open-ocean intake system. It is anticipated that the operational cost reduction would be greater than 15% in nearly all cases. Also, this assessment does not include the elimination of environmental impacts associated with impingement and entrainment of marine organisms which could also be assigned a true cost. This cost includes a reduction in the permitting costs required to demonstrate that a facility does not have a significant impact or can include an elimination of mitigation measures required to offset environmental impacts.

Another factor in the use of subsurface intakes that has been raised is the issue of potential risk for bidders or facility owners in terms of the applicability of a given intake type to a specific site, operational risk for failure or unexpected upsets, and the proverbial question of maturity of technology. There are limits on the use of various subsurface intake types based on the local geology of a site and on the maximum capacity of a type based on the costs associated with operating a large number of wells (Table 8). In general, there are limits on the use of conventional vertical wells, angle wells, and radial collector wells for very large SWRO systems. These intakes likely are limited to feedwater capacity requirements ranging from no greater than a range of 250,000 to 500,000 m^3/day, which equates to permeate capacities ranging from 87,500 to 250,000 m^3/day, depending on the conversion rate (salinity based from 35 to 50%). The technical limitations on use of each intake type are shown, which are most commonly geologic factors or a high sedimentation rate that could produce filter clogging. Conventional well intake systems have been used for the longest time period and must be considered to be the most mature technology with demonstrated success. Radial well and horizontal well systems are operating and have shown to be successful for seawater intake use. The radial well technology is very mature based on applications associated with freshwater intakes adjacent to rivers and streams. Gallery intakes are relatively new and the application to SWRO intakes cannot be considered to be “mature technology”, but the Fukuoka, Japan site has proven to be a quite successful demonstration of the technology. However, the design concept is analogous to the slow sand filtration process that has been used in water treatment for over a century. A fundamental advantage of gallery intake systems is that they can be used to supply virtually any capacity SWRO facility.

7. Conclusions

Fundamental goals for future desalination of seawater include reductions in the quantity of energy and chemicals, in the carbon footprint, and the overall cost of water to the consumer. The use of subsurface intake systems, wherever possible, helps achieve these goals. Subsurface intakes always produce a higher quality feedwater compared to conventional open-ocean intakes. This improvement in water quality leads to the simplification of required pretreatment processes with the elimination of many or all processes. The use of chlorine, coagulants, and other chemicals can be essentially eliminated by the use of subsurface intake systems. Reduction in chemical use and power consumption in operation of pretreatment systems causes a reduction in the carbon footprint of a SWRO system and in potential environmental impacts. Elimination of impingement and entrainment impacts on the environment is also an added advantage of using a subsurface intake system. Finally, the life-cycle cost analysis of virtually any capacity, stand-alone RO treatment system will show that the use of subsurface intake systems reduces the cost of desalination to the consumer, provided that the technology is locally available to construct the system. While not all facility locations can use subsurface intakes, it should always be a priority of a utility, project owner, or project developer to consider the use of a subsurface intake and provide tender bidders with sufficient technical information concerning subsurface or offshore conditions to allow a subsurface intake to be bid without great risk.

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ATTACHMENT TWO

Final Summary Report Doheny Ocean Desalination Project Phase 3 Investigation

MUNICIPAL WATER DISTRICT OF ORANGE COUNTY

South Coast Water District

LAGUNA BEACH COUNTY WATER DISTRICT

Moulton Niguel Water

CITY OF SAN CLEMENTE CALIFORNIA

CITY OF SAN JUAN CAPISTRANO CALIFORNIA

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

DEPARTMENT OF WATER RESOURCES STATE OF CALIFORNIA

U.S. DEPARTMENT OF THE INTERIOR BUREAU OF RECLAMATION

FINAL SUMMARY REPORT
DOHENY OCEAN DESALINATION PROJECT
PHASE 3 INVESTIGATION

Extended Pumping and Pilot Plant Test
Regional Watershed and Groundwater Modeling
Full Scale Project Conceptual Assessment

PREPARED BY
MUNICIPAL WATER DISTRICT OF ORANGE COUNTY
JANUARY 2014

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Prepared by

Municipal Water District of Orange County

January 2014

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MWDOC also wishes to acknowledge the funding support and valuable contributions provided by the MWDOC staffs of the participating agencies throughout the project and their help and guidance provided in numerous technical advisory committee meetings and workshops, without which this project would not have been possible: City of Can Clemente (Dave Rebensdorf), City of San Juan Capistrano (Keith Van Der Maaten and West Curry), Laguna Beach County Water District (Renae Hinchey, Rich Mathis), Moulton Niguel Water District (Joone Lopez, Matt Collings), and South Coast Water District (Betty Burnett, Dave Youngblood, Mike Dunbar, Joe Sovella).

We also wish to acknowledge the project team for all their hard and dedicated work in making this investigation a great success: Carollo Engineers (Gary Meyerhofer, Brandon Yallaly, and Andrew Wiesner), WMI (Dr. Mark Williams), Intuitech (Eric Hoopes), INDAR (Christian Wehrli), SPI (Gerry Filteau, Silvana Ghiu and Mark Donovan), and Geoscience Support Services (Dr. Dennis Williams, Dr. Johnson Yeh, Diane Smith, and Russ Kyle).

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GLOSSARY

AFY	acre-feet per year.
Alluvial/Alluvium	A geologic term describing beds of sand, gravel, silt, and clay deposited by flowing water through which groundwater can readily flow.
Aquifer	A geologic formation or group of formations which store, transmit, and yield significant quantities of water to wells and springs.
Anoxic	A common condition in older natural groundwater where the water is completely devoid of any dissolved oxygen.
ARB	California Air Resources Board
California Ocean Plan	The water quality control plan for the ocean that is established and periodically updated by the State Water Resources Control Board. The plan sets out the standards under which wastewater discharge permits are based upon.
dFe/dMn	Reduced, divalent iron and manganese occur in the dissolved form, primarily as hydroxides in anoxic waters.
D.O.	**D**issolved oxygen
Drawdown	The change in hydraulic head or water level relative to a background condition.
Dual Rotary Drill Rig	A water well drilling rig that combines the ability to drill and construct an outer casing to protect the open hole without the use of drilling muds.
DWR	California Department of Water Resources
Evapotranspiration	The combined loss of water from a given area by evaporation from the land and transpiration from plants.
Fault	A fracture in the earth's crust, with displacement of one side of the fracture with respect to the other. Faults may be impervious to the flow of water due to the grinding of adjacent formation materials into very fine sediments.
Fe/Mn	Iron and manganese
gpm	gallons per minute
Groundwater	Water contained in interconnected pores located below the water table in an unconfined aquifer or located in a confined aquifer.
He/Tr	Helium and Tritium isotopes

LBCWD	Laguna Beach County Water District
MET	Metropolitan Water District of Southern California
MGD	million gallons per day
mg/l	milligrams per liter
MNWD	Moulton Niguel Water District
MWDOC	Municipal Water District of Orange County
Natural Isotope Tracer	Naturally occurring radioactive isotopes provide information about a groundwater's age, which refers to the last time the water was in contact with the atmosphere. They can be used to evaluate the sources of pumped groundwater over time.
NTU	nephelometric turbidity units, a measurement of turbidity and clarity of water.
O&M	Operation and maintenance
OTE	Operations, testing and evaluation
R & R	Repair and Rehabilitation
Ranney or Radial Well	A horizontal well built from a central large shaft with radial intakes horizontally pushed out into the formation, usually spaced equidistantly around the circumference of the shaft. These types of wells allow water to be drawn from the lower portion of river or stream channels to maintain yield during dry periods.
RO	Reverse Osmosis. A treatment process that uses high pressure to force water through very fine membranes.
SDCWA	San Diego County Water Authority
SDG&E	San Diego Gas & Electric
SCWD	South Coast Water District
SDI	Silt Density Index, a measure of the suspended solids in water commonly used to measure the clogging potential of feedwater to reverse osmosis membrane systems.
SJBA	San Juan Basin Authority
Slant Well	A water supply well-constructed at a relatively flat angle.

SOCOD	South Orange Coastal Ocean Desalination Project. Former name of the Doheny Ocean Desalination Project.
SOCWA	South Orange County Wastewater Authority
SWP	State Water Project
TDS	Total Dissolved Solids
UCI	University of California Irvine
UF	Ultra Filtration
USBR	United States Bureau of Reclamation
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
WHOI	Woods Hole Oceanographic Institute
µ	Micron

A. Project Information

1. Type: Ocean Desalination Feasibility Investigation
2. Title: Phase 3 Doheny Ocean Desalination Project – Extended Pumping and Pilot Plant Test, Regional Watershed and Groundwater Modeling, and Full Scale Project Conceptual Assessment
3. Start Date: January 11, 2008
4. End Date: December 31, 2013
5. Grant and Funding Information:
    a. California Department of Water Resources, Prop 50 Grant Agreement No. 4600007435 for $1,500,000.
    b. U.S. Environmental Protection Agency, STAG Grant Agreement No. XP-00T40501-0, for $848,000.
    c. U.S. Bureau of Reclamation, WaterSmart Grant R10AP35290 for $499,000
    d. Project Participants (South Coast Water District, City of San Clemente, City of San Juan Capistrano, Moulton Niguel Water District) Local Funding totaling $3,300,000.
6. Grantee and Managing Agency: Municipal Water District of Orange County
7. Contact: Mr. Karl W. Seckel, PE, Program Manager; Mr. Richard B. Bell, PE, Project Manager and Principal Engineer
8. Phase 3 Total Project Cost: $6,147,000.

B. Executive Summary

The Municipal Water District of Orange County (MWDOC) in partnership with five participating agencies, investigated the feasibility of slant wells to extract ocean water for the planned Doheny Ocean Desalination Project (aka Dana Point and South Orange Coastal Ocean Desalination (SOCOD) Project). The Phase 3 Extended Pumping and Pilot Plant Test, Regional Watershed and Groundwater Modeling and Full Scale Project Conceptual Assessment work were initiated in January 2008. The five participating agencies provided technical review and elected official decision-maker direction through a project governing committee structure. MWDOC provided overall project management, project development and permitting, technical support work, and staffed the committee.

Project Location and Development of the Doheny Ocean Desalination Project

The Phase 3 test facilities are located in Doheny State Beach in Dana Point, California. The test facilities consisted of the Test Slant Well, submersible pump, control vault, two monitoring wells, conveyance lines, the Mobile Test Facility, electrical service, and a temporary diffuser for discharge to the surf zone.

The full scale project would produce 15 MGD of drinking water (95% operational load factor = 15,961 AFY) and would be situated on a nearby 5-acre parcel being reserved for the project by South Coast Water District. The project site is crossed by the two regional imported supply pipelines and the adjacent San Juan Creek Ocean Outfall has sufficient brine disposal capacity. The major technical issue for the project was to determine the most cost-effective method to produce ocean water.

Figure 1A - Schematic of Test Slant Well

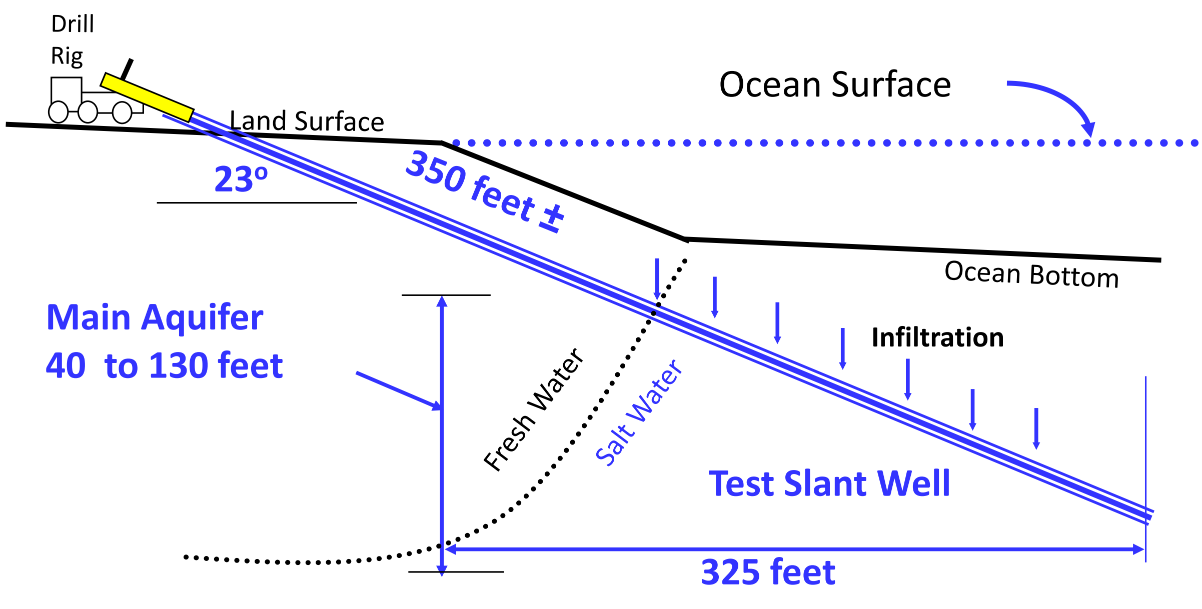


Figure 1B - Schematic of Doheny Desal Project Layout

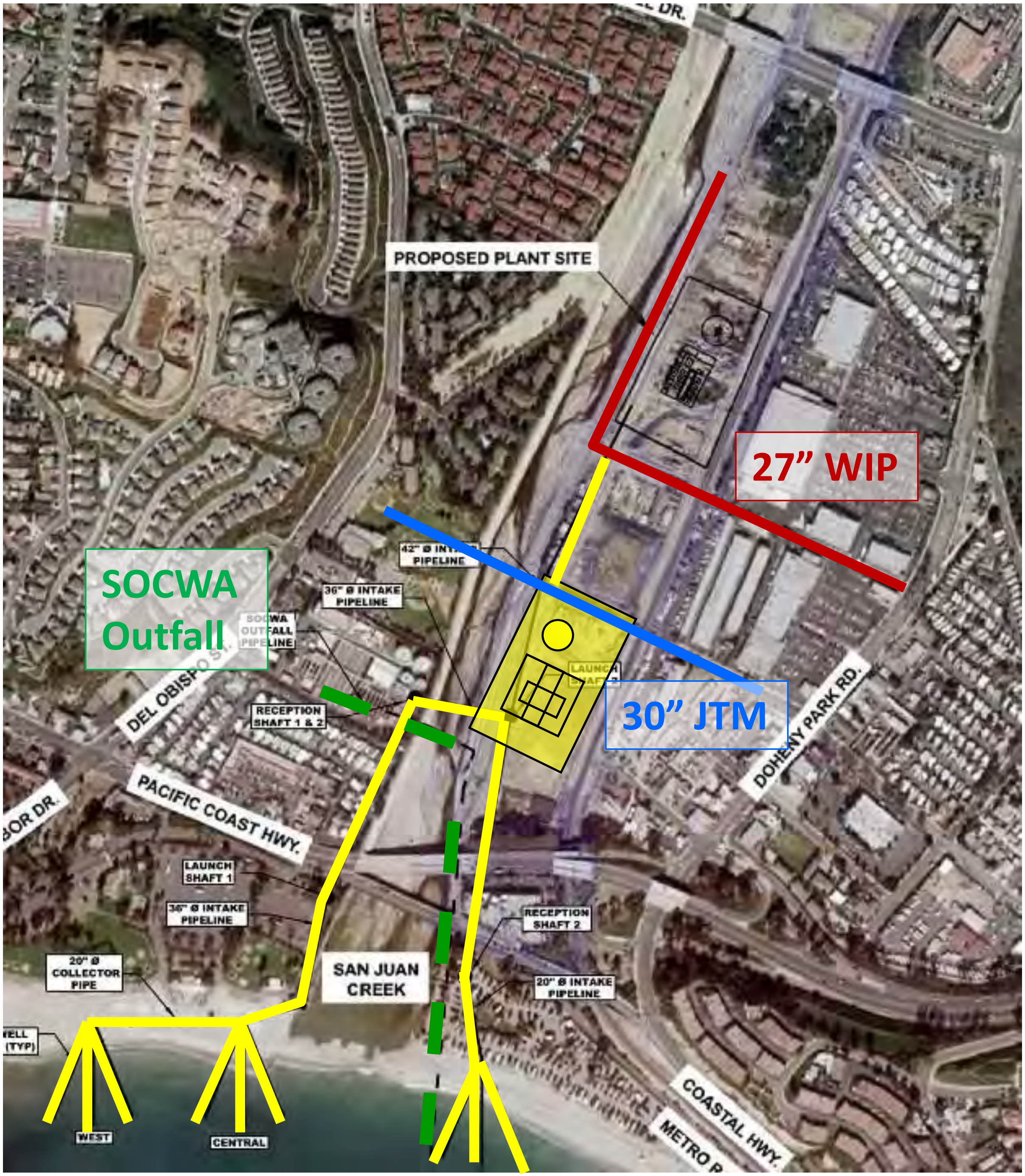


Figure 2 - Schematic of Test Facility

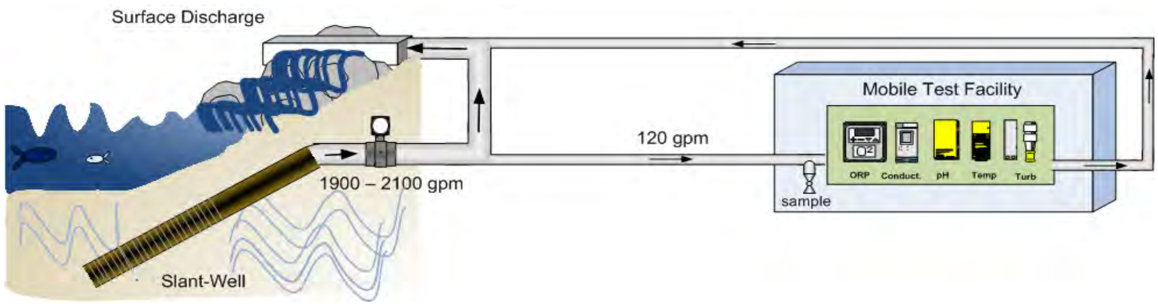
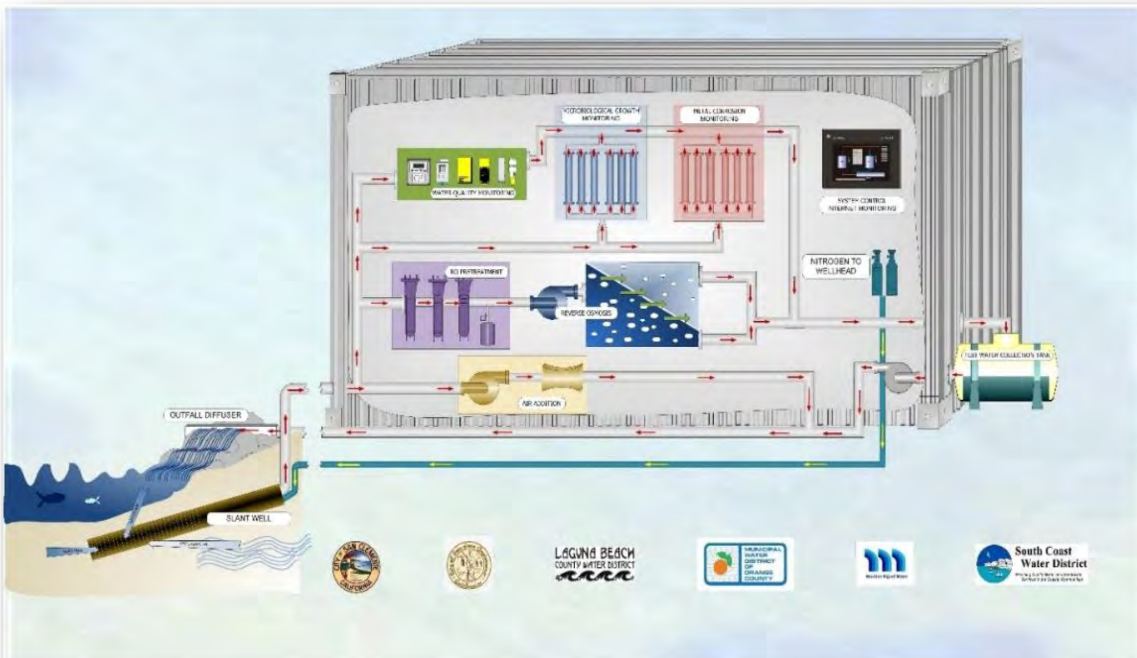


Figure 3 - Layout of Test Facilities

In 2003/04, MWDOC undertook preliminary studies to assess alternative approaches to produce ocean water in the vicinity where San Juan Creek discharges to the ocean in Dana Point. Options included a conventional open intake, a subsurface infiltration gallery, and various types of beach wells. A flat continental shelf in this location would require that a conventional open intake be situated about 7,000 feet offshore to provide sufficient depth for protection of the intake. Due to the

Figure 4 - Mobile Test Facility (MTF)



expected high cost and difficult permitting for an open intake system and based on early discussions with the California Coastal Commission staff, a decision was made to investigate the feasibility of constructing a subsurface intake system using a horizontal or angled well construction method. Infiltration galleries were deemed infeasible due to high costs, ocean floor impacts, clogging, decreasing yields and maintenance challenges. Radial wells (aka Ranney Wells) were deemed infeasible due to high costs, a long construction period that would exceed the 8-month off-season construction window allowed by State Parks, limitations on the ability to gravel pack the laterals, and the limitation to extend the laterals at significance distance out under the ocean.

To investigate the feasibility of a subsurface slant well intake, a phased hydrogeology and subsurface well technology investigation was undertaken. In 2004/05, four exploratory boreholes were drilled along the beach to a depth of 188 feet below the ground surface. The boreholes encountered highly permeable alluvium throughout their depth. In 2005/06, after a thorough review of several technologies it was determined that the most cost-effective approach for this location was the use of slant beach wells constructed with a dual rotary drill rig from the beach out under the ocean. A test slant well was deemed necessary to evaluate the aquifer response, water quality, and aquifer filtration. Groundwater modeling was also necessary to evaluate the impacts of the project draw on the groundwater basin associated with San Juan Creek and to determine the potential capacity of a slant beach wellfield.

In 2005/06 with grant funding support from the California Department of Water Resources, U.S. EPA and U.S. Bureau of Reclamation and MWDOC, a demonstration Test Slant Well was permitted, designed and constructed and a short-term aquifer pumping test was performed. Initial groundwater modeling indicated a full scale slant wellfield could produce about 30 million gallons per day at acceptable drawdowns to wells in the local vicinity. The results from this demonstration well were encouraging and it was then determined that an extended pumping and pilot plant test was necessary.

Phase 3 Extended Pumping and Pilot Plant Test – AN OVERVIEW

The extended pumping and pilot plant test required the installation of a submersible pump, vault with control valves, a diffuser for surf zone discharge of the pumped water, conveyance lines to and from a mobile test facility, and electrical service. MWDOC conducted the planning, environmental documentation and permitting with the assistance of consultants. The mobile test facility was designed by Dr. Mark Williams and the submersible pump was designed by Bayard Bosserman under contracts to MWDOC. The Mobile Test Facility was procured from Intuitech and the submersible pump was procured from INDAR. The remainder of the test facility infrastructure was designed by Carollo Engineers and awarded to and constructed by SCW Contractors. This work was conducted in 2008 to 2010.

Separation Processes (SPI) was the contractor selected for the extended pumping and pilot plant Operations, Testing and Evaluation (OTE) work. They were awarded the work through a competitive proposal/interview process that consisted of staff from the participating agencies and outside experts. The OTE work consisted of pumping the test slant well for a period over 21 months to evaluate the performance of the pump, well and aquifer and to determine water quality produced from the marine aquifer, filtration performance of the aquifer, and corrosion and microbial fouling potential. In addition, the work included iron/manganese pretreatment pilot tests.

The testing work found that the pump and aquifer performed exceptionally well. The well experienced some sand clogging that was due to insufficient well development which was a result of a decision to construct the test slant well with only a 12-inch internal diameter (to reduce costs) and to utilize a high speed submersible pump that would enable a shorter test duration at high pumping rates to adequately stress the aquifer. This problem should not occur in the full scale project as proper and full development would be provided and the well would be equipped with a lower speed production pump.

Over the extended test period, the salinity increased from 2,500 mg/l to over 17,000 mg/l, which was fairly close to what was predicted by the initial variable density groundwater model. It is estimated, that under constant pumping it would have eventually reached about 32,000 mg/l when fully connected with the ocean assuming 95% ocean water at 33,700 mg/l (average of analyses during Phase 3) and 5% brackish groundwater at 2,200 mg/l. The increase in salinity showed that ocean water was slowly being pulled into the well over the test period. A major and unexpected finding was the high level of dissolved iron and manganese contained in the pocket of old marine groundwater that lies under the ocean. This water was anoxic (devoid of oxygen) and slightly acidic, and was found to be about 7,500 years old. From the groundwater modeling work, it was estimated that under full production capacity, the old marine groundwater would be mostly pumped out and replaced by ocean water within a year or so. However, further work is needed to zero in on this time estimate.

The pump out of the old pocket of marine groundwater will likely significantly reduce or potentially eliminate the need for iron/manganese pretreatment. There is also some uncertainty whether the pumped water would remain anoxic under full scale production. In all other respects, the produced water showed a very low silt density index (average around 0.5 units) and turbidity (averaged around 0.1 NTU), indicating excellent filtration by the aquifer which eliminates the need for conventional pretreatment filtration and saves costs.

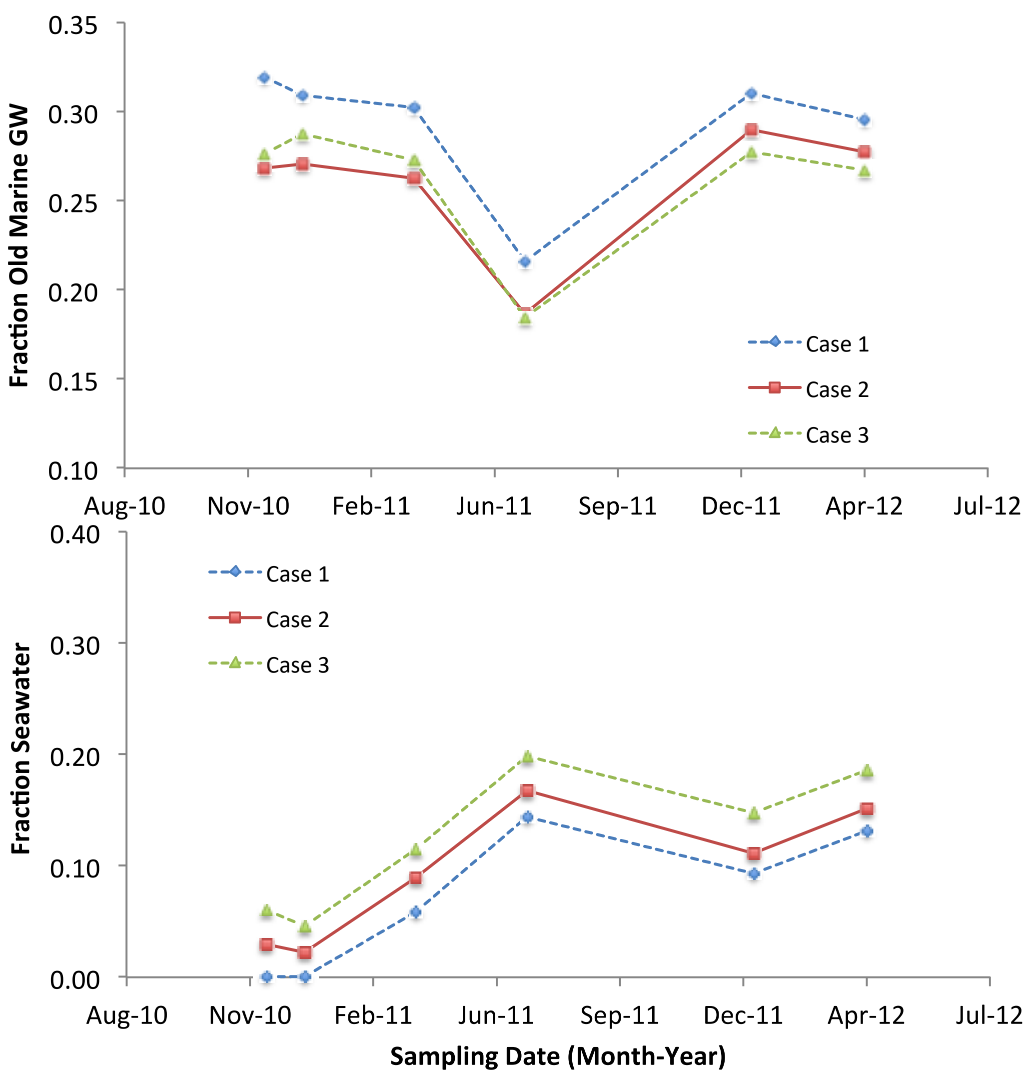
In addition, the produced water showed no presence of bacterial indicator organisms which were found to be present in high concentrations in the ocean and seasonal lagoon. Initial pump out of the brackish groundwater showed higher levels of TOC (Total Organic Carbon) which decreased with increasing production of marine groundwater and ocean water. During the initial period of pump out, a higher level of groundwater bacteria were observed which steadily decreased to extremely low levels. Biofilm growths by the end of the test were found to be less than 10 µ in thickness, a level of no concern for biofouling.

Pumped well water was run directly to the test RO units continuously for over four months. No fouling or performance deterioration was observed during the test or in the post-membrane autopsy as all the dissolved iron and manganese was easily removed as anoxic conditions were maintained throughout the test period.

A pilot plant study was conducted to test advanced iron/manganese removal pretreatment systems. The tested pretreatment processes were oxidized pressure filtration and pre-oxidized UF membrane filtration. Column tests were performed to determine the best media, oxidants, and dosages. Oxidation and sedimentation tests were also performed to evaluate approaches for use during well development to meet discharge requirements. The results showed that the oxidized advanced media filtration process provided higher levels and consistency of removal. A final decision on whether pretreatment would be required must wait until the initial period of pump out of the old pocket of marine groundwater is accomplished. It is recommended that prior to final design, that a final pilot plant test be conducted on the produced water after it has stabilized and the old pocket of marine groundwater has been pumped out.

To determine how much ocean water was being recharged into the aquifer and pumped, natural isotope testing and analyses were conducted throughout the test. This work utilized a multiple tracer approach to quantify the groundwater source captured by the slant well intake. Tracers included natural isotopes of radium, helium, tritium and radiocarbon. Three iterations of a mixing model that utilized the multiple tracer dataset were performed. The model runs suggested ocean water recharge capture was 14-20% by the end of the test with the remainder being a mixture of old marine and brackish groundwater. At the beginning of the test the capture was 0-6%. The 6% range in the model estimates can be narrowed by sampling of the old marine groundwater (see Figure 5).

Figure 5 - Natural Isotope Model - Slant Well Source Production



If the pumping test were to have continued, the old marine groundwater would have been most likely fully pumped out of the offshore formation and replaced by ocean water. Under steady state pumping conditions, there is a high probability that the pumped water would contain very low levels of dissolved iron/manganese. This would result from a combination of the infiltration and plug flow movement of the oxic and slightly alkaline ocean water into and through the aquifer that is reduced to either slightly oxic or anoxic groundwater as a result of microbial activity that consumes dissolved oxygen depending on the amount of available organic carbon. Furthermore, given the observed levels of dissolved Fe and Mn in the old marine groundwater, it is unlikely that their in-situ precipitation from any boundary mixing of oxygenated seawater recharge flows would have a measurable impact on the aquifer permeability at the expected Fe and Mn concentrations, especially under the plug flow conditions that would largely occur. Further, the accumulation of Fe (and Mn) oxides is likely present within the upper shallow aquifer where there is a likely redox boundary where iron precipitation would occur under groundwater ocean discharge conditions. With pumping, ocean water would flow down into the aquifer.

There are two likely locations for precipitation: (1) in the shallow zone of the terrestrial-marine groundwater interface before the water discharges into the ocean and (2) in the shallow sediments on the ocean side of the ocean water interface, where wave and tide driven pore water exchange drive high pH and oxygen rich groundwater into the aquifer. Altogether, under steady-state pumping conditions, this zone would likely contribute little iron to the ocean water that would infiltrate and move through the aquifer to the wellfield. The presence of organic carbon and aerobic bacteria in the shallow seafloor sediments utilizes the oxygen in the ocean water rendering it anoxic, as demonstrated over the extended pumping test. Further evaluation of the organic carbon content in the shallow sediments and sources should be evaluated to determine if the anoxic condition of the recharged ocean water would be maintained over the long run.

Initial Pump Out and Disposal of Old Marine Groundwater

The alluvial channel within the continental shelf offshore of San Juan Creek was submerged by the ocean following the end of the last ice age. Under current conditions, subsurface outflows from San Juan Creek discharge out under and up into the ocean within the area shoreward of the saltwater interface. On the ocean side of this interface, the ocean filled alluvium groundwater has remained isolated since its inundation about 7,500 years ago. We have termed this “older” ocean groundwater as “old marine groundwater”.

Testing found that the old marine groundwater is slightly acidic, anoxic and enriched with reduced, divalent, dissolved iron and manganese. Dissolved iron and manganese concentrations increased by the end of the test to a peak of about 11 mg/l and 5 mg/l, respectively. Their concentrations in the old marine groundwater may range from 11 mg/l to as high as 30 mg/l, but the current range is inconclusive due to a lack of offshore aquifer water quality and microbial community conditions.

Water quality and isotope testing provided data to estimate the relative mix by source of the pumped groundwater over the test period. Based on the natural isotope data/model, the pumped water was first mostly brackish groundwater which then steadily decreased as ocean water steadily increased from zero to about 17%, and old marine groundwater. The fraction of old marine groundwater started out at zero, reached an apparent maximum of about 29% before decreasing and in time would have been fully replaced by replaced by recharged “young” ocean water. See Figure 6 for an illustration of how the change in source water would occur over time. Under the full production rate of 30 mgd ocean water recharge would be greatly accelerated from what was observed under the Phase 3 test of 3 mgd.

As illustrated, the source of water being pumped out will continually change in make up until it reaches a steady state condition. For the full scale project, initial modeling suggested that under steady state conditions the extracted well water would reach about 5% brackish groundwater and about 95% ocean water ("young" marine groundwater).

The Phase 3 test data is planned to be utilized in the calibration of a fine grid coastal groundwater flow, variable density, and geochemical model. The fine grid model will help to better predict pumped water quality over time and by source, to evaluate drawdown effects, and seawater intrusion and controls.

Under the full scale project, during the period of initial pumping when the pocket of old marine groundwater is being pumped out and replaced by "young" ocean water, there are two major questions:

(1) How long will it take to pump out the pocket of old marine groundwater?

(2) What is the best approach for handling the old marine groundwater?

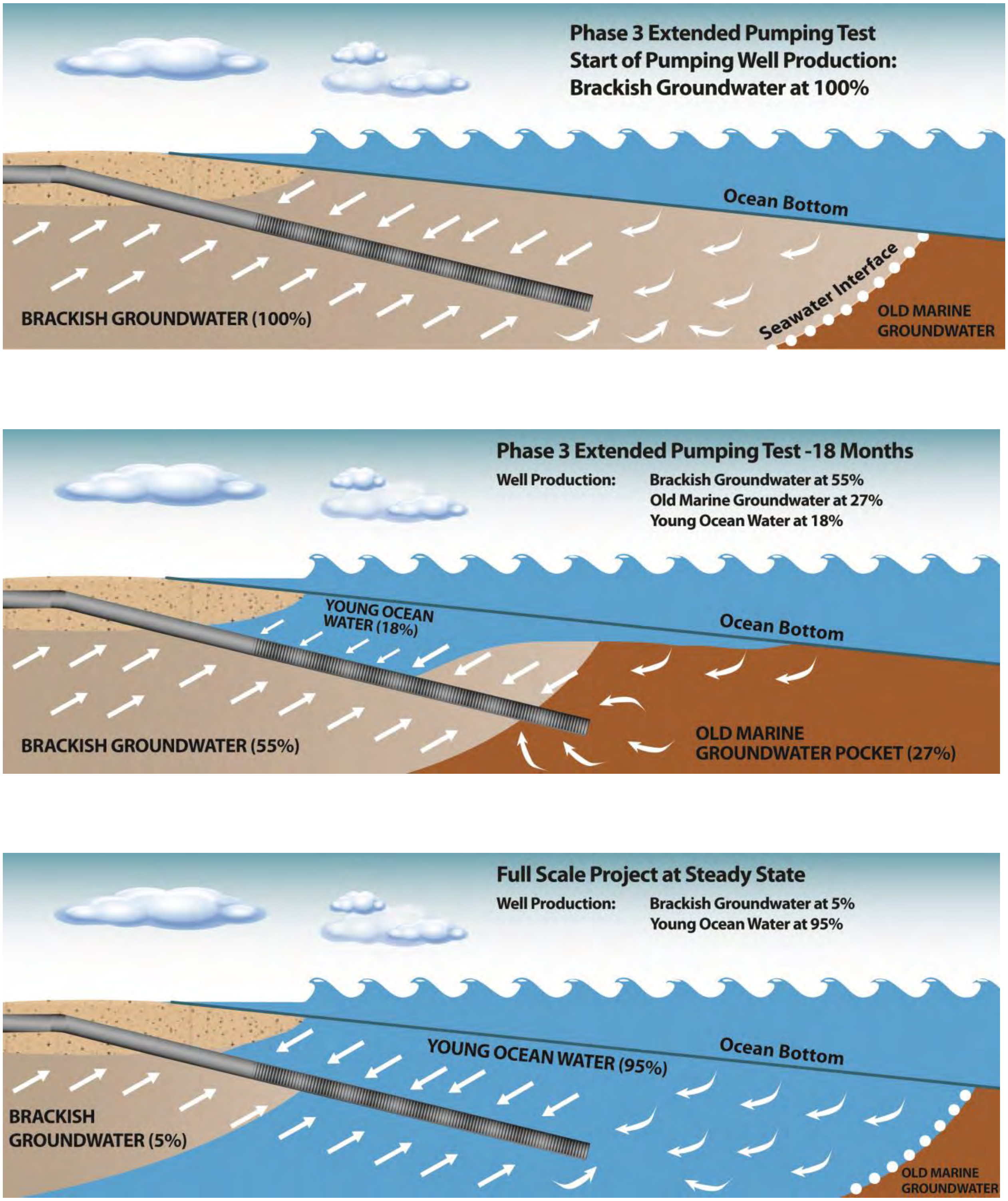
We see two basic approaches for construction of the full scale 30 mgd slant well intake capacity project: (1) include in the desalination plant an iron/manganese pretreatment unit (capital cost estimated at $50 million), or (2) pump out the old pocket of marine groundwater before completing the design and construction of the desalination plant, since it is expected that levels will drop significantly under steady state conditions to levels which will either significantly reduce or avoid the need for Fe/Mn removal.

In addressing the first approach, Arcadis (Malcolm Pirnie) assumed that the steady state iron concentration would remain constant at 6 mg/l and developed capital and O&M cost opinions for handling this amount of dissolved iron. This approach assumes a constant high level of iron/manganese throughout the project life. This is unlikely the case.

It should be noted that during the Phase 3 test, the iron concentration in the pumped water reached 11 mg/l and was fairly constant for several months. However, when considering the full scale project slant well intake production rate of 30 mgd, based on initial modeling, it would be expected that the old marine groundwater would be pumped out in about one year, reducing the concentration of iron/manganese in the feedwater to very low levels. As previously noted, the fine grid, variable density, geochemical model will aid in better understanding the old marine groundwater pump out time as well as aiding in understanding changes in water quality during the pump out period and what might be expected under steady state conditions.

For the second approach to be feasible, we need to better know how long it will take to pump out the old marine groundwater until it is fully replaced with "young" ocean water and reaches steady state conditions. During the Phase 3 test, the iron levels increased steadily and then stayed relatively constant after reaching about 10 mg/l after 8 months of pumping and then slightly increased to 11 mg/l near the end of the test; the increasing amount of "young" ocean water and the slightly decreasing fraction of old marine groundwater kept the iron concentrations relatively flat over the last year of the test. The isotope data showed a slightly decreasing fraction of old marine groundwater being pumped over the test, as the "young" ocean water recharged the marine aquifer area where brackish groundwater had discharged out under the ocean. The location of the seawater interface was previously estimated at about 1,100 feet offshore under 2005 wet hydrologic conditions and lower basin pumping. For comparison, it is worth noting that the estimated volume of the brackish water from the shoreline to the saltwater interface was about 1200 AF (at a specific yield of 10 percent) under 2005 conditions and over the Phase 3 test the pumped volume of brackish water was estimated at about 3,600 AF out of a total volume of 5,286 AF by a salinity model that used actual test data (see Figure 6).

Figure 6 - Illustration of Slant Well Source Water Production vs. Time



Modeling will be required to evaluate the change in fraction of source water reaching the full scale project wells as a function of pumping rate and duration. Based on the earlier Phase 2 modeling, it had been roughly estimated that the old marine groundwater could be fully pumped out within about a year or so at the much higher 30 mgd production rate. The fine grid model will improve this estimate. At steady state after pump out of the old marine groundwater, the wells were predicted to produce about 95% “young” ocean water and 5% brackish groundwater.

The blended concentration at steady state is expected to be low from the large dilution of the “young” ocean water component. The iron/manganese concentrations at steady state are largely dependent on the concentration of iron/manganese in the brackish groundwater reaching the wells and if there is any trace amount of old marine groundwater remaining. Ocean water in the vicinity of the project is fully oxidized and would be expected to have a very low level of iron/manganese (levels are higher near the shoreline and decrease offshore away from San Juan Creek). As the ocean water is recharged into the aquifer, it is anticipated that the ocean water will pick up some dissolved Fe. Under steady state conditions, the produced water is expected to have a dissolved iron concentration around 0.10 mg/l assuming brackish groundwater iron at 2.0 mg/l. At this low total iron concentration the RO membrane should not have a problem removing any oxidized portion of the dissolved iron/manganese in the produced water. However, some chemical conditioning may be required to minimize cleaning. If higher concentrations occur, higher oxidized media filtration rates than assumed by the Arcasdis cost estimate could be used to remove iron/manganese at much lower capital and O&M cost.

If an injection barrier is found to be necessary to reduce drawdown impacts, in time both the injected and slant wellfield produced water would likely be largely free of dissolved iron/manganese.

Further fine grid flow, variable density and geochemical modeling is necessary to provide a better estimate of the pump out time, to estimate produced water quality over time, and to estimate pumped water quality under typical or steady state conditions. Offshore hydrogeology borehole lithology and water quality data and geophysical surveys for alluvial channel structural data will be necessary to fine tune these estimates during the project design, but are expensive to obtain. With operational data, the best method of handling the old marine groundwater iron/manganese loads can then be determined.

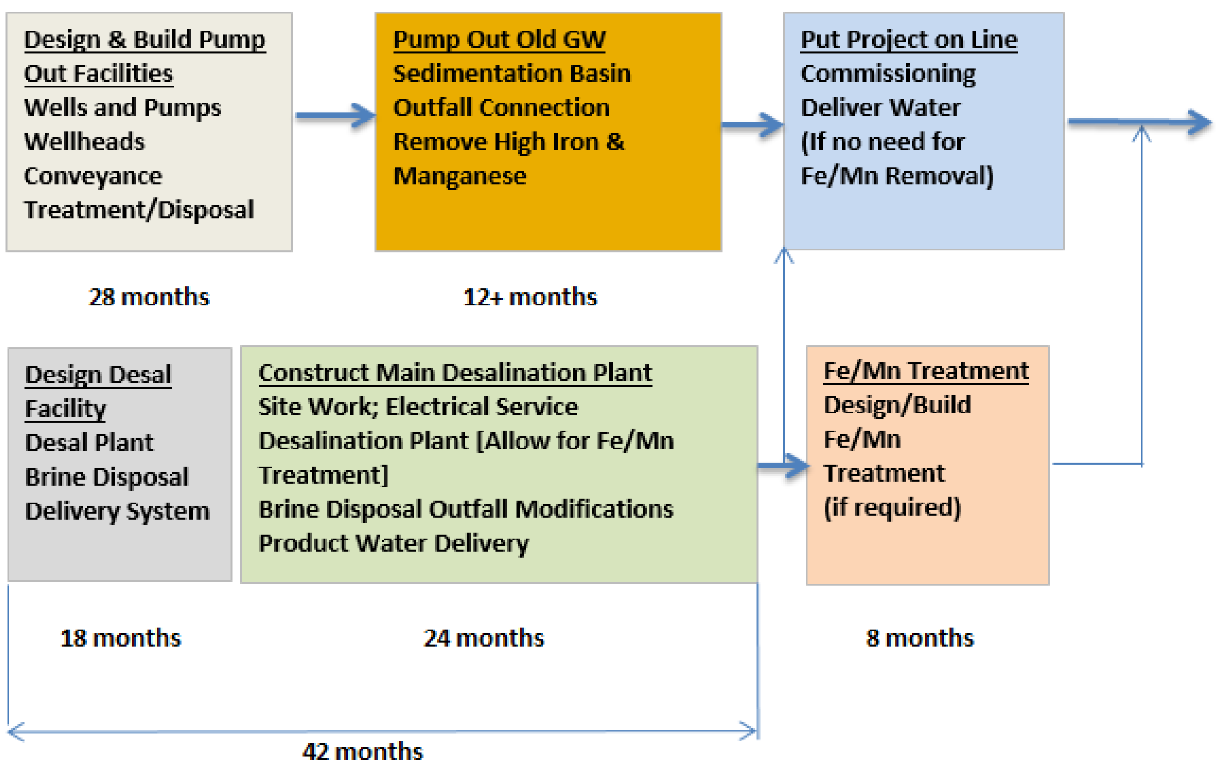
Assuming that the old marine groundwater can be pumped out in about a year or so under full scale production at 30 mgd, the second approach would be preferred. This approach would require that the project be constructed in two stages: (1) wellfield, conveyance and disposal system constructed and operated to pump out the old marine groundwater, complete pilot plant testing to finalize feedwater quality for treatment process design, and (2) complete construction of the remainder of the project. This may be necessary in any event due to the unknown steady state pumped water quality.

During the initial period of pump out of the old marine groundwater, it would be necessary to install a system to remove iron/manganese to levels that can meet discharge requirements through the SOCWA ocean outfall. The current NPDES permit does not have an iron/manganese numerical discharge limitation, but does have limits on settleable solids and turbidity, which would be impacted by the discharge of oxidized iron/manganese. This operation would require permitting through SOCWA and under its NPDES discharge permit.

To meet discharge requirements, iron/manganese will need to be reduced to acceptable levels in a cost-effective manner. During the Phase 3 iron/manganese pilot plant testing work, data were obtained on the effectiveness of oxidizing soluble iron/manganese followed by sedimentation to reduce the iron/manganese load. It was found that chlorine addition was necessary to provide effective oxidation followed by sedimentation at 15 minutes detention, which nearly fully removed all the iron and manganese. The cost for this short-term operation, for one year would include the costs for outfall use, slant well pumping energy, outfall O&M, ocean monitoring, and treatment equipment with chemicals and O&M. The cost for one year of operation is estimated around $4.5 Million. If a longer period is required, a second year is estimated to cost about $3.5 M. Compared to the cost of installing a full scale iron/manganese removal plant at $50 Million, the two stage approach is warranted.

Figure 7 "Full Scale Project Design and Construction Staged Implementation" illustrates the sequence for the major design and construction activities for the full scale project following the recommended approach to pump out the old marine groundwater prior to a decision on Fe/Mn treatment.

Figure 7 - Full Scale Project Design and Construction Staged Implementation



Regional Watershed and Groundwater Modeling

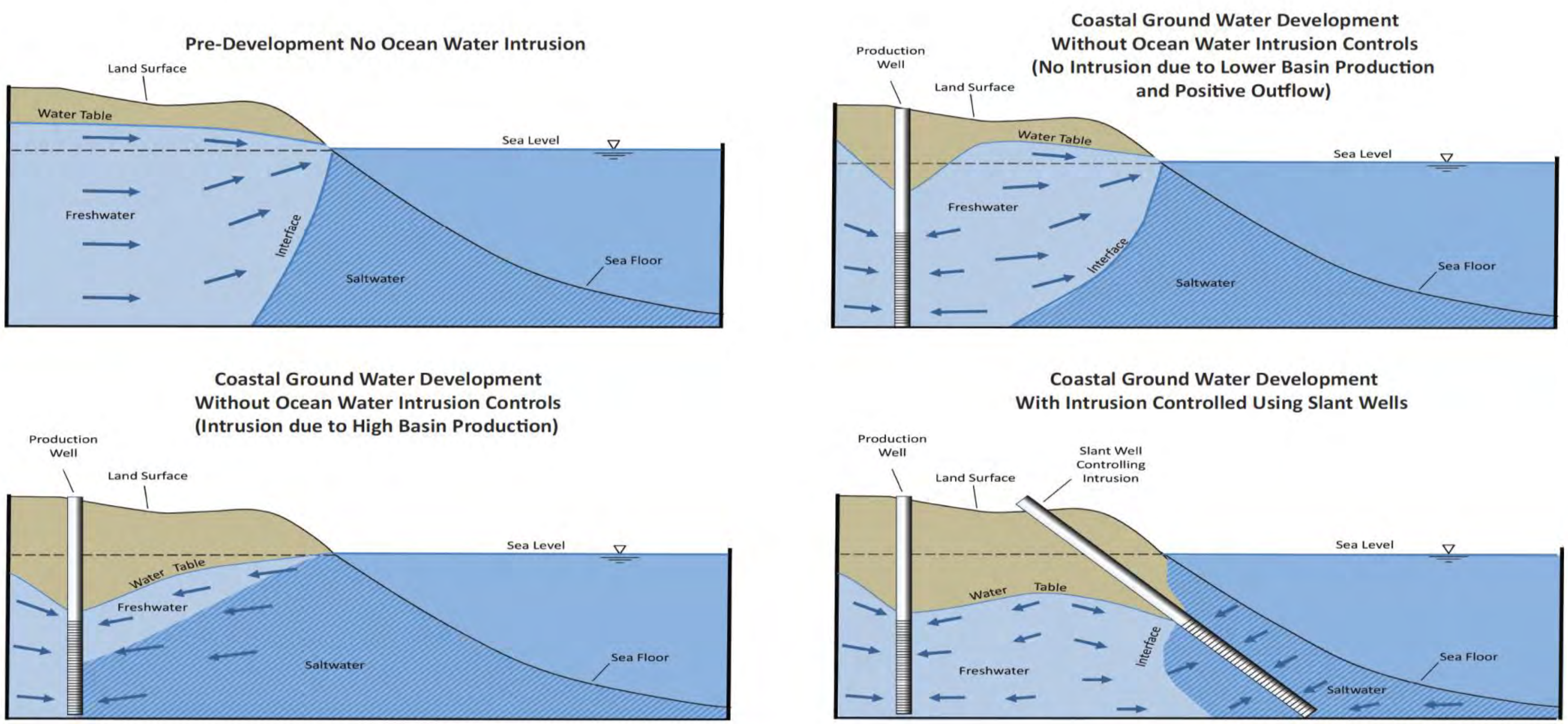
In this location, the paleo San Juan Creek alluvial channel extends out under the ocean within the continental shelf for about three miles. This paleo-channel offers a permeable connection to the ocean. The slant wells would tap into this alluvial structure to pull in filtered ocean water. Under steady state conditions, about 5% of the pumped water would be pulled in from the landward portion of the aquifer, which is brackish groundwater. Groundwater development of the Lower San Juan Basin has occurred over the last several years with the construction of two groundwater recovery desalter plants. To determine the Doheny Desal project impact on the basin and the desalter plant wells, it was necessary to develop analytical models to evaluate drawdown and groundwater take impacts on the basin.

To determine these impacts, a regional surface watershed and groundwater model was developed to determine the basin operable yield using a 64 year hydrology record (1947-2010) which included a 31 year dry period. The first tasks were to determine the basin operable yield without the ocean desalination project. This work which required nearly three years of effort, determined that the lower basin total storage capacity is about 46,000 acre-feet, about 12% less than previously estimated by DWR in 1972 and that the actual volume of water in storage in 2010 was about 30,000 af. The modeling also showed that basin yields over an extended dry and average periods would be about 8,040 AFY and 9,150 AFY, respectively, less than previously believed. Over the 64 year hydrology, it was found that basin storage levels would drop to about 25% of capacity during the long dry period and would refill relatively rapidly under average and wet periods. The model also indicated that seawater intrusion would occur over both dry and average conditions and would reach the SCWD wells in 9 to 12 years, assuming the higher production levels at the long-term sustainable yield levels, rendering them inoperable if additional desalination process treatment were not constructed. Accounting for the seawater intrusion would reduce the yields noted above by 300-400 AFY. Further work is necessary to refine these estimates.

As previously noted, about 5% of the 30 mgd slant well field production (about 1,660 AFY) would be basin brackish groundwater. In addition, the slant well field would provide seawater intrusion control through a coastal trough created from pumping. To mitigate the drawdown and take impacts on impacted producers, make-up water from the desalination project up to 1,660 AFY could be provided to them, less the amount that the basin would otherwise have to use to curtail production to avoid seawater intrusion impacts. Also, seawater intrusion control benefits that would be provided by the Doheny Desal Project should greatly reduce or fully avoid SJBA seawater intrusion control costs.

Future detailed coastal groundwater and geochemical modeling are required to fine tune drawdown impacts and to predict pumped water quality over time. This work will also evaluate physical mitigation using injection wells to create an artificial barrier by raising groundwater levels in the coastal area. This analysis will help to determine the least cost mitigation approach. Other work by the SJBA will investigate the ability to augment the groundwater supplies through stormwater conservation and recycled water and means to protect against seawater intrusion. The two monitoring wells constructed by MWDOC in Doheny State Beach should be maintained and used to monitor for seawater intrusion under upstream groundwater operations.

Figure 8 - Illustration of Seawater Intrusion and Extraction Control



Full Scale Project Conceptual Assessment

The full scale Doheny Desal Project will consist of five major components: (1) feedwater supply system, (2) power supply, (3) desalination plant, (4) brine disposal and (5) system integration. Following is a brief description of each major system component.

Feedwater Supply System. At this time, it is expected that 30 MGD of ocean water supply can be drawn from a slant beach well system consisting of nine wells constructed in three clusters of three wells each along the mouth of the paleo-channel of San Juan Creek along Doheny State Beach. The wells will be fully buried and will extend out under the ocean. Seven wells will be fully operational with two standby wells for operating flexibility and redundancy. The slant wells, wellhead vaults, submersible pumps, power supply, instrumentation cables, nitrogen feed lines, and conveyance pipelines will all be fully buried. Since the wells will be constructed on Doheny State Beach, the construction and maintenance periods are restricted to the off-peak recreational use season, September 15 to May 15.

The wells will be constructed from the beach upslope of the ordinary high water line near the back of the sandy beach, at a 23 degree angle from horizontal, fully penetrating the offshore paleo-channel alluvial deposits. The preferred construction method is Dual Rotary Drilling which avoids the need for drilling muds by advancing an outer pipe shield casing that also prevents cave ins. The well lengths will be approximately 520 feet, consisting of about 280' of 24-inch diameter blank pump housing and 240' of 12 to 16-inch diameter well screen. The long pump housing permits maximum drawdown and yield.

The wells will be constructed in arrays of three wells each with a single construction location and common well vault. The three vaults will be buried to a depth of about five feet below the beach. The vaults will contain the well headers, distribution pipeline, well spools for well cleaning, control valves, flow meters, check valves, isolation valves, nitrogen gas feed lines, and power and instrument cable connections. The nitrogen gas is required to prevent air being pulled into the well in order to minimize any potential oxidation of dissolved iron and manganese prior to the treatment processes.

Preliminary vault drawings are shown in Figure 9. Acoustical damping of the submersible pump noise to very low levels on the beach may be required.

Conveyance from the slant wells to the Desalination Plant site will be by pipeline/tunneling. Preliminary alternative alignments were identified in the Boyle Engineering Corporation Engineering Feasibility Study (March 2007). Two candidate alignments were recently laid out and costs estimated by Kiewit. A collection pipeline to each of the three well vaults will parallel the shoreline and then combine into a single line to cross under PCH and/or cross under San Juan Creek and then to the Desalination Plant. Excavation and microtunneling construction methods, with launch and reception shafts for construction under the beach, PCH and San Juan Creek will be required. The conveyance system will terminate at the Desalination Plant at the Feedwater Supply High Pressure Pumping Station. This pumping station must be in-line without a wet well to prevent air entrainment and oxidation of iron/manganese which is expected in the feedwater at low concentrations, at least during the initial start-up period.

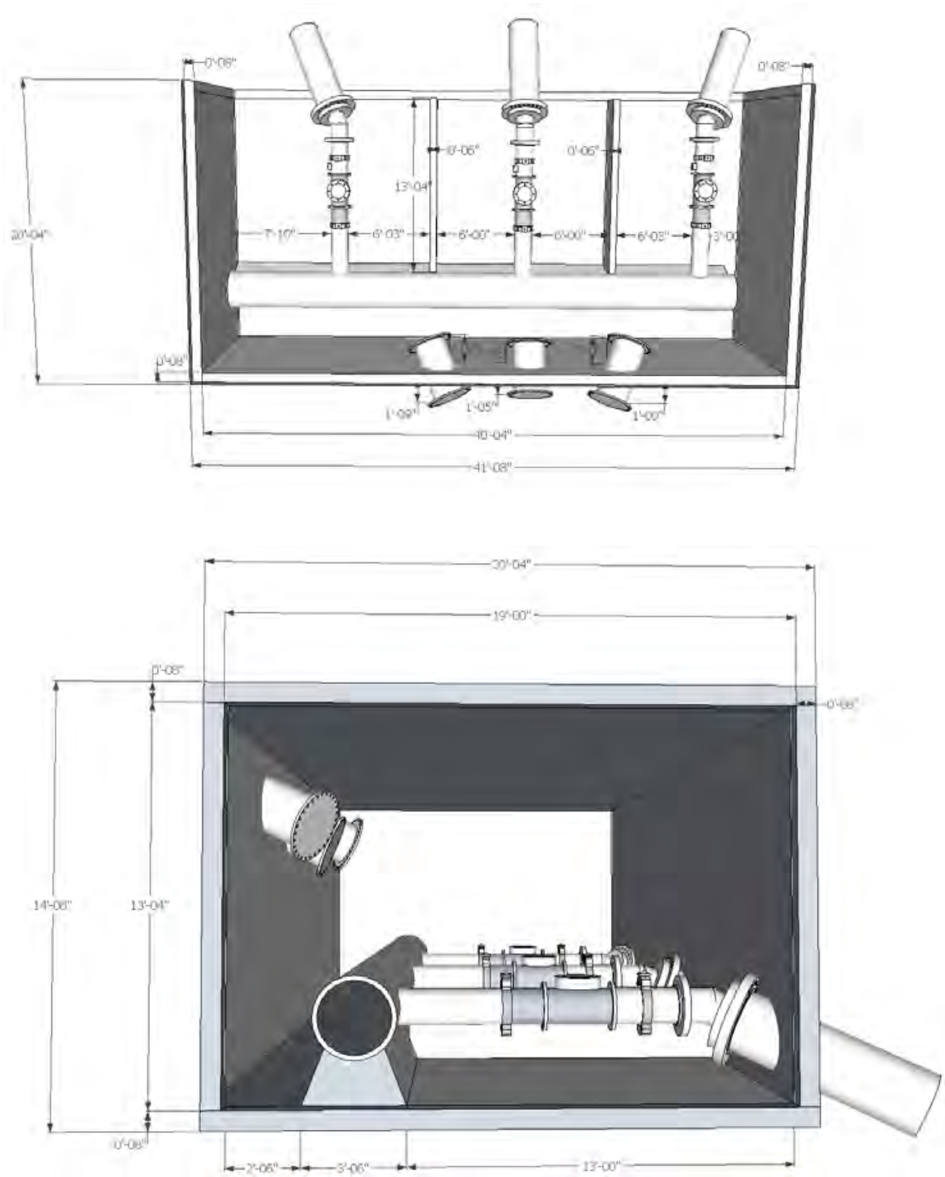


Figure 9 - Top and Side Views of Conceptual Wellhead Vault

Power Supply. Electrical service to the facility will be provided by San Diego Gas & Electric Company. SDG&E prepared an "Engineering Study for Electric Service at the Dana Point Ocean Desalination Plant" dated March 2007. An updated study will be required and is being discussed at this time. Based on an estimated load of 8.3 MW, one to two 12kV transmission circuit feeds would be extended to the plant site, with transformer, panels, cables and meter. About 1,000 feet in new trenches for 4-5" conduits would be required to extend existing feeds to the plant site. Additional facilities and equipment to step voltage down to 4kV or lower voltages would be the responsibility of the project and would be placed on the desalination plant site. The capital cost of these facilities is about $700,000 with the bulk of the power supply costs being built into the rates by SDG&E. The full options for power service will need to be evaluated. In addition, it may be possible to enter into a "demand shedding" agreement with SDG&E

for short-term "called" interruptions in the power supply to help them manage loads during peak demand periods. In exchange, a discount on the energy rate is provided. These options have not been fully explored at this time. Clearwell storage and/or reservoir storage would be used to maintain supplies during the few hours of "load shedding".

Renewable energy capabilities at the site and within the ocean are quite limited. Solar panels may be placed on the building roofs, but would only support minimal energy needs. Wave energy is considered infeasible in this location. Third party wheeling of renewable energy sources developed outside of the area is not available to water utilities at this time. Further, it would be expected that the costs for these types of renewable projects would be higher than what the electrical utility can develop. If the same requirements are placed on the project as incurred by the Poseidon Resources project, offset energy would be required to make the project carbon neutral with imported water deliveries. The cost of providing this mitigation is modest, estimated at about $50,000 per year.

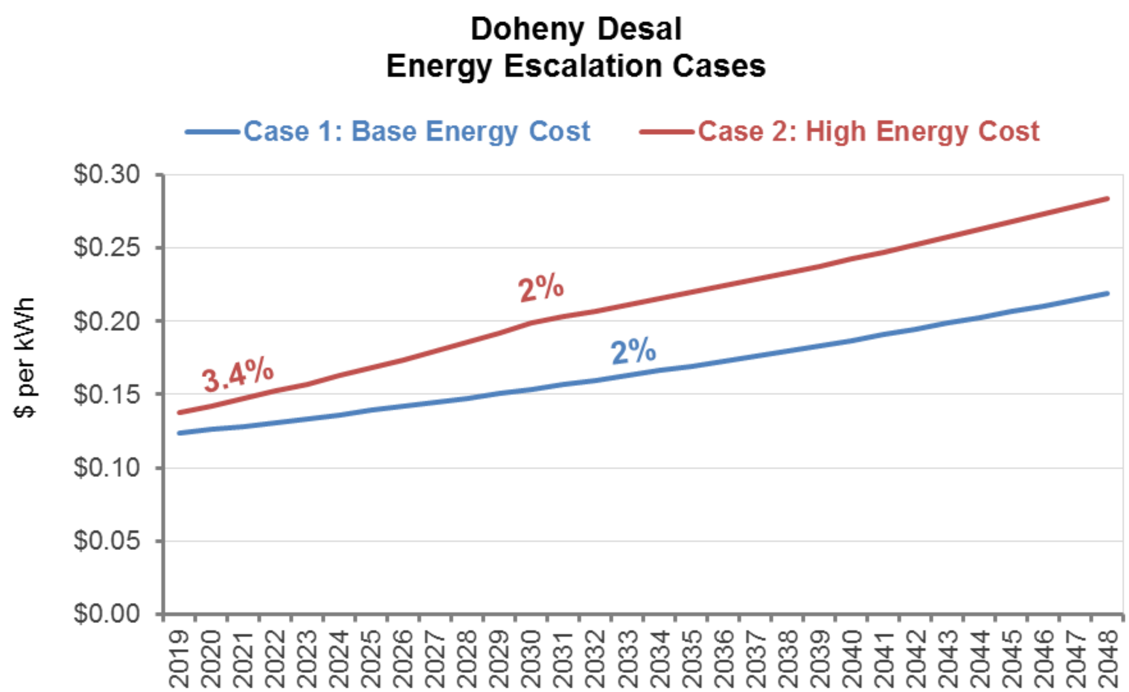
Projected Cost of Electricity for the Plant. Electricity charges are projected to bump up over the next 7 years and then level off due to several coincidental factors. There are three main causes for the bump up in rates: (1) California's mandate to achieve 33 percent renewable energy by 2020 which includes solar, wind and ocean generation, energy storage, and new transmission and distribution facilities, (2) phase out of once-through cooling systems and retirement of older inefficient generation facilities, and (3) closure of the San Onofre Nuclear Generation Station. Long-term estimates of electrical energy costs to supply the plant are difficult to make in California given the uncertainty in how far California will pursue renewable energy goals beyond the 2020 mandate, the effect of future increased distributed user generation and storage systems, long-term natural gas fuel prices, efficiency standards and usage, future population and economic growth drivers, and general inflation.

For the Doheny Desal economic analysis, two rate projection scenarios were evaluated. These rate projections were developed by SDCWA in July 2012 for their energy cost analysis for the Carlsbad Desalination Project and are considered applicable at this time. It should be recognized that actual energy prices will likely be higher or lower than the forecasts. It should be remembered that the Doheny Desal would be a base-loaded 24-7, 365 day per year operating facility. Recent changes by SDG&E in their cost of service have favored these types of facilities compared to typical residential customers, which has resulted in a lowering of the rates. The two cases analyzed are:

- Base Case 1 – Assumes significant RPS (renewable portfolio standard) and AB 32 implementation with electricity cost escalation at 2% annually through 2030 (5 successive 6% rate case increases from July 2012 – actual rate effective in July 2012 was 10.5¢ per kwhr) and then at 2% thereafter. The first bump up in rates occurred in late September 2013 when the AL-TOU rate increased from 10.54¢ to 11.54¢ per kwhr, a 9.5% increase in 15 months (7.6% annualized rate of increase).
- Higher Rate Scenario Case 2 – Assumes high RPS/AB 32 implementation with electricity costs escalation at 3.4% annually through 2030 (6 successive 10+% rate case increases from July 2012) and then reversion thereafter to 2%.

Figure 10 below shows a comparison of the two rate forecasts. Since energy costs account for about 30% of the project cost, the issue of future energy costs needs to be carefully tracked. Depending on future regulatory policy, renewable technology advancements, and shale gas production and natural gas prices, self-generation or investments in outside projects to deliver the energy to the site may be viable options, but competing with SDG&E at their cost of energy and based on the level of reliability they bring will be difficult.

Figure 10



Desalination Plant. The Desalination Plant site is a 5-acre parcel situated on the east side of San Juan Creek just north of PCH on land owned by South Coast Water District. This parcel is situated within the jurisdictional boundary of the California Coastal Commission under the category of "Appeal Jurisdiction". The parcel is currently rough graded to an elevation of approximately 22 feet msl. A geotechnical study is required to determine the design measures to reduce geotechnical hazards from either an earthquake, flood or tsunami. It is anticipated that the site will need to be raised to provide flood control protection with an allowance for sea level rise. 100 or 200 year storm flood protection and flow criteria will need to be determined for protection of the site. In addition, it is anticipated that the site will need to be excavated, compacted and stabilized to provide an adequate foundation for the facility structures.

The Desalination Plant will consist of the following main system components: (1) Electrical Service Sub-Station and Equipment, (2) High Pressure Feedwater Supply Pumping Station, (3) possible Pretreatment Facilities, (4) Reverse Osmosis Desalination Building and Equipment, (5) Post-Treatment Facility, (6) Concentrate Brine Holding Storage and Discharge Connection to the adjacent San Juan Creek Ocean Outfall, (7) a potable clearwell reservoir and (8) a booster pumping station. The site will also consist of roads, parking areas and other related storage, equipment, chemical storage and feed system, and related appurtenances. The structures will need to be constructed in an architecturally pleasing style fitting to the area and will be constructed to be energy efficient with possible solar roof panels and/or green roofs and other related "green" energy systems.

The plant will receive feedwater at 30 MGD. Due to the limitations on yield, it is recommended that a recovery rate of 50% be designed in order to yield 15 MGD of product water. Energy recovery pressure exchanger devices will be utilized to recover 95% of the energy in the high pressure brine stream.

Subject to regulatory and economic feasibility, the Doheny Desal project may be designed to recover the RO concentrate streams from the City of San Juan Capistrano and South Coast Water District groundwater recovery plants by using those flows as feedwater. It is estimated that both of these plants will be enlarged from their current combined 6 MGD capacity to 10 MGD in the future, producing about 2 MGD of brine at a concentration of approximately 10,000 mg/l. This could result in an increased Doheny Desal Project plant yield by up to 1 MGD. This approach appears promising as it would reduce costs to both the City of San Juan Capistrano and South Coast Water District and to the Doheny Desal Project. The feasibility of an integrated brine recovery plan should be evaluated.

Post-Treatment for the RO permeate will be required to stabilize the water so that it is not corrosive to the distribution system. The standard method is to add in lime to the permeate to produce a stabilized water. Some locations, such as Israel now also require the addition of magnesium to achieve a more balanced cation mix. One option that will be considered for regulatory and economic feasibility is to further condition the water with about 1 MGD of brackish water, potentially from one of the SCWD wells, treated for removal of dissolved iron and manganese, disinfected and blended back with the permeate. This will allow production of water that more closely resembles in quality imported water, including providing a more natural blend of cations (calcium, magnesium, potassium) and anions (carbonate, bicarbonate, chloride, sulfate). Additional stabilization with respect to calcium carbonate saturation will be required.

Product water quality criteria will be developed for the desalination system. Key considerations are the level of bromide and boron in the product water. A second pass system at a minimum of 40% capacity is being planned to lower bromide to acceptable levels that prevent accelerated decay of chloramine disinfection residuals in the finished water. Boron levels will also be reduced when achieving the bromide levels. This will provide a product water that is fully protective of ornamental landscape plants.

Brine Concentrate Disposal. The waste brine concentrate from the Reverse Osmosis unit process will be co-disposed with treated municipal wastewater in the adjacent San Juan Creek Ocean Outfall. Due to the diurnal flow pattern of the wastewater flows, a regulatory storage basin at the desalination plant will be required. The concentrate will have a concentration of approximately 66,000 mg/l and will be combined with wastewater having a concentration about 800 mg/l. The current average dry weather municipal wastewater flow in the outfall is 17 MGD. It is anticipated that this flow rate will decrease in the future with additional upstream recycling.

The SWRCB (State Water Resources Control Board) is in the process of amending its California Ocean Plan for Ocean Desalination Intakes and Brine Disposal. When the plan is amended it is anticipated that more stringent requirements for brine discharges will be required.

The ocean outfall diffusers may need to be modified to meet the new SWRCB Ocean Plan Amendment requirements. Modifications might include new diffusers, such as tidal or rosetta valves, or other diffuser devices to increase initial dilution to meet new regulatory requirements. The San Juan Creek Ocean Outfall has an estimated hydraulic capacity of 85 MGD. Plant operations and brine disposal will be ceased only during major storms when total wastewater and infiltration/inflow rates exceed the ability to discharge the brine. This is a rare event and only occurs during very wet years when the collection system trenches are saturated and when stormflows greater than an estimated 25 year intensity occur.

The existing outfall requires structural improvements at the ocean junction structure and at the surge chamber connection from the Latham Plant to the outfall where it joins with the Santa Margarita Water District land outfall on the east side of San Juan Creek. These improvements would be undertaken by South Orange County Wastewater Authority as they are needed for wastewater disposal. The brine concentrate line would connect to the surge chamber structure which is located adjacent to the project site. Flow and water quality monitoring will be required for the discharge. SOCWA approval is required. For project participants not discharging wastewater to the San Juan Creek Outfall, it will be necessary to acquire capacity in the system. The current San Juan Creek Ocean Outfall capacity and ownership are shown in the following Table 1. Cost allowances for the outfall capacity have not been included in the Project Cost Estimate because final capacity selection by agencies have not yet been made and nor has an engineering study been completed, which needs to be held off until the new SWRCB Ocean Plan Amendments are finalized.

Table 1 – SOCWA San Juan Creek Ocean Outfall – Agency Ownership

Agency	Ownership Percentage (%)	Capacity Ownership (mgd)	
		80 mgd	85 mgd
Moulton Niguel WD	15.51	12.42	13.18
San Clemente	16.62	13.30	14.13
San Juan Capistrano	11.08	8.86	9.42
Santa Margarita WD	44.32	35.46	37.67
South Coast WD	12.47	9.98	10.60
	100.00	80.00	85.00

Ref: SOCWA Hydraulic Capacity Evaluation, Carollo Engineers, June 2006

System Integration. The project water will be pumped into the Joint Transmission Pipeline and the Water Importation Pipeline. The hydraulic grade line is approximately 450 feet in both pipelines. Both pipelines cross near the Desalination Plant site on South Coast Water District property, requiring short pipelines to the two points for interconnection. Connections to Laguna Beach County Water District will require a small pump station addition at the existing SCWD/LBCWD interconnection station. Some additional provisions to assure maintenance of the disinfection residual at sag points may be required.

Conceptual Level Cost Opinion

Arcadis (Malcolm Pirnie) prepared a conceptual level cost opinion update for the project in 2011. The cost estimate was modified for the RO system cost, based on cost reviews provided by three firms.

Operation and Maintenance costs were estimated for labor, replacements and repairs, chemicals and feed systems, maintenance materials, and energy. These costs are shown in Table 2. Without energy, the O&M costs are estimated at about $5.8 million per year which is equal to $363/AF. Energy costs are estimated at $7.1 million per year which is equal to $446/AF. Total O&M, plus energy is estimated at $809/AF.

The overall adjusted project capital cost opinion was $152,800,000 (2012$) for the case without iron/manganese removal as shown on the following Table 3. The reviewers had more recent bid data and recommended reducing the RO system cost by 20% ($8 million). The costs include a 25% contingency ($22.6 million) and 15% for professional services ($18.8 million).

The unit cost of water from the project, in current dollars, assuming high iron and manganese removal is not required, is estimated at:

- $1,611 per AF without the MET subsidy of $250 per AF
- Capital at $588 per AF (includes contingency and professional services)
- O&M at $363 per AF
- Energy at $446 per AF
- Land Lease at $47 per AF
- GW Mitigation at $167 per AF for take of 1,660 AFY on average

- Accounting for the MET subsidy results in a cost of water of $1,361 per AF (2012 dollars)
- For comparison purposes, MET avoided water costs in 2013 (Tier 1 + Capacity Charge Readiness to Serve Charge) amounts to $953 per AF

More detailed cost information is shown in the subsequent cost and economic analysis section.

Areas of greatest cost uncertainty are: (1) electrical energy and (2) brine disposal. The projected rate of increase in electrical energy costs over the next decade is a major uncertainty due to a combination of factors: implementation of AB32 and renewable energy, elimination of coastal power plants once through cooling systems, and the shutdown of the San Onofre Nuclear Generation Station (SONGS). These costs will need to be closely followed and incorporated into the project economic analysis.

Brine disposal costs for purchase of capacity in the San Juan Creek Ocean Outfall for those needing new or additional capacity are not yet included in the costs. The costs to modify the outfall diffuser to allow meeting discharge requirements are unknown at this time and no estimates have been included. A placeholder for modifications to the outfall junction structure at $2 million has been included. The outfall costs may further increase if significant recycling depletes the wastewater discharge. Evaluation of new diffuser systems and the performance of the system under the forthcoming SWRCB brine disposal regulations will need to be undertaken to determine the cost for brine disposal. This work also will require brine dispersion modeling and possibly some marine biology assessments.

Table 2 - Full Scale Doheny Desal Project O&M Cost Opinion

Excluding Electrical Energy Malcolm Pirnie (2011)	
	No Pretreatment
Labor	$1,260,000
Replacements/Repairs (Includes RO membranes & other)	$1,937,000
Chemicals/Feed Systems	$1,300,000
Maintenance Materials	$750,000
Other	$550,000
Subtotal O&M	$5,797,000
O&M $/AF	$363
Energy	$7,112,900
Energy $/AF	$446
Total - $/AF	$809

Notes
1. Average Labor rate updated to $105,000/year (OCWD GWRS O&M labor cost plus benefits)
2. Malcolm Pirnie assumed 12 FTE no Pretreatment
3. Replace First Pass RO Membranes every 3 years and Second Pass every 5 years; plus includes all other equipment replacements.
4. Energy at 4,228 kwhr/af and 10.5¢/kwhr
5. O&M increases to $421 per AF if high iron and manganese treatment is required.

Table 3 - Doheny Ocean Desalination Project Capital Cost Opinion

South Orange Coastal Ocean Desalination Project Conventional Design-Bid-Build Project Cost Opinion (Oct 2011)				
Major Activity Cost Item	**Description/Sub-Activities**	**Estimated Schedule (Months)**	**Case 1 Fe/Mn Pretreatment**	**Case 2 No Pretreatment**
PRE-CONSTRUCTION PHASE				
Preliminary Engineering Work	Engineering Work and Support for Environmental and Permitting Work	24	$750,000	$750,000
CEQA/NEPA Work	Baseline Environmental Monitoring	12	$300,000	$300,000
	Prepare and Process EIR/EIS	18	$500,000	$500,000
Additional Studies & Investigations	Outfall Modeling & Modification Engineering	15	$250,000	$250,000
	San Juan Creek Property Geotechnical and Site Investigations	15	$100,000	$100,000
	Offshore Geophysical Investigation	12	$400,000	$400,000
	Offshore Hydrogeology/Downcoast Drilling/Testing Investigation	12	$3,600,000	$3,600,000
	Power Supply Plan	12	$100,000	$100,000
Permitting and Approvals	Agency Meetings (Parks, CDPH, RWQCB, ACOE, CCC, SLC etc)	24	$400,000	$400,000
	Permit Applications Supporting Technical Data/Analyses			
	Permit Applications Preparation and Submittals			
	Permit Processing and Approvals			
JPA Formation, Legal/Financial Advisors	JPA Formation	12	$300,000	$300,000
	Legal and Financial Advisor			
Design/Construction Team Selection	RFP Development and	12	$300,000	$300,000
	Design Engineer Selection			
SUBTOTAL UP FRONT ACTIVITIES COST	Subtotal		$7,000,000	$7,000,000
	Contingency at 20%		$1,400,000	$1,400,000
	Total		**$8,400,000**	**$8,400,000**
DESIGN & CONSTRUCTION PHASE		30		
Design/Construction Project Costs	Intake and Raw Water Conveyance		$44,759,000	$44,759,000
	Pretreatment for Fe/Mn Removal		$43,300,000	$0
	RO Treatment		$53,534,000	$53,534,000
	Post Treatment		$15,636,000	$15,636,000
	Miscellaneous (Brine, SDGE, State Parks, Mitigation)		$11,648,000	$11,648,000
	Subtotal Construction Contractor Cost		**$168,877,000**	**$125,577,000**
	Base Construction Contractor Cost		$138,503,250	$102,991,000
	Contingency (25%) **(1)**		$30,373,750	$22,586,000
	Prof Services (Design & Construction Phases at 15%)		$25,331,550	$18,836,550
	Subtotal Contstruction Cost		**$194,208,550**	**$144,413,550**
Total Project Duration and Capital Cost		**70**	**$202,608,550**	**$152,813,550**

(1) Cost of pump-out and treatment of high iron and manganese laden water prior to start of operations estimated at $4.5 million, assumed part of contingency

Cost Comparison to Imported Water and Economic Analyses

Local projects that develop new sources of supply provide both source and system reliability benefits. In the case of ocean desalination, there is also a water quality benefit derived by production of desalinated water that has lower salts and hardness than the imported supply. Typically, when evaluating new projects, the cost of the new supply is first compared to the projected cost of MET water. The desalination supply will offset MET water purchases and in time these costs are projected to be less than imported water costs resulting in a net positive savings (benefit #1). In addition, ocean desalination improves system reliability (benefit #2), provides a drought proof supply (benefit #3) and provides improved water quality (benefit #4). The question is how to more accurately account for these benefits. Since the local agency drought benefit is reduced under the current approach taken in MET's Water Supply Allocation Plan and water quality benefits are derived by the end-user through longer water fixture life, the analysis conducted focused only on the direct supply and reliability benefits.

The unit costs were favorably compared to the projected costs of imported water, showing a possible cross over in about 10 years after start of operations. The investment cost was also favorably compared to the value of system reliability provided by the project when compared to alternative emergency reservoir costs and capabilities.

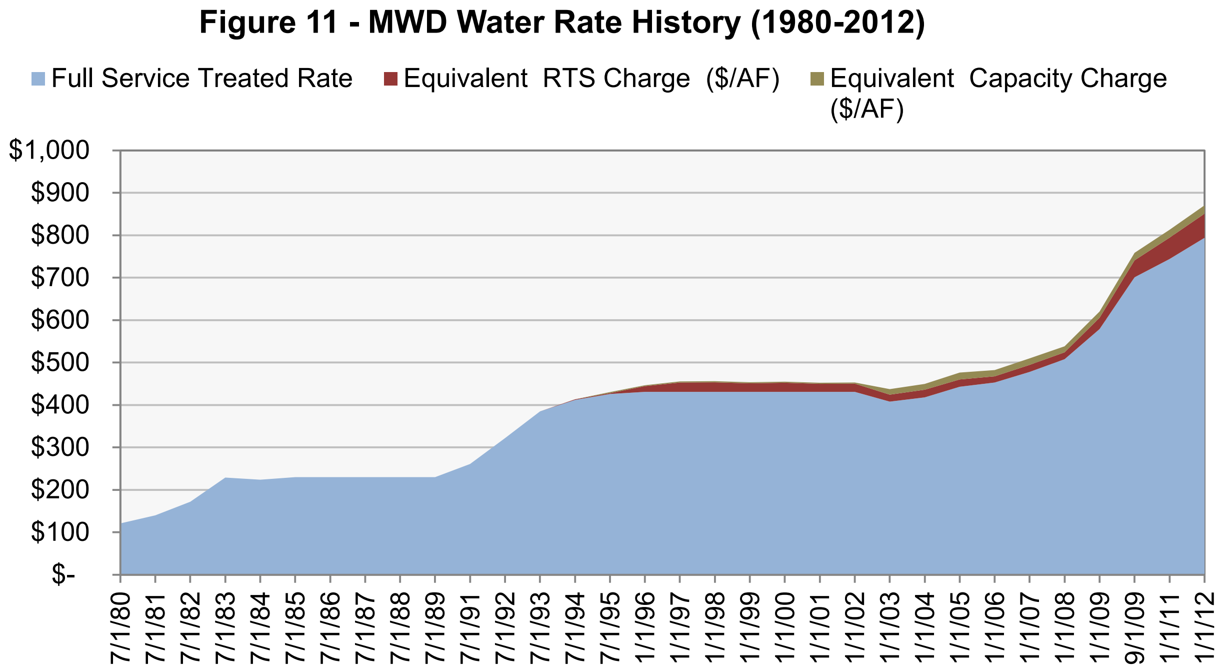
Cost of MET Water. MET has recently updated the projected cost of water to 2017. MET staff believes the near-term projection of rates is a reasonable estimate. Many factors that will result in upward pressure on MET rates have been reflected in these projections including a lower water sales assumption. The effect of a lower water sales assumption by MET is more conservative and, hence, is able to provide more flexibility for covering unexpected rate impacts in the future. Discussions with MET staff indicated that out-year projections beyond 2017 would best be covered by looking at a range of escalation factors from 3 percent on the low side to 6 percent on the high side.

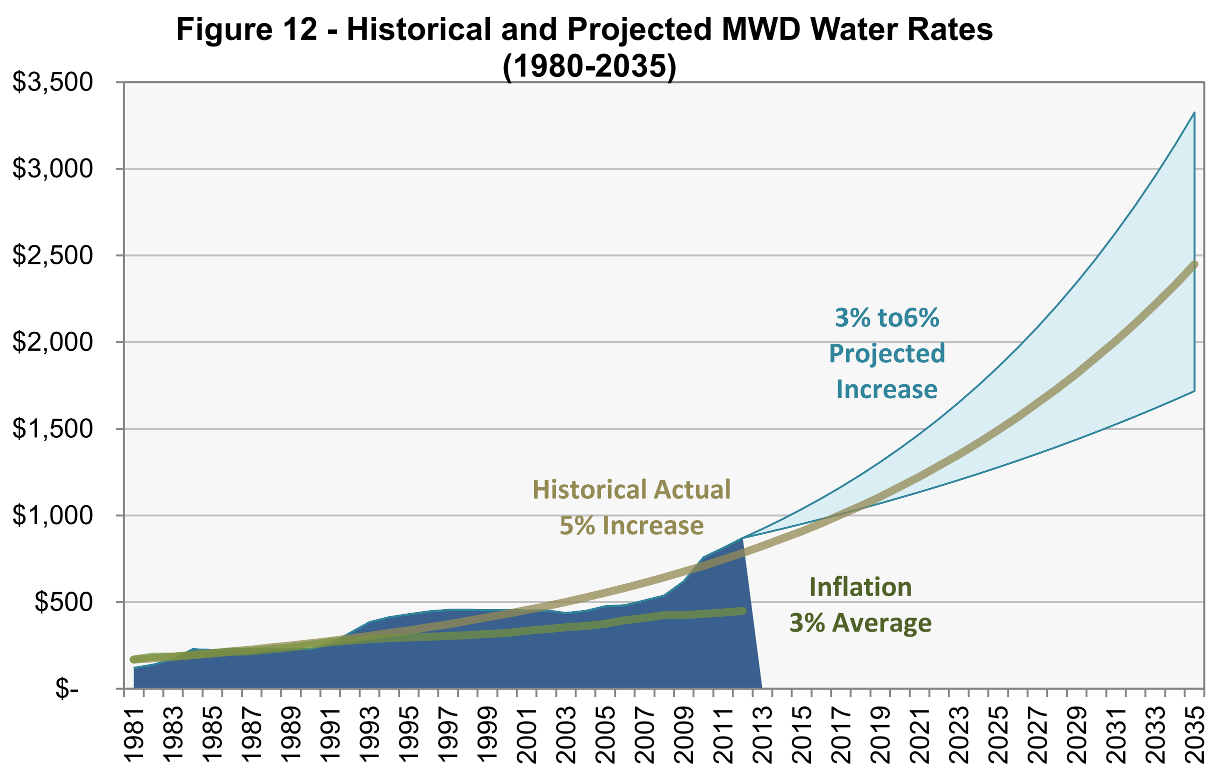
The future cost of water from MET is sensitive to a number of variables, making it difficult to develop an accurate long-term projection. Following are potential factors that could impact rates into the future:

- Energy Costs – The impact of California's Global Warming and Solutions Act (AB 32) on electricity prices is not factored in and is unknown at this time. Higher energy rates are forecasted due to several factors: AB32 mandated requirement for a higher mix of renewable energy sources, replacements and expansions in the Statewide electrical transmission system, phase out of Once-Thru-Cooling coastal power plants, and the shutdown of the SCE SONGS Plant (San Onofre Nuclear Generation Station) and its replacement. MET and the State Water Project Contractors are also facing a particular nuance of the AB 32 legislation whereby the electricity they import from out-of-state for Colorado River Aqueduct and State Water Project pumping may be assessed by California Air Resources Board as an "energy generator" in the state. MET staff is in the process of negotiating a method to provide relief and at this time ARB has indicated that they may provide MET some allowances, but not to the SWP. The impact of this decision could impact MET costs on the order of several million dollars per year.

- Bay-Delta Conservation Plan (BDCP) – A portion of the future costs of the BDCP have been factored into the near-term forecasts with the remaining portion of the costs to be included in the escalation range. The most recent estimate of costs for the fix, assuming MET pays for about 25%, is the cost of water for capital amortization and O&M costs estimated around $200 per AF on the MET water rate. Depending on what actually occurs, the costs could likely be either higher or lower, but would probably tend to cluster towards a higher cost. These are factored in between now and 2026 when the project is expected to start-up. Inflation is not included in these costs.
- MET Rehabilitation and Repair (R&R) Costs of Infrastructure (PAYGO funding) – MET has over $6 billion of investments in the ground not including their share of the SWP. These assets require periodic R&R or replacement. MET's asset management analysis completed several years ago estimated that the R&R program can be achieved at an annual cost of $125 M per year. This program is funded annually through the Pay-As-You-Go (PAYGO) funding, which is still considered sufficient at this time. When inflation picks up, the spending over time will have to correspondingly increase to keep in step with the R&R and replacement needs.
- SWP R&R – It is widely reported that the SWP is not maintained in nearly as good a condition as the MET system. Currently, the SWP is limited by facility conditions to about 70% of the delivery capacity of the SWP and hydropower generation has been reduced because of the failure at the Oroville facilities. MET has included some additional costs of future requests for SWP R&R funding in their budget (higher than what the State is requesting). This may or may not be sufficient to cover the deficiencies in the SWP needs. The SWP contracts expire in 2035 and as the contracts are renewed, it is possible that the renewed contracts will allow for additional levels of R&R and replacement funding without rate increases when the original debt of the SWP is fully repaid. MET and DWR are currently looking at options for the SWP R&R needs.
- Treatment Costs – The full capital and O&M costs associated with the ozone retrofit project at all five of MET's treatment plants are fully captured in the near-term projected water rates.
- Pension/Health Costs – A portion of the (not all) MET pension costs are already built into the rate projections. Other Post Employment Benefits (OPEB) have about a $500 million unfunded liability. MET believes they can eliminate the exposure with an annual contribution of about $50 M per year over the next 10 years. This is not fully reflected in the near term water rates. The other possibility is that by setting a more conservative assumption on water sales, any excess revenue, should it occur, could be used to fund this liability.
- The most recent population projections for the MET service area show an increase of 7.5 million by 2060. This increase in population will require additional new water supply at an increased cost to the region. The share of these costs between MET and the retail suppliers is the subject of future decisions.
- MET staff is examining methods to increase their fixed revenue. One such method is to change the basis of future AV tax revenue so that the percentage of tax levy remains fixed into the future at the current level rather than having the tax levy transition to zero between now and 2035 as planned. The additional tax levy, if successful, would tend to hold rates down in the future because of the estimated $80 million or so in fixed revenue that would accrue each year.

Figures 11 and 12 provide a summary of historical and projected MET water rates. Note the stair step pattern seen in the historical chart. This pattern is caused by water sales, costs and reserve variations.





Discussions with MET staff indicate that outyear cost projection beyond 2017 ranging from an annual escalation of about 3% per year on the low side to about 6% per year on the high side can be expected. Discussions with various sources in the industry note more cost pressures pushing rates towards the higher side of this range although recent discussions with MET staff indicate the potential that MET costs will trend towards the lower side of the range over both the near and mid-term, depending on future inflation rates and other potential unexpected costs.

Sensitivity Modeling. A sensitivity analysis approach was utilized to set up an economic analysis which would allow various input assumptions to be tested to understand the effects on both the cost of water from the Doheny Desal Project and to evaluate the project cost cross over point with MET rates (the point in time when the project cost would be less than imported water costs). This allows an analysis of the potential net present value difference between Doheny Desal and MET water rate scenarios. Figure 9 presents the "base case" analysis. The model provides the ability to vary the following parameters:

- Cost and escalation assumptions for Doheny Desal, the level of contingency assumed and whether or not pre-treatment facilities for iron and manganese will be needed

- Energy consumption and cost information can be varied. Two periods of energy escalation were provided, 2012 to 2030 and then after 2030 to allow the rate assumptions to be tested

- General inflation rates

- Project financing assumptions including the bond interest rate and whether any grant funds will be provided

- For the economic analysis, the Present Value factor can be modified

- A place-holder for land costs and an escalation factor is provided

- The MET rates are hard coded into the analysis through 2017 and then an escalation rate is used for rates beyond 2017

- The calculation summary provides the capital and O&M cost breakdown

- The Net Present Value function calculates the difference between the project rate and the MET rate and provides a present value to 2012 dollars. The purpose of this calculation is to understand the amount of costs above the MET rates up to the point of cross over and then it also quantifies the amount of costs less than the MET rate after the cross over and summarizes the full 30-year Net Present Value (positive = savings).

- A Reliability Benefit is the last input function. This is a measure of the system reliability benefit for the project. There are good reasons for investing in a project, even if the initial cost of water from the project may be above the cost of MET water. These include the reliability provided by having a local production facility able to supply system needs during an outage of the imported system in the event of a major earthquake or other cause and through an extended drought, as the desalination supply is independent of hydrology. The project would provide a significant emergency supply, system reliability benefit to protect the area from an outage of the imported water system as well as a drought supply benefit.

Discussion of Economic Assumptions in Table 4. Nine different economic scenarios were run to test the sensitivity of the assumptions in the sensitivity model, and the results can be found in Table 4. The findings indicated that the Doheny Desal Project supply cost is generally competitive with projected imported water costs. When considering the system reliability benefit of avoided investment in other local projects, the project provides a substantial cost savings and economic value to the community. The cross over point and net present value savings is most sensitive to future MET rates escalation assumption, e.g. higher MET rates improve the project comparisons. The detailed presentations of the nine sensitivity cases are included in the Appendix. The nine scenario runs include the following assumptions:

- **Reliability Benefit**. A project benefit is the ability to continue providing water into the local system in the event of an outage of the import system. The ocean is analogous to an emergency reservoir. Santa Margarita WD recently constructed the Upper Chiquita Reservoir Project at a cost of $50 M. This facility can provide emergency water supply at 23 cfs for about 2 weeks. The Doheny Desal Project can supply 23 cfs continuously. For a one month outage, the desal project provides the same emergency supply as two Upper Chiquita Reservoirs. The cost of two reservoirs would be about $100 M, which is the equivalent emergency reliability benefit that would be provided by the Doheny Desal Project assuming a 30 day outage. The value increases with the length of outage. Taking this benefit into account by amortizing it at the same rate and period as the overall project results in lowering the “cost” line (shown below by a second “project cost line” by about $385 dollars per AF (amortized cost of $100M). Accounting for the second benefit does not truly lower the cost of the project, but it does help identify and account for the emergency supply value of the project and the avoided cost of new reliability projects.

- **Fe/Mn Treatment.** The basis for the iron/manganese pretreatment system cost estimate was the assumption that Fe/Mn concentrations would remain at 6 mg/l throughout the project life, resulting in a capital cost for the oxidized filtration system at $50 million. Based on our expert panel review, it is expected that the old marine groundwater which is high in Fe/Mn would be pumped out in about a year, leaving just the 5% contribution from the brackish groundwater which has Fe/Mn concentrations around 2 mg/l. Under this scenario, the steady state Fe/Mn concentration would be 0.10 mg/l, not 6 mg/l. At this low level, pretreatment is not likely necessary, or if it is the costs would be substantially below the $50 million estimate as much higher loading rates could be utilized in the oxidized media filters. Also, use of an injection barrier along the coast to mitigate the project’s take of brackish groundwater would eliminate in about a year or so the Fe/Mn contribution from brackish groundwater, thus eliminating any need for Fe/Mn removal.

- **Energy Scenario.** For the base case, energy costs have been escalated at 2% per year and have been projected at that same rate based on studies by SDG&E and others before the shutdown of the SONGS and increase in renewable requirement to 33% by 2020. For the high energy rate escalation scenario, 3.4% was used out to 2030 and 2% thereafter, based on work done by SDCWA.
- **Project Financing.** Project financing was assumed at an interest rate of 4.5% (current municipal AA bond rates). It is likely the project could receive a low interest loan from the State Water Resources Control Board State Revolving Fund that would further reduce the interest rate (at one-half of the State's prior year's general obligation bond rates).

- **Additional Benefits.** The project would also provide seawater intrusion control and water quality benefits to the basin, avoiding the need for a dedicated seawater intrusion control barrier. The project supports optimum utilization of the San Juan Basin without the basin having to incur the cost for seawater intrusion control. The basin benefits have not been factored into the economic analysis. This benefit was NOT specifically addressed in this analysis and is likely better to be accounted for in any future mitigation discussions.

Figure 13 – Doheny Ocean Desalination Project Economic Analysis – Base Case

Doheny Ocean Desalination Project - Economic Analysis - DRAFT VERSION 1.8

Input

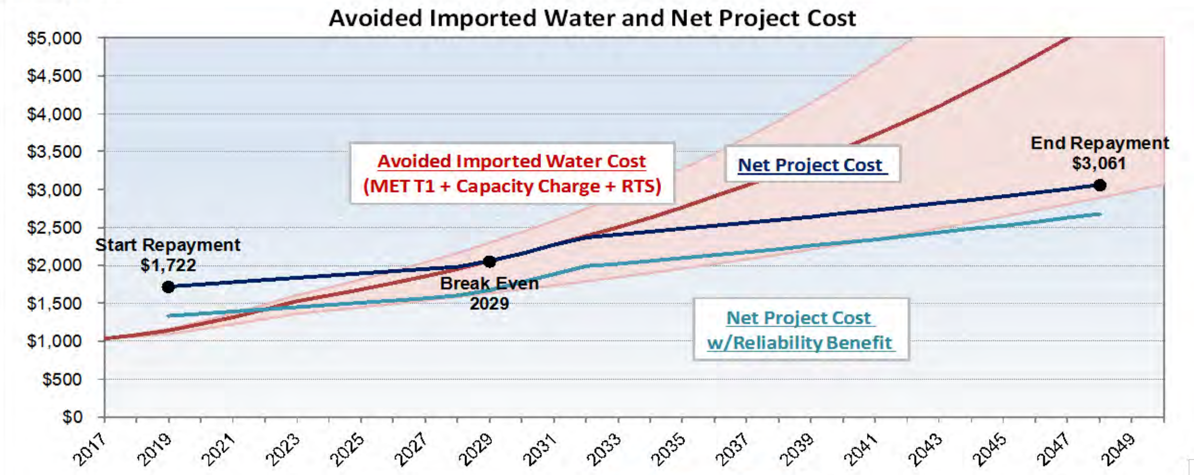
Capital Cost		
Fe/Mn Treatment?	No	
Contingency of Const.	**25%**	
Start of Construction		2017

O&M Costs		
Energy Costs		
Energy Usage (kWh)		**4,228**
Base Energy Rate ($/kWh)		**$ 0.105**
Energy Escalation 2012 - 2030		**2.0%**
Energy Escalation after 2030		**2.0%**
Land Cost		
Land Cost per AF (2011)	**$ 47**	
Lease Escalation Rate	**2.5%**	
General Inflation Rate		
Current - 2020	**2.5%**	
2021 - Future	**2.5%**	

Project Financing		
Grant Amount		$ -
Bond Repayment	Select →	30
Bond Interest Rate	4.50%	
PV Discount Rate	**4.00%**	

MET Avoided Costs		
Esc. Rate After 2017	5.0%	
Melded Rate- % Tier 1	100%	

Output



Project Capital Costs	
Capital Cost (2012)	**$130,227,550**
Grants	**$0**
Contingency	**$22,586,000**
Total Cost (2011)	**$152,813,550**
Total Cost Escalated to Midpt. of Const.	$181,647,290

	Current Year	First Year
Costs per AF	**2012**	**2019**
Capital Cost	$588	$699
O&M	$363	$489
Energy	$446	$522
Annual Cost	$1,397	$1,709
Annual Cost w/ Land	$1,444	$1,767
Mitigation Costs	$167	$205
Total w/ MET Subsidy	$1,361	$1,722

Net Present Value	
Up to Break Even	($31,436,811)
Break Even to End	$72,613,733
Total Savings	$41,176,923

Additional Reliability Benefit	
Storage Reservoir	$100,000,000

Table 4 - Summary of Economic Analyses							
Case	Description	Fe/Mn Treat.?	Energy Scenario	MET Esc.	Cross Over Year	30 Year PV Savings	With Reliability Added
1	Base Case – Expected w/ 4.5% Finance	No	Base	5%	2029	$41 M	$141 M
2	With Fe/Mn	Yes	Base	5%	2032	$-6 M	$94 M
3	High Electrical Costs	No	High	5%	2032	$7 M	$107 M
4	Expected with $15 M Grant	No	Base	5%	2028	$55M	$155 M
5	Low Interest Rate at 2.5%	No	Base	5%	2026	$72M	$172M
6	Base w/Low MET Costs	No	Base	3%	2046	$-7M	$93M
7	Fe/Mn with High Energy	Yes	High	5%	2035	$-10 M	$90 M
8	Fe/Mn with Low MET Costs	Yes	Base	3%	2048	$-10M	$90M
9	Low Interest & Low MET Costs	No	Base	3%	2040	$-5M	$95M

Cost Comparison to the Poseidon Resources Huntington Beach Project

Comparison of the cost of ocean desalination projects from location to location can be difficult, especially when comparing a public project to a private project. Typically, public financing offers cost advantages compared to private equity financing. Private projects can be crafted in a manner to take on additional responsibilities and risks when they are providing water to public entities. Site characteristics can also vary and result in cost differences from project to project.

For the Doheny Desal Project, there are several site and other factors that make the costs very competitive:

- For the size of the Doheny Desal Project, slant wells are less expensive than open intakes which also require pretreatment systems to remove sediments and organic materials. Slant wells provide highly filtered water via the natural filtration process provided by the marine aquifer, thus avoiding the cost of having to construct and operate conventional pretreatment strainers, filtration and solids handling/disposal facilities. It has been determined from the results of the extended pumping test that the use of a slant well intake system will avoid the need for conventional pretreatment costs estimated at $56 million in capital and about $1 million in O&M costs, thus reducing the costs compared to other sites by more than $300 per AF.

- Co-disposal with wastewater through an existing outfall with sufficient hydraulic capacity avoids construction of a new brine discharge line and should make compliance with brine discharge easier to meet.

- System integration is relatively simple as the regional pipelines cross the desalination plant site and the pumping lift is relatively moderate at 450 feet. The savings of this integration system when comparing to other locations can be over $100 per AF or more.

- Public financing costs are typically lower than private financing

For the Huntington Beach site:

- Quite a bit of work has been done at the site and the engineering and permitting for moving forward with a construction project is nearly complete.

- Initially, the project can use the existing intake and outfall system. Uncertainties exist with the need for potential regulatory driven future changes to the intake and outfall systems. Use of the open ocean intakes also requires investments for the pre-treatment of the water.

- System integration is more complex than at the Doheny site.

- The methodology for capital recovery is on an escalated basis at 2.5% per year and has the result of lowering the early year costs and increasing the later year cost. This is an appropriate technique for phasing the costs of the project with future escalation; however, it results in a "different" cost compared to equalized annual debt recovery. The approximate first year impact is a decrease of about $300 per AF. If Doheny Desal used the same technique, the first year cost would be about $180 per AF lower.

- The costs also include repayment of private equity at considerably higher interest rates than available to public financed projects, project development costs, profit, and franchise tax and related payments. However, Poseidon has also agreed to take on much of the construction and performance risks for providing potable drinking water that meets specific quality criteria at the purchased water price.

The Poseidon Huntington Beach project unit cost as of February 2013 is around $1,800 per AF, including all costs and assuming a contribution from MET of $250 per AF. The Doheny Desal Project cost, **assuming an escalation of debt repayment similar to the Huntington Beach Project at 2.5%**, is currently estimated around $1,200/AF including all costs and assuming a contribution from MET of $250 per AF. Most of the differential in costs between the two projects can be explained by the factors noted above with the exception that:

- Poseidon found that their early cost estimates were overly optimistic compared to what was finally agreed upon. We will not have a more detailed estimate for Doheny until additional work is completed

- The element of "risk" taken on by Poseidon is not able to be defined as a cost per AF value.

Conclusion and Recommendations

The project is awaiting decisions by the project participants, SJBA and MWDOC on the next activities for the Project. The only work scheduled at this time is the upcoming Foundational Action Plan work; each of the Phase 3 Participants are now considering what their interest and role will be in that work. Key remaining issues for the project include how best to mitigate the drawdown and take impacts from the project on the San Juan Basin, the produced water quality from the slant wellfield over time, energy costs, and project costs. The groundwater basin and project mitigation alternatives questions will be answered through the work to be undertaken through the MET Foundational Action Program proposed work. This work includes groundwater basin management planning and additional project groundwater modeling work that will be completed over the next year or two by both SJBA and several of the Doheny Desal partners. This work will be important in formulation of the final project concepts and configuration.

Over the past several years of work, a great deal of information on the basin and the project has been developed. Our understanding of the basin and the project interaction has evolved over these years but additional information, study and project development work remain necessary. With respect to the groundwater basin, the necessary work falls under the following areas:

- Complete project impact analysis using a more detailed coastal model
- Evaluate alternative project mitigation measures – providing make-up water from the project or injecting recycled water along the coast to mitigate the drawdown and take impacts of the project on the basin.

- Evaluate seawater intrusion control effectiveness with a more detailed, coastal model

- Evaluate any project impacts to the seasonal coastal lagoon water levels

- Coordinate and track work with the SJBA on its implementation of the Groundwater Management Plan Recommended Alternative No. 6 and opportunities for coordinated and/or joint facility development and use.

The work has resulted in a "lot of new news" and a better understanding of the relationship among these various parameters. At this time, both the work to be conducted by the SJBA and several of the Doheny Desal partners needs to occur to focus in on the final projects configuration.

At any time, the pre-design CEQA and permitting work could be started. The critical path items are the environmental baseline monitoring, offshore geotechnical work, and preliminary engineering for the ultimate project, or the schedule could include a waiting period to finish the work at hand. Discussions with the five Doheny Desal Participants regarding how they would like to move forward will be occurring over the next several months.

The Participants recommended staff develop a "watch" list of issues that could ultimately impact the cost and/or feasibility of the Project. The following Table 5 identifies issues to keep within our monitoring efforts as we move forward.

Table 5 Doheny Desal Cost Impact "Watch" List
These are issues that could impact the ultimate cost of water from the Doheny Desal Project and so should be reviewed from time to time for their status and impact to the project assessment:
1. Financing has been at record low levels.
2. Outside funding may be available from State or Federal sources, either via grants or legislative actions; the State Revolving Fund and anticipated Water Infrastructure Finance and Innovation Authority (WIFIA) funding and 2014 State Bond are examples.
3. Technology Improvements can lower the costs of desalination.
4. The bidding environment has been at record low levels; many companies are interested in getting involved in ocean desalination in the U.S. and California.
5. The cost of energy is difficult to predict in the State of California due to implementation of AB 32, related regulatory policies and programs, hydraulic fracking and natural gas prices, changes in solar energy technology and costs, etc.
6. Iron and manganese pretreatment may be necessary (the costs have been estimated) but at what level is uncertain at this time.
7. The State Water Resources Control Board Ocean Plan Amendment is pending and the cost implications are unknown. New regulations could impact brine discharge through the SOCWA outfall.
8. Other regulatory issues that might arise during permitting.
9. Future costs will be higher due to inflation but are uncertain on a real dollar basis with improvements in technology and increased competition.
10. Mitigation costs with the San Juan Groundwater Basin have to be negotiated – a placeholder has been included in the conceptual level cost opinion.
11. Fisheries issues (e.g., southern Steelhead) in San Juan Creek and the Seasonal Coastal Lagoon due to groundwater drawdown may need to be worked out.
12. Design/Build and Operate, and Design/Build/Operate delivery mechanisms could offer savings in life cycle project costs compared to the conventional Design, Bid, Build, Operate method.
13. As other projects in California get up and operating, relevant knowledge can be transferred to the project.
14. Drought supply shortages and an increasingly greater public recognition of the value of water may spur increased public and political support and willingness to pay for improved supply reliability.

C. Goals and Objectives

The three main goals for Phase 3 were:

- Conduct an extended pumping and pilot plant test to determine the performance of the well and aquifer, to determine water quality over time, and to determine the pretreatment effectiveness of the aquifer

- Evaluate the project impacts and mitigation approaches on the groundwater basin using a regional watershed and groundwater model by first estimating the basin yield and its performance without the project and then determine the effect on the basin with the project.

- Conduct a conceptual level assessment of the full scale project and its costs.

To support the overall goals of the Phase 3 work, 10 specific objectives were developed:

1. Obtain long-term well performance, salinity, and drawdown data and use in validating and refining the groundwater model that will be used in aiding in the design of the feedwater supply system and evaluating project impacts. Conduct natural isotope testing on the extracted water to quantify the sources of water pumped from the well over the extended test period.

2. Collect and analyze slant test well water quality to determine the character of groundwater produced over the extended pumping period. Assess how water quality may change over time as the well pulls in offshore marine groundwater and ocean water. Evaluate how potential changes in ocean water quality, such as red tides, may influence the produced well water. This information will also help to validate the existing SEAWAT groundwater model predictive capability and develop source water quality specification that can be used for project environmental review and permitting.

3. Conduct corrosion studies to determine appropriate materials for the wells, pumps, and system piping and valves.

4. Evaluate the effectiveness of using a nitrogen blanket in the test slant well headspace to minimize introduction of air into the well. This step is intended to control microbiological growth and oxidation/precipitation of dissolved iron and manganese in the produced well water and to facilitate evaluation of any oxygenated ocean water entry into the well over the test period.

5. Conduct studies to identify and measure the extent of microbiological growth over the extended pumping period on the well and selected materials, which are anticipated to result from both brackish and ocean water influences. Determine the speciation of natural organisms that may grow in the well/conveyance facilities and evaluate control approaches as necessary.

6. Evaluate the pretreatment effectiveness of the aquifer and well through the use of standardized testing procedures (e.g., silt density index (SDI), turbidity, pilot unit RO membrane performance); evaluate microbial, colloidal, and particulate fouling; and determine and test any additional pretreatment that may be necessary.

7. Conduct an extended "Under the Influence of Surface Water" study for determining if the well production is affected by San Juan Creek water quality, evaluate applicable California Department of Public Health (DPH) treatment requirements, and develop testing protocols with DPH review.

8. Test RO process performance using test slant well water initially without pretreatment then with the addition of pretreatment, if necessary.

9. Develop a regional watershed model to generate streamflows and a groundwater model to determine groundwater basin yield over an extended period of time including a dry period and to determine the impact of the project on the basin and mitigation approaches.

10. Conduct conceptual level assessment of the full scale project to develop an opinion of probable construction and O&M costs.

The Phase 3 investigation accomplished all of the above objectives.

D. Phase 3 Project Implementation

MWDOC was responsible for carrying out the implementation of the Phase 3 test project. This work included:

Environmental Documentation

A consultant was retained who prepared the project description and mitigated negative declaration for the Phase 3 facilities construction and their operation and maintenance, publication, processing and adoption. This work was done by Chambers Group, an environmental consulting firm.

Permitting and Approvals

This work included the preparation of information and special studies for the permit applications, the permitting process, including agency meetings, and execution of the permits. The following permits and approvals were required and issued: (1) California Department of Parks and Recreation (Right of Entry Permit), (2) State Lands Commission (amended lease), (3) California Regional Water Quality Control Board (NPDES Discharge Permit and a Water Quality 401 Certification), (4) California Department of Fish and Game (Streambed Alteration Agreement), (5) U.S. Army Corps of Engineers (404 Outfall Nationwide Permit), and (6) California Coastal Commission (Coastal Development Permit).

Design, Procurement and Construction of the Test Facilities

This work included consultant selection and design, procurement and construction of the test facilities. The test facilities were designed, procured, or constructed under the direction of MWDOC, who served as the project manager. This work included: (a) well inspection and redevelopment, (b) design and procurement of a submersible pump, (c) installation of the submersible pump, (d) design and procurement of a Mobile Test Facility, and (e) design and construction of appurtenant test facility infrastructure (placement of the Mobile Test Facility, pipelines, conduits, control and metering vault, outfall diffuser and electrical service).

These facilities were located entirely within Doheny State Beach. GEOSCIENCE/Boart Longyear provided the well work and Carollo Engineering provided the design and construction observation services for the test facility. Williams McCaran, Inc. designed the Mobile Test Facility, which was then procured by MWDOC. MWDOC procured this item due to its long-lead time in manufacturing and special features that were required for the Phase 3 extended pumping and pilot plant test. This also allowed MWDOC to control overall quality of the facility. MWDOC also solicited bids as part of this effort. Intuitech, a company specializing in assembling pilot water and wastewater process test equipment, manufactured the test facility. Prior to installation at Doheny State Beach, Intuitech performed shakedown testing using a freshwater supply to make sure that all process equipment, instrumentation, and electrical equipment was functioning properly. This work was observed by WMI to ensure all work was completed in compliance with the design.

Pilot Facilities Start-up and Operation

After installation and construction of the test facilities, SPI was selected to operate the test facility and to conduct the various testing work over the extended pumping test.

Remove/Destroy/Abandon Test Facilities and Restore Site

Participant funds are being reserved to eventually remove the test facilities and restore the project site. Currently, an agreement with State Parks allows the test facility to remain in place. Permits are also maintained. The temporary facilities that will eventually be removed are: (1) the mobile test facility (this is planned to be salvaged and moved to the full scale plant site for use during start up and for future testing work); (2) test slant well submersible pump, wellhead, discharge piping and outfall diffuser; (3) temporary electrical and instrument conduits run from the test facility to the wellheads and; (4) the meter and electrical conduit supply to the test facility. Additionally, the test horizontal/slant well and nested monitoring well MW1 located on the beach will be abandoned or destroyed if there is no future use for these facilities. MW1 is expected to be transferred to San Juan Basin Authority which will require a long-term use agreement with State Parks.

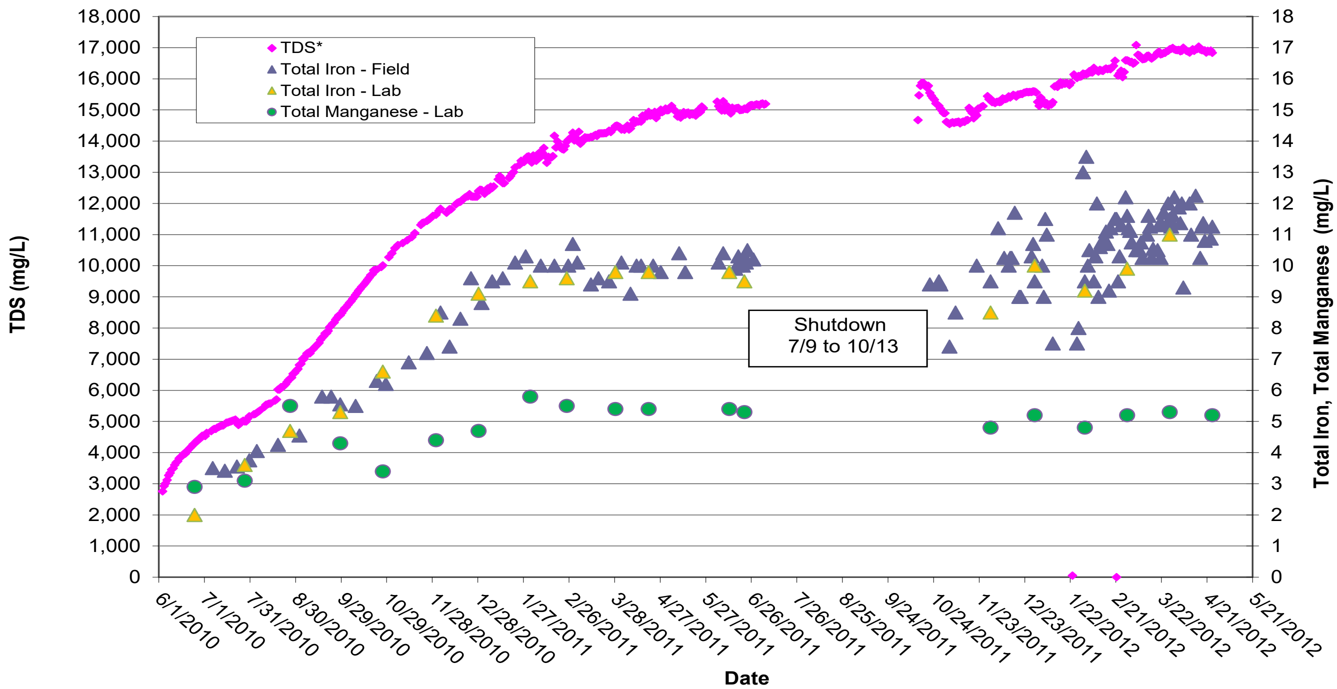
E. Project Results – What Was Learned

Following is a summary of results, findings and conclusions gained from the Phase 3 work.

Feedwater Supply

1. Construction and operation of slant wells along Doheny State Beach is feasible.
2. Old Marine groundwater was encountered and was found to be enriched with dissolved iron and manganese and remained anoxic (without oxygen) throughout the nearly two year extended pumping test. This test showed a continuing increase in salinity and of ocean water (from isotope data) being pulled into the well. See Figure 14.

Figure 14 - Slant Well TDS, Total Iron and Total Manganese



* Note: TDS calculated by 0.65 x Conductivity

3. We believe the pocket of old marine groundwater will be pumped out over time. Geochemical modeling or offshore geophysics and borings are required to more accurately estimate the time required to pump out the old water.
4. The Marine Aquifer provides excellent filtration as evidenced by nearly two years of pumping and testing data.

5. The natural isotope study provided excellent information on the rate of connection to the ocean and the data can be used to refine the coastal groundwater model calibration. The data clearly showed an increasing trend in the amount of ocean water being pumped (which is a good trend).
6. The corrosion study recommends 2507 Super Duplex Stainless Steel for the wells. This was the material used to construct the test submersible pump.
7. The microbial biofouling study showed very low levels of microbial biofilm growth.
8. The slant wellfield configuration is expected to consist of 3 clusters of 3 wells located along Doheny State Beach for a total of nine wells. Preliminary study indicates that the wells would be about 520 feet long at an angle of about 23 degrees. The actual wellfield configuration, well and wellhead design, and wellfield capacity needs to be determined. In the future, the offshore geophysics survey will be needed for both the coastal groundwater model update and wellfield configuration design work.
9. The slant wellfield can be permitted as a water supply. The subsurface intake is regarded favorably by the regulatory agencies based on verbal comments and staff reports by the Coastal Commission for other projects. Further, the State Water Board draft Ocean Desalination Policy is also supporting a slant well subsurface intake approach. Using a subsurface intake will save significant permitting time and costs. Drawdown impacts on the lagoon are expected to be minor. Environmental baseline monitoring is required to support the environmental impact report and permitting activities.
10. Based on work being conducted by West Basin MWD, an open ocean intake system may also be feasible with the use of wedge wire screens. However, conceptual work indicates that it will be a very expensive proposition to construct a “new intake” structure via tunneling if pursued at the Doheny site. Another potential option is to put the intake in the easterly basin in Dana Point Harbor, but limited depths and fueling operations would make this option problematical. This approach was not investigated.

Lower San Juan Basin Groundwater Yield and Integrated Operations

1. The 2007 preliminary groundwater model has been significantly improved through development of a basin wide surface water flow model and updated groundwater model for the Lower San Juan Basin completed in April 2013. This work was developed in close cooperation with San Juan Basin Authority (SJBA) and with their Groundwater Management Plan development work.

2. The groundwater model has been recently re-calibrated to a reasonable level of accuracy for planning purposes over the more recent period, 2004-2010, a period with higher groundwater pumping than under historical operations.

3. Groundwater production in the basin during the period 2004-2010 averaged 5,370 AF per year. Under this level of production, groundwater discharges to the ocean from rising water and subsurface outflow were estimated at 1,880 AFY. The near-term pumping by San Juan Capistrano and South Coast in the Lower San Juan Basin will increase over these historical levels which will

significantly reduce the rising water and subsurface outflow losses. Continued increased pumping can result in seawater intrusion.

4. Without the Doheny Desal Project, the 2013 modeling results indicate that net basin water supply on average came out to 9,150 afy and during a repeat of the 30-year dry period the supply would decrease to 8,040 afy. These values include ocean water intrusion, rising groundwater outflow to the ocean, subsurface outflow to the ocean and change in basin storage. Under this run, ocean water intrusion began to occur; the South Coast wells were turned off after nine years when the salinity reached 2,600 ppm. It is likely these basin yield values are over estimated by about 300-400 AFY as the modeled pumping amounts results in seawater intrusion. The breakdown of this analysis is shown below in Table 6:

Table 6 - Groundwater Modeling Production Analysis – Base Case (2i/2j)
Pumping Water Level Constraint with Salinity Constraint

Producer	Groundwater Pumping Yield (afy) Dry	Average
City's GWRP Wells	5,808	6,690
City's Other Wells	823	942
Subtotal City	6,631	7,632
SCWD	559	664
Private Wells	850	850
Total	8,040 afy	9,146 afy

5. With the Doheny Desal Project intake production at 30 mgd, the groundwater modeling indicates that on average about 5% of the slant well production (1.5 mgd, 1,660 afy) will be San Juan Creek brackish groundwater. This estimate was made by averaging the Doheny Desal draw on the basin of 1,495 afy in dry periods and 1,820 afy in average periods, averaging about 1,660 afy.

6. The modeling indicates that South Coast Water District wells (the wells in the basin closest to the ocean) would be potentially impacted by a drop in groundwater elevation between 15' to 20' with slant wellfield production level at 30 mgd. The drawdown impacts to the City of San Juan Capistrano wells further up in the basin would be approximately 1 to 3 feet.

7. The 30 mgd slant wellfield production level will protect the SCWD wells and the lower basin (e.g., Latham WWTP) from ocean water intrusion.

8. The leaking underground storage tanks at the gasoline stations in the vicinity are in the process of being cleaned up and are not expected to impact the project start up. Continued coordination with the Orange County Heath Care Agency (OCHCA) and oversight is required.

9. Drawdown impacts to the San Juan Creek seasonal lagoon at the ocean interface will likely be small as the lagoon is underlain by a shallow highly permeable aquifer and an areal extensive clay layer. The seasonal lagoon receives ocean water recharge as well as streamflow from storms and urban runoff. A more detailed coastal groundwater model will be needed in the future to assess this impact as well as intrusion through the shallow aquifer.

Desalination Facility, Product Water Quality and System Integration

1. The desalination facility site (5 acres) is proposed to be located just north of PCH on existing South Coast Water District property. South Coast Water District has generally reserved the site for the project. Negotiations for use of the plant site will have to be completed. The current cost estimate has a placeholder lease cost for the site. The site will require geotechnical work to prepare the foundation for location of a new plant. The rough grade of the site will need to be raised to protect against flooding including an allowance for sea level rise.

2. Product water quality will be driven by the level to which bromide and boron need to be reduced. A bromide level of 0.3 mg/l will provide adequate protection for disinfection residual stability. This requires about a 40% second RO pass. This will also produce a boron level around 0.5 mg/l which will be protective for ornamental plants. Typical second pass RO configurations for plants range from 30% to 100%.

3. System integration is relatively low in cost, as both imported water pipelines cross near the Plant site. The water would be boosted out of a clearwell reservoir to a 450 foot hydraulic grade line to match with the imported water system (Joint Regional Water Supply System (JRWSS) and Water Importation Pipeline (WIP)). Additional pumping of about 110 feet would be required to supply the water to the Laguna Beach 400 zone from the SCWD 290 zone.

Brine Disposal

1. The San Juan Creek Ocean Outfall has adequate capacity to dispose 15 mgd of brine flow from the Doheny Desal Project. The outfall has a capacity of about 85 mgd and present day average daily dry weather flow is about 17.5 mgd; the current permitted capacity is 30 mgd. In the future the average daily dry weather flow will likely decrease with additional recycling and water use efficiency measures.

2. The brine disposal point of connection would be into the surge chamber junction, located adjacent to the Desalination Facility site.

3. A brine disposal study needs to be undertaken with South Orange County Wastewater Authority (SOCWA) to determine if any modifications are necessary to the outfall and its diffuser for compliance with SOCWA's National Pollution Discharge Elimination Standard (NPDES) permit. The study would need to evaluate ranges of blending with wastewater for co-disposal of 0% up to about 50%.

4. Non participants in the SOCWA outfall will have to acquire capacity from agencies with excess capacity.

5. The SWRCB is in the process of amending its California Ocean Plan which will include new regulations and standards for brine disposal. This amendment is expected to be completed either late this year or in early 2014.

Energy Supply and GHG Offsets

1. The project will have an electrical load of about 8.2 megawatts (MW). The project is estimated to consume 4,228 kilowatt-hours (kwhr) of electrical energy per acre-foot (AF) of produced water, including the pumping lift for system integration. For comparison purposes, imported water delivered to the area from the East Branch of the SWP through the Water Importation Pipeline uses a net of about 3,440 kwhr/af.

2. An electrical service study by SDG&E was completed in 2007; we are working with SDG&E to update this study. As of this time we don't have any response from SDG&E on the cost of the new work or time required to complete the update.

3. SDG&E is embarking on a $500 million reliability upgrade to their electrical distribution system in its Orange County service area.

4. The SDG&E reliability improvements include a new enlarged San Juan Capistrano substation. This should reduce the cost of running a 12 kV service to the Desalination Facility (the previous study ran the 12 kV line from the Laguna Niguel substation).

5. SDG&E has indicated that their worst case power outage would be for 12 hours. Based on this, no back-up power would be required for this short of an outage. This does not include any electrical reliability issues that have arisen with the recent SONGS plant closure.

6. SDG&E offers programs to shed load for electrical cost savings. The two main programs are their Critical Peak Pricing and Base Interruptible schedules. These will be further explored to reduce costs to the project.

7. A new law allows an agency, not a Joint Powers Authority (JPA), to build and wheel up to 3 MW of renewable energy through the PUC regulated agency grid. However, typically these costs are higher than grid energy from SDG&E.

8. SDG&E service environmental impacts could be covered under the Doheny Desal Project EIR.

9. SDG&E indicated that 2 years are required to design and construct their service facilities.

10. Energy costs will increase due to reliability improvements, expansion of the State's transmission and distribution system, meeting renewable energy targets of 33 percent by 2020, phase out of power plants using Once Thru Cooling (OTC) technology, impact of SONGS closure and replacement power, and general rate increases. However, natural gas fuel costs continue to stabilize the cost of energy from natural gas fired power plants. Predicting future energy costs with a reasonable degree of certainty is difficult at this time. Future decisions on SONGS replacement (assumed) and consumer liability by the PUC and SDG&E have not yet been made and no projections are available.

11. Greenhouse gas (GHG) offsets will likely be required by the State Lands Commission and Coastal Commission. Without any mitigation, the annual cost for GHG offsets is not expected to be significant, at about $50,000 per year at today's market rate.

Project Costs and Economics

1. Project capital cost is estimated at $153 million ($2012).

2. Capital and Project Unit Costs ($/AF) are lower than other desalination projects due to the attractive project location: slant wells avoid pretreatment costs compared to an open intake system, land is available near the coast, outfall capacity is available, system integration and pumping lift costs are very low, and SDGE is investing $500 million to improve electrical service reliability to the area (which should slightly reduce the electrical service cost to the Doheny Desal Project). Slant well intakes have unit costs per capacity similar to open intake systems, but can be built at lower capacities at much reduced capital cost than open intakes, which are best suited to large scale plants.

3. Estimated project unit costs (at this time) in 2012 dollars without grants or low interest loans are:

   - $1,611 per AF without the MET subsidy of $250 per AF
   - Capital at $588/AF (includes a 25% contingency and a 15% allowance for professional services)
   - O&M at $363/AF
   - Energy at $446/AF
   - Land at $47/AF
   - GW Mitigation at $167/AF for take of 1,660 afy on average
   - Total of all costs = $1,611 per AF.
   - Accounting for the MET subsidy results in a cost of water to the local agencies in 2012 dollars of $1361 per AF
   - For comparison purposes, MET avoided water costs in 2013 (Tier 1 + Capacity Charge + Readiness to Serve Charge) amounts to $953/AF.

4. Projected imported and desalination water costs cross about 8 to 10 years out (or further depending on the assumptions used) from which point on the desalination water costs would be

lower than imported water costs. Nine different economic scenarios were run to test the sensitivity of the assumptions. The most sensitive assumption was the out-year escalation of MET water rates (a higher MET escalation makes the Doheny Desal Project look more favorable and a lower escalation of MET rates is not favorable to the economics of the project).

5. One of the scenarios included higher energy cost escalation, which would increase the cost of the project. Current energy escalation costs are somewhat speculative. Future work should focus on refining the energy costs inputs to the project.

6. The system reliability benefit of the project has been estimated at about $100 Million when valued on the cost of storage at Upper Chiquita Reservoir Project. The project also provides benefits during droughts and helps prevent water shortages during emergency situations – these last two benefits have not been captured in the economic analysis.

F. Conclusions Regarding Slant Wells

Water supply wells when properly designed, constructed and developed can last for 75 years or more. There is no difference with Slant Wells as these will be built using tried and true water well technology along with the design and construction experience and innovations gained from the construction and operation of the Test Slant Well. We expect the Slant Wells to perform very well over the long- term and expect a useful life of 75 years.

Well Production Capacity

Based on the Test Slant Well pumping test at 2,100 gpm and recent groundwater modeling, we expect the full scale wells will be able to produce 3,000 gpm. Drawdowns, including well interference, will be approximately 90 feet vertically from mean sea level to the pumping water level in the well to produce the 30 mgd from seven pumping wells with two wells on rotational standby. The aquifer thickness is about 200 feet along the coastline, which is sufficient to allow the expected drawdowns and well yield. Should a problem occur during the summer when beach access is restricted there will be two standby wells that can then be turned on to continue uninterrupted production at the 30 mgd level. Drawdown impacts to wells in the San Juan groundwater basin will only be significant to the most nearby wells owned by South Coast Water District.

Well Design, Construction and Development

Design and construction of the full scale slant wells will need to be approached similarly to conventional water well design and drilling, but since the wells will be relatively flat in slope, additional care must be taken in gravel placement and well development. The design and construction will be aided through the experience gained in design and construction of the Test Slant Well. A key to the long-term success of the wells will be to provide thorough development work to assure minimum levels of sand clogging to the gravel pack. Sand clogging can occur over time in a well when it is not properly designed, constructed and/or developed. Causes include too large of well screen slot spacing, too large of gravel size in the gravel pack, gaps in the gravel pack, and most commonly, insufficient development of the well. The well screen and gravel pack size can be properly sized assuming the well designer has good technical capability and experience. Improper well development can occur due to insufficient swabbing, bailing and/or air lifting and due to insufficient development pumping rate and time.

For the full scale slant wells development, the development pumping rate needs to be around 1.5x the production rate with development pumping over a sufficient period of time to allow complete removal of entrainable fines from the near borehole formation. Assuming the full scale well capacity at 3,000 gpm, the development pumping rate should be specified at 4,500 gpm.

To assure adequate development pumping, procurement of high speed 4,500 rpm pump(s) in advance of the construction will be required. Well contractors typically do not stock submersible pumps of this capacity that would be able to fit into the well. Contractors often use suction development pumping, but this option will not be possible, as these pumps are limited to a suction or drawdown of 32 feet and a greater lift will be required. The designed drawdown will be approximately 45 feet below sea level (lower low water) and the wellhead floor elevation will be approximately minus 2 feet MSL, a differential of 43 feet, exceeding suction limits.

Another consideration in the construction of the nine wells is the ability to complete the work within the 8-month winter time window. This will likely require three well drilling crews working concurrently. The advantage of three wells drilled from a single site is the time and cost savings from moving the drill site. The well driller will need to possess well in advance of construction three large dual rotary drill rigs (DR-40) and trained crews. Sufficient lead time will need to be provided to acquire any additional rigs from the manufacturer.

Well and Pump Materials and Corrosion Protection

The Slant Wells will be constructed with Super Duplex 2507 Stainless Steel, an alloy which showed very little corrosion over the extended pumping test and which is considered suitable for achieving a long useful life for the well. Over the nearly two year extended pumping test, this alloy showed no corrosion. It is used in many ocean desalination projects worldwide. Super Duplex 2507 will not support biofouling iron bacteria that are common in carbon steel cased wells. It is considerably less costly than AL-6XN, another superior stainless steel used in ocean applications.

Long-Term Aquifer Performance

Over the nearly two-year extended pumping test, the step drawdown test indicated no observable change in aquifer losses. Aquifer loss can occur in certain types of aquifers that are susceptible to biochemical in-situ encrustation or precipitation, especially in limestone formations. For the alluvial aquifer system offshore of San Juan Creek this condition will not occur.

During the initial start up pumping period, the wells will pump out the old (age 7500 years) marine groundwater that is anoxic and enriched with dissolved iron and manganese. As the wells pump, the ocean water, which is oxic and has only trace levels of iron and manganese, will slowly recharge the aquifer and flow towards the well. No mixing will occur along the boundary of the marine groundwater and recharge front of ocean water, except for trace convective diffusion effects which will have no observable effect on aquifer permeability due to any minimal oxidation along the front as the masses in the boundary zone are insignificant.

The oxic ocean water will slowly become less oxic as microbial activity consumes the available organic carbon and dissolved oxygen as the recharging ocean water flows through the aquifer to the wells. Since the ocean water will have some dissolved oxygen over part of its flow course to the wells, this oxic condition will not cause any further dissolution of iron and manganese minerals that might remain in the sediments. Likely all of the iron and manganese mineral oxides in the original sediments were fully dissolved out of the formation since the time the ocean flooded these sediments, some 7,500 years ago ("old marine groundwater"). Over the extended pumping test, the well was pulling in about 20% ocean water, which became anoxic by the time it reached the well. This ocean recharge most likely entered the well near its upper screens that are only 50 feet below the ocean floor. Sufficient organic carbon was available to the naturally occurring aerobic bacteria in the seafloor sediments. The travel path to the remainder of the screens is longer and will allow for further uptake of any dissolved oxygen in the recharging water. The San Juan Creek and lagoon produce significant organic carbon loads which are swept out to the ocean by periodic storms. This condition is likely to indefinitely continue into the future.

Within the aquifer, where the ocean water groundwater flow and brackish groundwater flow boundary occurs, there will be a small mass reaction over time along this boundary due to slowly varying heads and tidal forces that will result in some convective diffusion along the boundary area which would cause some iron oxide precipitation within this brackish/ocean water flow boundary. However, the masses are quite small compared to the volume of the alluvium pore space that it would take a very long time to seal this flow boundary with iron oxy-hydroxide precipitates. The effect would be to reduce the amount of brackish groundwater that would enter the wells, which is a desirable outcome.

The project microbiologist, Dr. Sunny Jiang from UCI studied biofouling rates over the two year extended pumping test. Biofouling rates were found to be very low with biofilms less than 10 µm in thickness on the stainless steels. She does not expect much biofouling activity in the full scale wells.

Under the initial period of pump out, a large portion of the pumped water was brackish groundwater. This water has a much higher TOC than the old marine groundwater and ocean water. Initial levels of naturally occurring bacterial growths were fairly high but declined dramatically as the TOC levels dropped significantly as the ocean water was pulled into the well. It is uncertain what impact if any the project will have on the seasonal lagoon associated with San Juan Creek, as this area is underlain by an extensive 4-foot plastic clay layer that minimizes drawdown effects on water levels in the lagoon. The reverse condition is also true – the lagoon should have very little if any effect on the water quality produced from the slant wells.

Well Oxidation Control

The wells will be designed to be fed nitrogen gas into the headspace in the well above the pumping water level to prevent oxygen transfer into the water. This was used successfully over the Phase 3 extended pumping test and performed quite well.

Well and Pipeline Cleaning

If the ocean water that enters the wells contains some dissolved oxygen it will then mix with any anoxic brackish groundwater that has dissolved iron and manganese that enters the well. Once the mixing is initiated the oxidation reaction times are fairly rapid. If the DO levels are above about 1 ppm, this will lead to oxidation during the movement of water through the pipeline to the plant of dissolved iron and manganese. Under this condition, some accumulations of iron deposits along the walls in the upper well screen area, through the pump column, and along the conveyance pipeline can be anticipated. A mitigation design measure is to size the conveyance system to maintain high velocities around 8 to 9 fps, within a reasonable headloss, to help to scour and minimize iron deposition accumulations.

The submersible pumps will be serviced or replaced once every 5 to 10 years along with well inspection and any required maintenance. It may be necessary to acquire a dual rotary drill rig with angled set up to allow for less costly well maintenance, as the mobilization costs can be high as these rigs are often kept out of state as they are frequently used in the mining industry. In the future, the merits of this approach should be evaluated.

Phase 3 Final Reports

Separately published Project reports from Phase 3 are listed below in Table 7.

Table 7 - Phase 3 Final Reports

#	Title	Author	Issued
1.	Project Summary Report	MWDOC	Final Jan 2014
2.	Volume 1 – Phase 3 Project Development Report	MWDOC & Carollo Engineers	Final Sep 2013
3.	Volume 2 – Pilot Plant Operations, Testing, Evaluation Report	SPI	Final Aug 2013
4.	Volume 3 – Phase 3 San Juan Basin Regional Watershed and Groundwater Models Report	Geoscience	Final Nov 2013
5.	Pilot Testing of Slant Well Seawater Intakes and AWT Pretreatment Technologies for Control and Removal of Iron and Manganese	SPI	Final July 2013
6.	Expert Panel Workshop Report: Offshore Hydrogeology/Water Quality Investigation Scoping, Utilization of Slant Beach Intake Wells for Feedwater Supply	Dr. Susan Paulson, Flow Science and MWDOC	Final Oct 2012
7.	Final Report: Desalination Corrosion Study	Dr. Joseph King, Engineering Materials	Final May 2012
8.	Natural Isotope Tracer Study: Test Slant Well Phase 3 Extending Pumping Test	Matthew A. Charette, Ph.D. - Coastal Groundwater Consulting & WHOI	Final Nov 2012
9.	TECHNICAL MEMORANDUM: Aquifer Pumping Test Analysis and Evaluation of Specific Capacity and Well Efficiency Relationships, SL-1 Test Slant Well	Geoscience	Final Sept 2012
10.	Microbial Testing – Phase 3 Extended Pumping Study	Dr. Sunny Jiang, UCI	Final Nov 2012

Appendix

Project Photographs

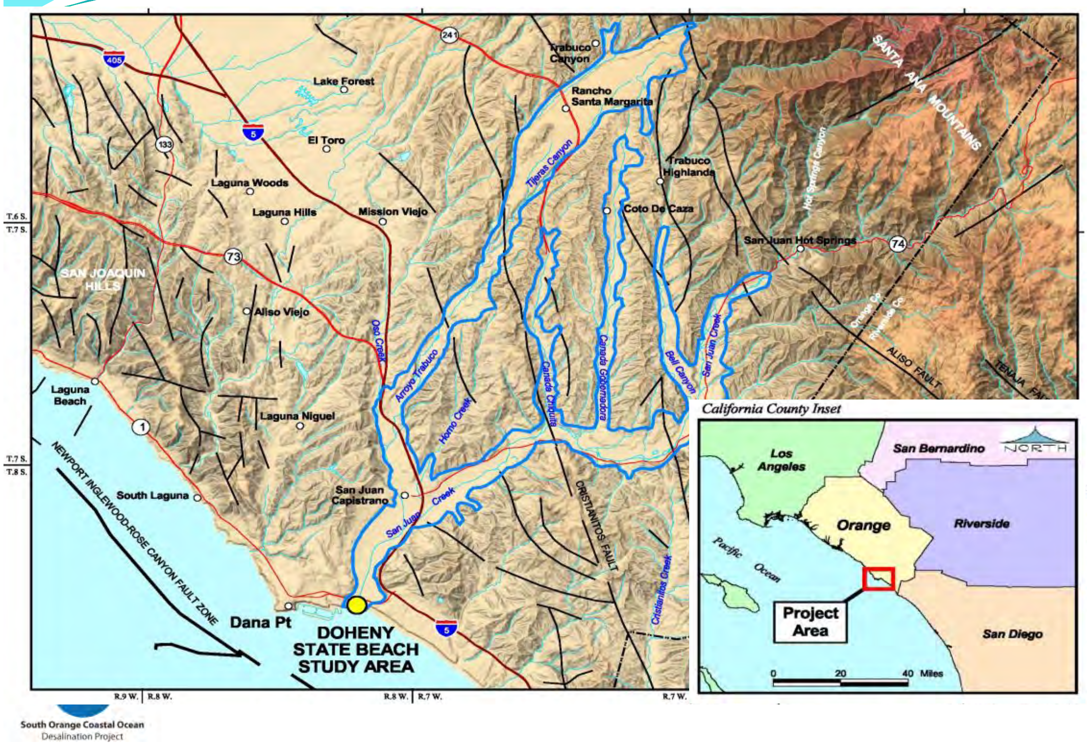
Groundwater Modeling Exhibits

Project Economic Analyses Scenarios

View of Slant Well and Test Facility Site
Doheny State Beach

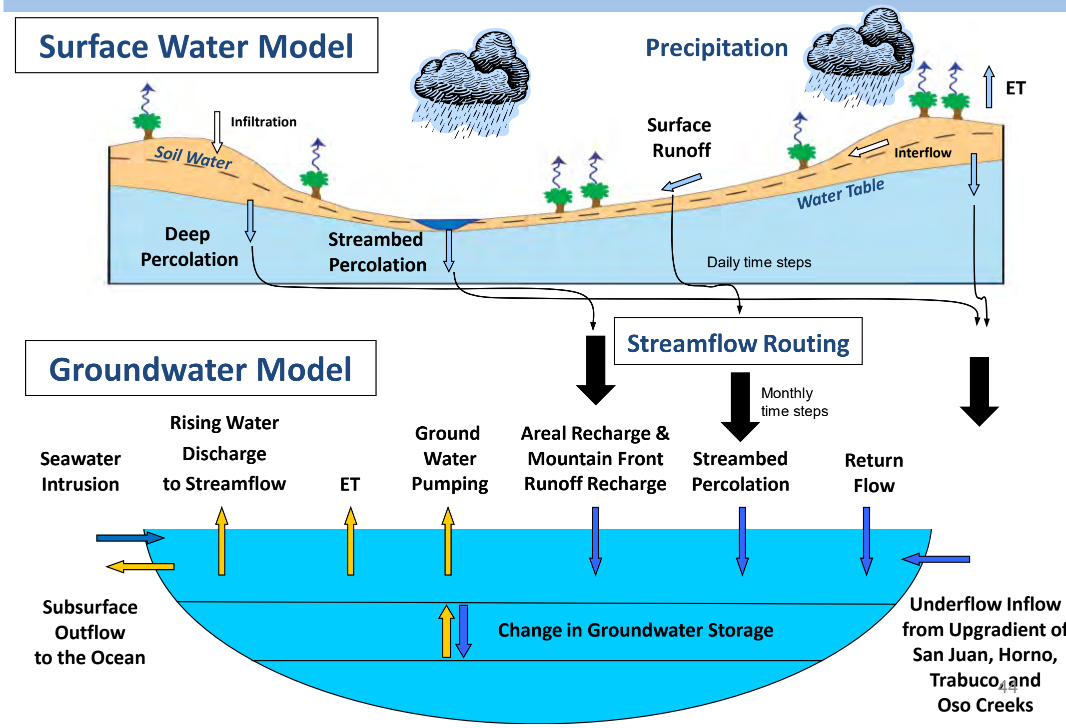
Mobile Test Facility

San Juan Groundwater Basin



South Orange Coastal Ocean Desalination Project

Surface Water Model/Groundwater Model Interface



Project Economic Analyses Cases

Economic Analysis – Case 1 Base
No Fe/Mn Pre-treatment (with MITIGATION costs)

Doheny Desalination Project - Economic Analysis - Draft Version 1.8

Input

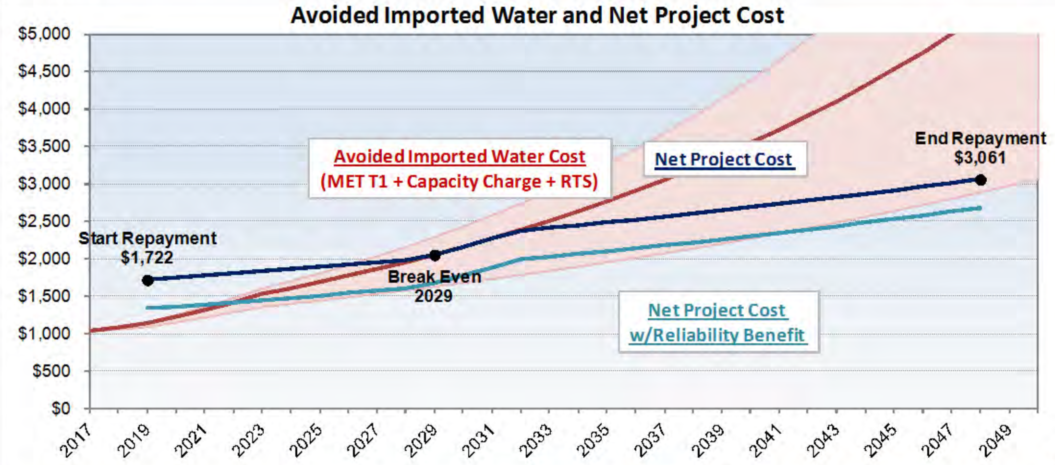
Capital Cost	
Fe/Mn Treatment?	No
Contingency of Const.	25%
Start of Construction	2017

O&M Costs		
Energy Costs		
Energy Usage (kWh)		4,228
Base Energy Rate ($/kWh)	$	0.105
Energy Escalation 2012 - 2030		2.0%
Energy Escalation after 2030		2.0%
Land Cost		
Land Cost per AF (2011)	$	47
Lease Escalation Rate		2.5%
General Inflation Rate		
Current - 2020		2.5%
2021 - Future		2.5%

Project Financing		
Grant Amount		$ -
Bond Repayment	Select →	30
Bond Interest Rate		4.50%
PV Discount Rate		4.00%

MET Avoided Costs	
Esc. Rate After 2017	5.0%
Melded Rate- % Tier 1	100%

Output



Project Capital Costs	
Capital Cost (2012)	$130,227,550
Grants	$0
Contingency	$22,586,000
Total Cost (2011)	$152,813,550
Total Cost Escalated to Midpt. of Const.	$181,647,290

	Current Year	First Year
Costs per AF	2012	2019
Capital Cost	$588	$699
O&M	$363	$489
Energy	$446	$522
Annual Cost	$1,397	$1,709
Annual Cost w/ Land	$1,444	$1,767
Mitigation Costs	$167	$205
Total w/ MET Subsidy	$1,361	$1,722

Net Present Value	
Up to Break Even	($31,436,811)
Break Even to End	$72,613,733
Total Savings	$41,176,923

Additional Reliability Benefit	
Storage Reservoir	$100,000,000

Economic Analysis – Case 2
Base Case with Fe/Mn Pretreatment (with MITIGATION costs)

Doheny Desalination Project - Economic Analysis - Draft Version 1.8

Input

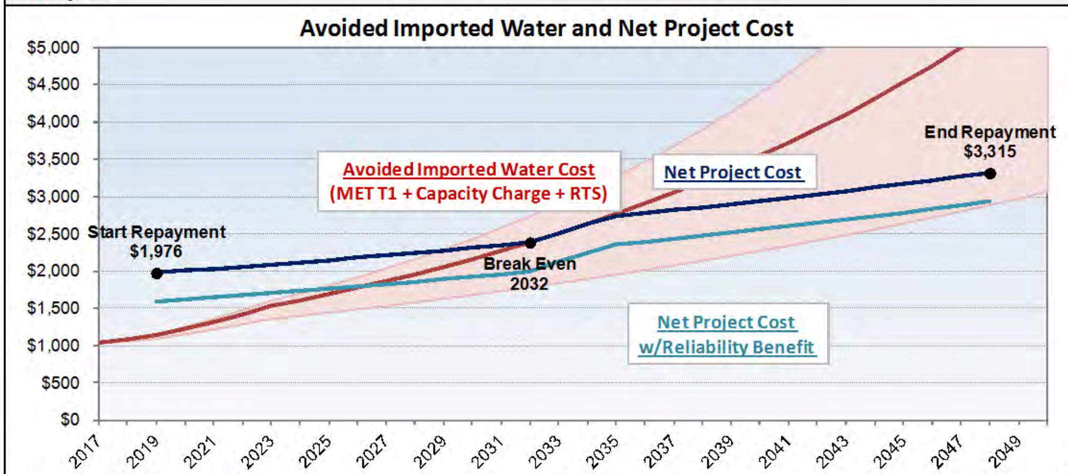
Capital Cost	
Fe/Mn Treatment?	Yes
Contingency of Const.	25%
Start of Construction	2017

O&M Costs		
Energy Costs		
Energy Usage (kWh)		4,259
Base Energy Rate ($/kWh)	$	0.105
Energy Escalation 2012 - 2030		2.0%
Energy Escalation after 2030		2.0%
Land Cost		
Land Cost per AF (2011)	$	47
Lease Escalation Rate		2.5%
General Inflation Rate		
Current - 2020		2.5%
2021 - Future		2.5%

Project Financing		
Grant Amount		$ -
Bond Repayment	Select →	30
Bond Interest Rate		4.50%
PV Discount Rate		4.00%

MET Avoided Costs	
Esc. Rate After 2017	5.0%
Melded Rate- % Tier 1	100%

Output



Project Capital Costs	
Capital Cost (2012)	$172,234,800
Grants	$0
Contingency	$30,373,750
Total Cost (2011)	$202,608,550
Total Cost Escalated to Midpt. of Const.	$240,837,897

	Current Year	First Year
Costs per AF	2012	2019
Capital Cost	$779	$926
O&M	$421	$489
Energy	$446	$522
Annual Cost	$1,646	$1,937
Annual Cost w/ Land	$1,693	$1,994
Mitigation Costs	$196	$231
Total w/ MET Subsidy	$1,640	$1,976

Net Present Value	
Up to Break Even	($59,808,624)
Break Even to End	$53,308,026
Total Savings	($6,500,598)

Additional Reliability Benefit	
Storage Reservoir	$100,000,000

Economic Analysis – Case 3
No Fe/Mn; High Electrical (with MITIGATION costs)

Doheny Desalination Project - Economic Analysis - Draft Version 1.8

Input

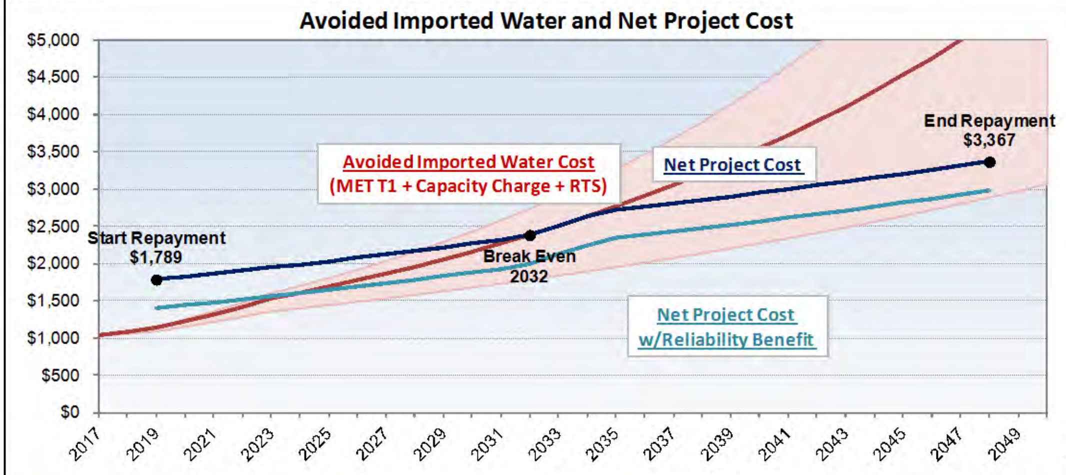
Capital Cost		
Fe/Mn Treatment?	No	
Contingency of Const.	**25%**	
Start of Construction		2017

O&M Costs	
Energy Costs	
Energy Usage (kWh)	**4,228**
Base Energy Rate ($/kWh)	**$ 0.105**
Energy Escalation 2012 - 2030	**3.4%**
Energy Escalation after 2030	**2.0%**
Land Cost	
Land Cost per AF (2011)	**$ 47**
Lease Escalation Rate	**2.5%**
General Inflation Rate	
Current - 2020	**2.5%**
2021 - Future	**2.5%**

Project Financing		
Grant Amount		$ -
Bond Repayment	Select →	30
Bond Interest Rate	4.50%	
PV Discount Rate	**4.00%**	

MET Avoided Costs	
Esc. Rate After 2017	5.0%
Melded Rate- % Tier 1	100%

Output



Project Capital Costs	
Capital Cost (2012)	**$130,227,550**
Grants	**$0**
Contingency	**$22,586,000**
Total Cost (2011)	**$152,813,550**
Total Cost Escalated to Midpt. of Const.	$181,647,290

Costs per AF	Current Year 2012	First Year 2019
Capital Cost	$588	$699
O&M	$363	$489
Energy	$446	$582
Annual Cost	$1,397	$1,769
Annual Cost w/ Land	$1,444	$1,827
Mitigation Costs	$167	$212
Total w/ MET Subsidy	$1,361	$1,789

Net Present Value	
Up to Break Even	($45,288,833)
Break Even to End	$52,460,361
Total Savings	$7,171,528

Additional Reliability Benefit	
Storage Reservoir	$100,000,000

Economic Analysis – Case 4
Base Case with $15M Grant; No Fe/Mn (with MITIGATION costs)

Doheny Desalination Project - Economic Analysis - Draft Version 1.8

Input

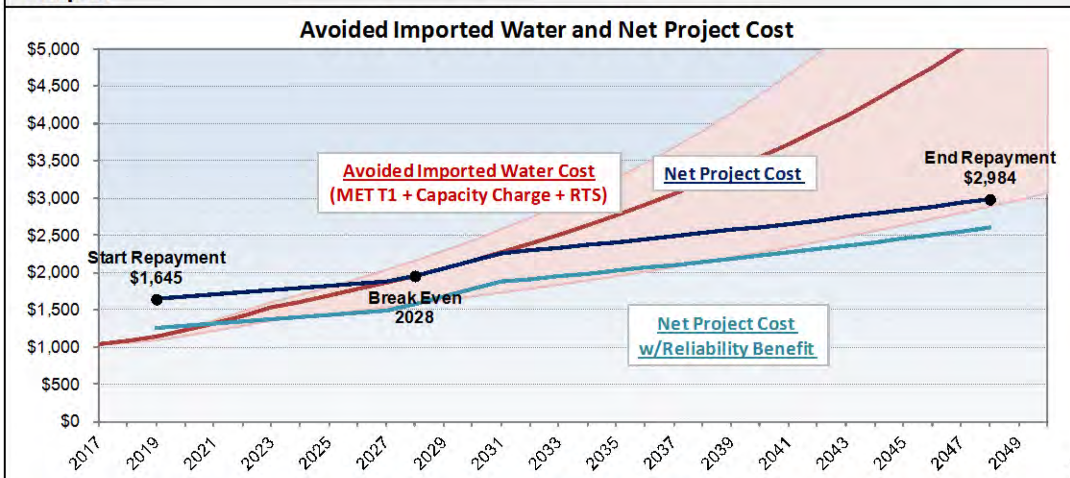
Capital Cost		
Fe/Mn Treatment?	No	
Contingency of Const.	**25%**	
Start of Construction		2017

O&M Costs	
Energy Costs	
Energy Usage (kWh)	**4,228**
Base Energy Rate ($/kWh)	**$ 0.105**
Energy Escalation 2012 - 2030	**2.0%**
Energy Escalation after 2030	**2.0%**
Land Cost	
Land Cost per AF (2011)	**$ 47**
Lease Escalation Rate	**2.5%**
General Inflation Rate	
Current - 2020	**2.5%**
2021 - Future	**2.5%**

Project Financing		
Grant Amount		$ 15,000,000
Bond Repayment	Select →	30
Bond Interest Rate	4.50%	
PV Discount Rate	**4.00%**	

MET Avoided Costs	
Esc. Rate After 2017	5.0%
Melded Rate- % Tier 1	100%

Output



Project Capital Costs	
Capital Cost (2012)	**$130,227,550**
Grants	**$15,000,000**
Contingency	**$22,586,000**
Total Cost (2011)	**$137,813,550**
Total Cost Escalated to Midpt. of Const.	$163,817,004

Costs per AF	Current Year 2012	First Year 2019
Capital Cost	$530	$630
O&M	$363	$489
Energy	$446	$522
Annual Cost	$1,339	$1,641
Annual Cost w/ Land	$1,386	$1,698
Mitigation Costs	$161	$197
Total w/ MET Subsidy	$1,297	$1,645

Net Present Value	
Up to Break Even	($24,278,982)
Break Even to End	$79,452,496
Total Savings	$55,173,514

Additional Reliability Benefit	
Storage Reservoir	$100,000,000

Economic Analysis – Case 5
Low Interest Rate; No Fe/Mn (with MITIGATION costs)

Doheny Desalination Project - Economic Analysis - Draft Version 1.8

Input

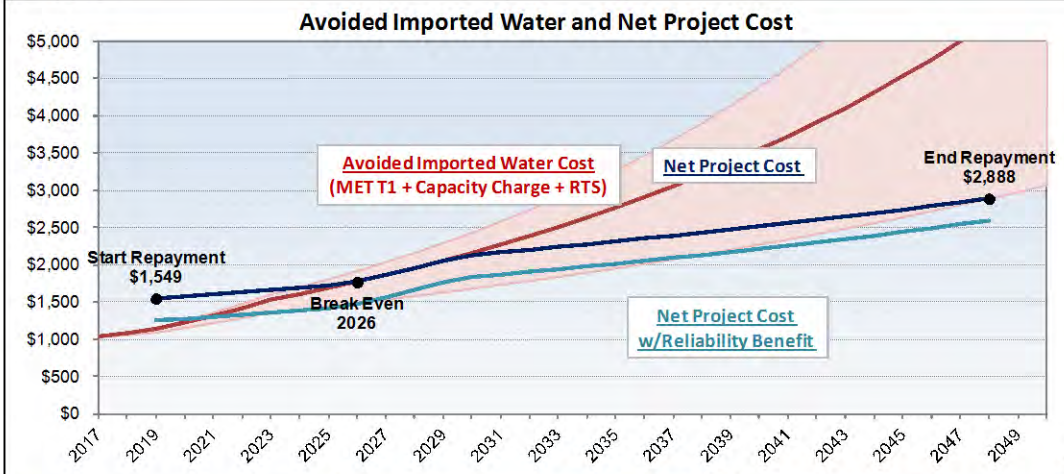
Capital Cost		
Fe/Mn Treatment?	No	
Contingency of Const.	25%	
Start of Construction		2017

O&M Costs		
Energy Costs		
Energy Usage (kWh)		4,228
Base Energy Rate ($/kWh)		$ 0.105
Energy Escalation 2012 - 2030		2.0%
Energy Escalation after 2030		2.0%
Land Cost		
Land Cost per AF (2011)	$ 47	
Lease Escalation Rate	2.5%	
General Inflation Rate		
Current - 2020	2.5%	
2021 - Future	2.5%	

Project Financing		
Grant Amount		$ -
Bond Repayment	Select →	30
Bond Interest Rate	2.50%	
PV Discount Rate	4.00%	

MET Avoided Costs	
Esc. Rate After 2017	5.0%
Melded Rate- % Tier 1	100%

Output



Project Capital Costs	
Capital Cost (2012)	$130,227,550
Grants	$0
Contingency	$22,586,000
Total Cost (2011)	$152,813,550
Total Cost Escalated to Midpt. of Const.	$181,647,290

Costs per AF	Current Year 2012	First Year 2019
Capital Cost	$457	$544
O&M	$363	$489
Energy	$446	$522
Annual Cost	$1,266	$1,554
Annual Cost w/ Land	$1,313	$1,612
Mitigation Costs	$152	$187
Total w/ MET Subsidy	$1,216	$1,549

Net Present Value	
Up to Break Even	($16,445,195)
Break Even to End	$88,913,956
Total Savings	$72,468,761

Additional Reliability Benefit	
Storage Reservoir	$100,000,000

Economic Analysis – Case 6
Base with Low MET Escalation; No Fe/Mn (with MITIGATION costs)

Doheny Desalination Project - Economic Analysis - Draft Version 1.8

Input

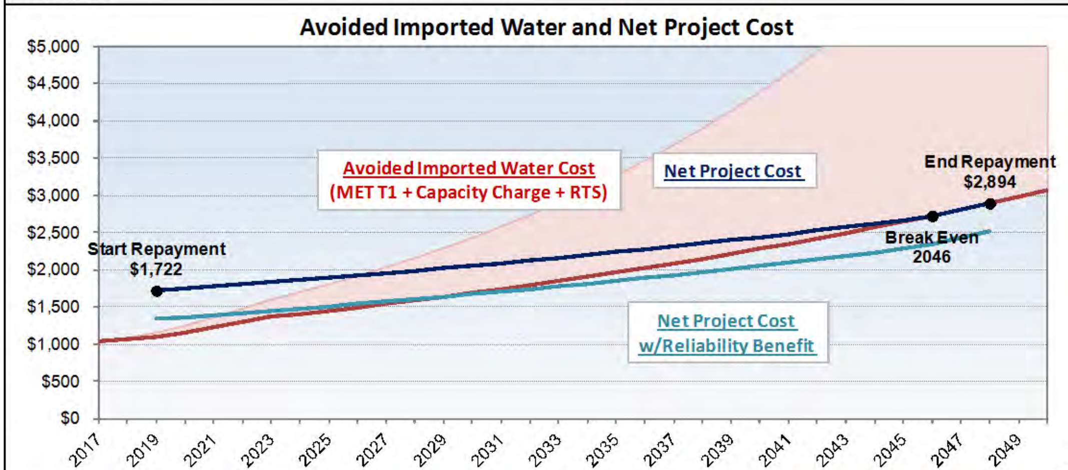
Capital Cost		
Fe/Mn Treatment?	No	
Contingency of Const.	25%	
Start of Construction		2017

O&M Costs		
Energy Costs		
Energy Usage (kWh)		4,228
Base Energy Rate ($/kWh)		$ 0.105
Energy Escalation 2012 - 2030		2.0%
Energy Escalation after 2030		2.0%
Land Cost		
Land Cost per AF (2011)	$ 47	
Lease Escalation Rate	2.5%	
General Inflation Rate		
Current - 2020	2.5%	
2021 - Future	2.5%	

Project Financing		
Grant Amount		$ -
Bond Repayment	Select →	30
Bond Interest Rate	4.50%	
PV Discount Rate	4.00%	

MET Avoided Costs	
Esc. Rate After 2017	3.0%
Melded Rate- % Tier 1	100%

Output



Project Capital Costs	
Capital Cost (2012)	$130,227,550
Grants	$0
Contingency	$22,586,000
Total Cost (2011)	$152,813,550
Total Cost Escalated to Midpt. of Const.	$181,647,290

Costs per AF	Current Year 2012	First Year 2019
Capital Cost	$588	$699
O&M	$363	$489
Energy	$446	$522
Annual Cost	$1,397	$1,709
Annual Cost w/ Land	$1,444	$1,767
Mitigation Costs	$167	$205
Total w/ MET Subsidy	$1,361	$1,722

Net Present Value	
Up to Break Even	($72,772,358)
Break Even to End	$65,495,638
Total Savings	($7,276,720)

Additional Reliability Benefit	
Storage Reservoir	$100,000,000

Economic Analysis – Case 7
High Electrical & Fe/Mn Pre-Treatment (with MITIGATION costs)

Doheny Desalination Project - Economic Analysis - Draft Version 1.8

Input

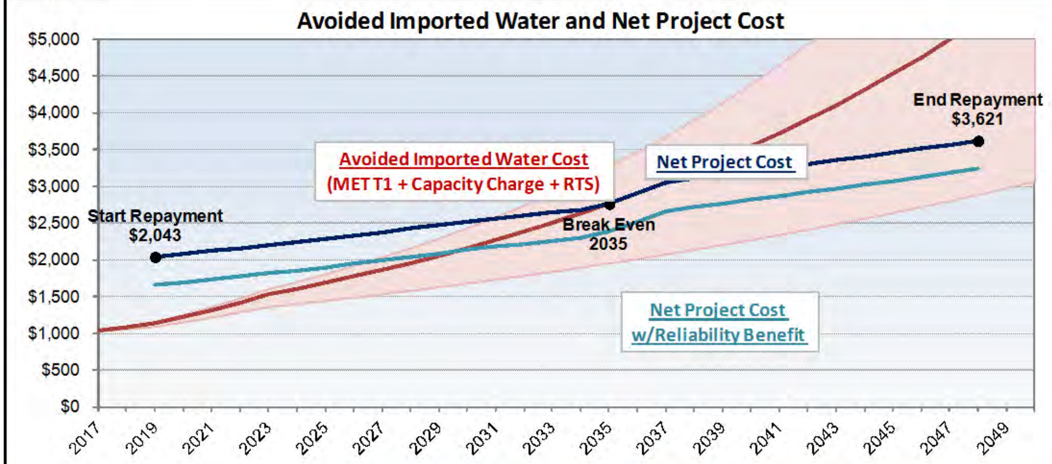
Capital Cost		
Fe/Mn Treatment?	Yes	
Contingency of Const.	25%	
Start of Construction		2017

O&M Costs		
Energy Costs		
Energy Usage (kWh)		4,259
Base Energy Rate ($/kWh)	$	0.105
Energy Escalation 2012 - 2030		3.4%
Energy Escalation after 2030		2.0%
Land Cost		
Land Cost per AF (2011)	$ 47	
Lease Escalation Rate	2.5%	
General Inflation Rate		
Current - 2020	2.5%	
2021 - Future	2.5%	

Project Financing		
Grant Amount		$ -
Bond Repayment	Select →	30
Bond Interest Rate	4.50%	
PV Discount Rate	4.00%	

MET Avoided Costs	
Esc. Rate After 2017	5.0%
Melded Rate- % Tier 1	100%

Output



Project Capital Costs	
Capital Cost (2012)	$172,234,800
Grants	$0
Contingency	$30,373,750
Total Cost (2011)	$202,608,550
Total Cost Escalated to Midpt. of Const.	$240,837,897

	Current Year	First Year
Costs per AF	2012	2019
Capital Cost	$779	$926
O&M	$421	$489
Energy	$446	$582
Annual Cost	$1,646	$1,997
Annual Cost w/ Land	$1,693	$2,054
Mitigation Costs	$196	$238
Total w/ MET Subsidy	$1,640	$2,043

Net Present Value	
Up to Break Even	($78,811,738)
Break Even to End	$68,285,103
Total Savings	($10,526,635)

Additional Reliability Benefit	
Storage Reservoir	$100,000,000

Economic Analysis – Case 8
Low MET Escalation with Fe/Mn Pre-Treatment (with MITIGATION costs)

Doheny Desalination Project - Economic Analysis - Draft Version 1.8

Input

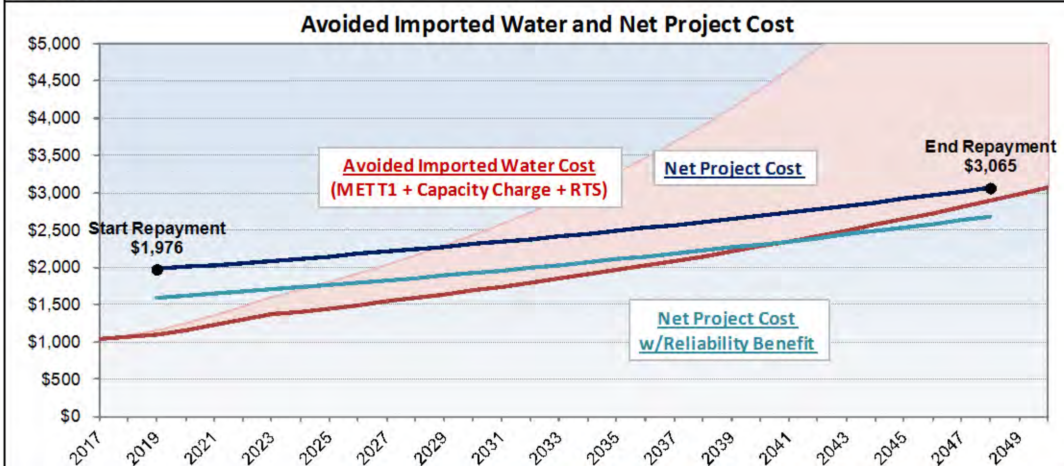
Capital Cost		
Fe/Mn Treatment?	Yes	
Contingency of Const.	25%	
Start of Construction		2017

O&M Costs		
Energy Costs		
Energy Usage (kWh)		4,259
Base Energy Rate ($/kWh)	$	0.105
Energy Escalation 2012 - 2030		2.0%
Energy Escalation after 2030		2.0%
Land Cost		
Land Cost per AF (2011)	$ 47	
Lease Escalation Rate	2.5%	
General Inflation Rate		
Current - 2020	2.5%	
2021 - Future	2.5%	

Project Financing		
Grant Amount		$ -
Bond Repayment	Select →	30
Bond Interest Rate	4.50%	
PV Discount Rate	4.00%	

MET Avoided Costs	
Esc. Rate After 2017	3.0%
Melded Rate- % Tier 1	100%

Output



Project Capital Costs	
Capital Cost (2012)	$172,234,800
Grants	$0
Contingency	$30,373,750
Total Cost (2011)	$202,608,550
Total Cost Escalated to Midpt. of Const.	$240,837,897

	Current Year	First Year
Costs per AF	2012	2019
Capital Cost	$779	$926
O&M	$421	$489
Energy	$446	$522
Annual Cost	$1,646	$1,937
Annual Cost w/ Land	$1,693	$1,994
Mitigation Costs	$196	$231
Total w/ MET Subsidy	$1,640	$1,976

Net Present Value	
Up to Break Even	($125,500,571)
Break Even to End	$115,260,666
Total Savings	($10,239,905)

Additional Reliability Benefit	
Storage Reservoir	$100,000,000

Economic Analysis – Case 9
Low MET Escalation with Low Interest (with MITIGATION costs)

South Orange Coastal Desalination Project - Economic Analysis - DRAFT VERSION 1.8

Input

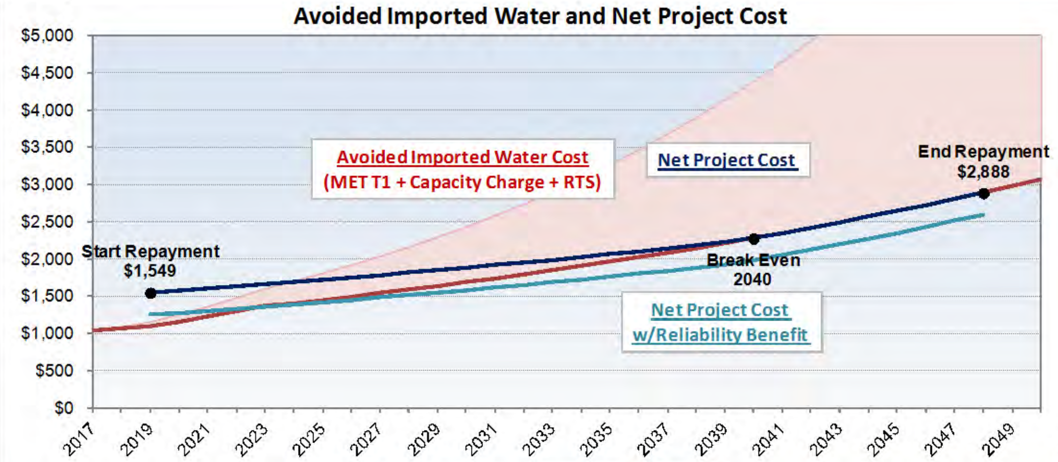
Capital Cost	
Fe/Mn Treatment?	No
Contingency of Const.	25%
Start of Construction	2017

O&M Costs		
Energy Costs		
Energy Usage (kWh)		4,228
Base Energy Rate ($/kWh)		$ 0.105
Energy Escalation 2012 - 2030		2.0%
Energy Escalation after 2030		2.0%
Land Cost		
Land Cost per AF (2011)	$ 47	
Lease Escalation Rate	2.5%	
General Inflation Rate		
Current - 2020	2.5%	
2021 - Future	2.5%	

Project Financing		
Grant Amount		$ -
Bond Repayment	Select →	30
Bond Interest Rate	2.50%	
PV Discount Rate	4.00%	

MET Avoided Costs	
Esc. Rate After 2017	3.0%
Melded Rate- % Tier 1	100%

Output



Project Capital Costs	
Capital Cost (2012)	$130,227,550
Grants	$0
Contingency	$22,586,000
Total Cost (2011)	$152,813,550
Total Cost Escalated to Midpt. of Const.	$181,647,290

Costs per AF	Current Year 2012	First Year 2019
Capital Cost	$457	$544
O&M	$363	$489
Energy	$446	$522
Annual Cost	$1,266	$1,554
Annual Cost w/ Land	$1,313	$1,612
Mitigation Costs	$152	$187
Total w/ MET Subsidy	$1,216	$1,549

Net Present Value	
Up to Break Even	($40,765,490)
Break Even to End	$35,505,320
Total Savings	($5,260,170)

Additional Reliability Benefit	
Storage Reservoir	$100,000,000

ATTACHMENT THREE

Peer Swan Presentation

HB Desalination

Residents for Responsible Desalination

March 5, 2015

Peer Swan

About the Speaker

- Director, Irvine Ranch Water District - 35 yrs.
- former Director, OC Sanitation District - 15 yrs.
- former Director, Metropolitan Water District
- former Director, National Water Research Institute
- Director, Association of California Water Agencies

Outline of the Talk

- IRWD position on the Huntington Beach project
- My view
  - Current Water Picture
  - Need for future projects
  - Process for matching needs with projects
  - Alternatives to the HB Desalter
  - How current MWD allocation rules impact
  - The HB Desalter
  - Why this is not the right project

IRWD Position

- NOT opposed to the Project but adopted policies that preclude IRWD interest because:
  - Water from the project exceeds cost of MWD water
  - No water agency financing of project
  - Water quality has to meet IRWD needs

Current Water Picture

- Multiple Dry Years
- No Allocation or Mandatory Cutbacks YET
- About half a year water supply in MWD storage
- Dry year and little snow pack 20% State Allocation
- Warmer temperatures
- Significant groundwater overdraft in San Jouquin Valley
- OC Basin ¾'s through operating range

Need for future Projects

- Water usage has been declining on a per capita basis – is this permanent?
- What is a prudent reserve supply?
- Declining flow in Santa Ana River
- What is the frequency and duration of allocations? or MWD curtailments of deliveries?

Alternatives

- Base load on MWD supply instead of local supply and build storage in the OC basin
- Slow the leakage into LA Central Basin
- Contract or purchase water from outside OC
- Expand the Ground Water Replenishment project from 100,000 MGD to 130,000 MGD
- Actively push Conservation
- HB Desalination

Current MWD Allocation Rules

- MWD is a supplemental supplier
- During allocations MWD offsets portions of local supplies to EVEN OUT total supplies within the MWD seven county service area
- So during periods of allocation local project benefits are distributed to others while the obligation to pay for them remains local

HB Desalter

- 50 MGD Plant or 50,000 af/yr
- Take or pay contract
- Pipeline to connect to customers
- Prior attempts to get direct purchase contracts
- OCWD negotiations
- Project costs ? $ 1,800 – 2,300 per acre foot versus current MWD water cost of about $600/af for untreated and about $1,000/af for treated

What cost for reliability?

- Assume HB Desalter $2,200/af
- Assume MWD interruption happens two times during a ten year period into the future
- Assume that MWD water purchases that are foregone cost $800/af
- Assume that the HB Desalter plant produces 50,000 af per year

Cost of reliability

- Eight years of unneeded purchases
- 8yrs x 50,000 af x ($2,200-800)/af = $560 million
- So would pay $560 million over what would pay for otherwise available MWD supplies
- If applied this amount to the two years of interruption it would be $280 million a year over he contract amount or $280,000,000 / 50,000 AF plus $2,200/af or $7,800/af
- If MWD offset benefit by 30% the reliability cost would exceed $10,100/af

Can this be done CHEAPER?

- If OCWD purchased extra untreated water during the eight years when it would be available and put it into the basin as stored water at the $600 rate, pumped and treated it at $100/af OCWD would save ($10,100-700)/af X 50,000 af X 2 yrs or a total
- $940,000,000 every 10 years or more than the cost of the HB Desalter Plant and Pipelines

Can this be done CHEAPER?

- If OCWD purchased Treated Water at $1,000/af and delivered it in lieu (in place of pumped water) it would save ($10,100-1,000) /af X 50,000 af X 2 yrs or a total of
- $910,000,000 every ten years (or more than the cost of the HB Desalter Plant and Pipeline)

HB Desalter versus MWD rates

- Currently half the cost of Desalter water is for for energy versus less than 20% for MWD water
- MWD has long term contracts for most of its power at rates that are a small fraction of those paid by the HB Desalter.
- Over 80 % of MWD current rates are fixed with the largest amount for the State Contract and the existing debt
- The bulk of OCWD purchases from MWD are for and will continue to be Untreated Water currently at $600 /af
- Not likely to change relationship with S2,200 desalter water

Other unresolved issues

- Will MWD allow Desalter water in its pipelines?
- Can OCWD deliver non Groundwater to customers?
- Can OCWD deliver water outside its boundaries?
- Can OCWD assume the Desalter take or pay contract without a serious downgrade of its credit?

Questions?

ATTACHMENT FOUR

Reliability Benefits in OC from the Poseidon Project

Item No.

DISCUSSION ITEM
July 7, 2015

TO: **Planning & Operations Committee**
(Directors Osborne, Barbre, Hinman)

FROM: Robert Hunter
General Manager

Staff Contact: Karl Seckel

SUBJECT: **Reliability Benefits in OC from the Poseidon Project**

STAFF RECOMMENDATION

Staff recommends the P&O Committee discuss and receive and file the report.

DETAIL REPORT

The Poseidon Project is being discussed in many venues at this time. Staff would like to update the P&O Committee on several issues related to the Poseidon Project. The questions being discussed are:

1. Does the Poseidon Project **qualify** for the MET Local Resources Program (LRP) subsidy?
2. Will the Poseidon Project **receive** the MET LRP subsidy?
3. Is there an improvement in water supply **reliability** in OC and the MET service area from the Poseidon Project? If so, then how much of an improvement?
4. What other issues are related to the water supply reliability discussions?

Staff will attempt to clarify several of the issues imbedded in the questions, although the issues can be complex, difficult to explain and difficult to comprehend. The discussion provided is just a starting point in understanding how the Poseidon Project and other projects fit into the reliability equation in OC and MET. This discussion does not necessarily address all questions raised to date. We will have many such discussions as the work

<table>
<tr><td>Budgeted (Y/N):</td><td colspan="2">Budgeted amount:</td><td>Core __</td><td>Choice __</td></tr>
<tr><td colspan="2">Action item amount:</td><td colspan="3">Line item:</td></tr>
<tr><td colspan="5">Fiscal Impact (explain if unbudgeted):</td></tr>
</table>

continues under the OC Water Reliability Study. The following discussions should be considered as preliminary and incomplete at this time, but will serve as a focus point for receiving input into these complex issues.

1. Does the Poseidon Project qualify for the MET Local Resources Program (LRP) subsidy?

Short Response: **Yes. Qualifying for the LRP subsidy requires that the project results in "supplies that replace an existing demand or prevents a new demand on MET's imported water deliveries either through direct replacement of potable water or increased regional groundwater production." Based on the program requirements and past MET actions, MWDOC staff believes the project qualifies for the LRP subsidy.**

Discussion: Some seem to believe that OCWD will not be able to demonstrate that the OCWD demand on MET will be reduced once the Poseidon Project is in place compared to NOT having the Poseidon Project. MWDOC's view is that OCWD **will qualify** for the subsidy. MWDOC notes that offsetting of MET supplies is not only associated with groundwater replenishment deliveries but is also associated with offsetting of full service supplies to the retail agencies within OCWD, which today is on the order of 300,000 acre-feet (AF), far exceeding the 56,000 AF from the Poseidon Project. MWDOC concurs that work with MET staff will be required on how best to measure the imported water demand reduction (or the increase in local production due to the Poseidon Project), but MWDOC does not anticipate a problem. (This remains just staff opinion until the MET Board actually agrees.) MWDOC has discussed with MET Local Resources Program staff how the Poseidon Project LRP Agreement provisions could be developed to demonstrate compliance for qualifying production of the Poseidon water for any of the three distribution options being considered:

- Seawater barrier operations
- Direct delivery to retail agencies
- Injection or percolation in the groundwater basin

While the MET staff cannot make commitments for their Board, it was noted that the current method for determining withdrawal of water from MET's Conjunctive Use Storage Account could possibly be utilized. There are other options. The final LRP Agreement is always subject to approval by the MET Board and cannot be brought forward until such time as Poseidon has received all permits for the project, including the final Coastal Commission permit. Once the final Coastal Commission permit is received, the LRP Agreement would be agendized for MET Board consideration.

2. Will the Poseidon Project receive the MET LRP subsidy?

<u>Short Response</u>: **Unknown. As noted above, once the final permits have been obtained by Poseidon, the LRP subsidy agreement will be taken to the MET board. It will be up to the MET board to make a final decision. MWDOC's role is to assist in the process.**

3. Is there an improvement in water supply reliability in OC and the MET service area from the Poseidon Project? If so, then how much of an improvement?

<u>Short Response</u>: **Yes, there is a water supply reliability improvement to both OC and MET from implementation of the project. The Poseidon Project will produce a new annual water supply of 56,000 AF. During periods of MET water supply allocations, OC would receive a direct benefit equivalent to whatever MET imported supply demand reduction percentage has been requested, say 10% to 50%, times the project yield. The remaining reliability benefit, 50% to 90% of the project yield, accrues to the MET service area. Out of the MET service area, OC purchases about 20% of MET's supplies, so OC gains a 20% benefit of the 50% to 90% benefit that accrues MET-wide. Tables 1 & 2 below track through sample calculations. It should be noted that all percentages in this response are generalized for discussion purposes. The more severe the allocation cut from MET (i.e., mandatory supply reduction) the greater the percent supply benefit to OC.**

<u>Discussion:</u> To completely answer this question, we need to first define "improvement in water supply reliability." In general terms, reliability relates to the percent of normal water demand that can be provided under water shortages. This can include drought conditions when MET has enacted formal supply reductions through their water supply allocation process. Reliability improvement is a measure of the difference in reliability by having implemented an additional local project, such as the Poseidon Project. The following attempts to characterize the reliability improvements that occur directly and indirectly:

a. From a narrow perspective, during years in which we are under water supply allocations from MET (such as this current year starting July 1), if OC will have more water available from a combination of local sources plus its allocation of water from MET, OC would be determined to be "more reliable". Thus, the "reliability improvement" is the increased supply of water (an acre-foot or percentage amount) over and above the amount of water that would have been available in OC in the absence of the Poseidon Project.

b. In a broader sense, the Poseidon Project would reduce the demands OC has for purchases of MET water. Thus, MET would sell less water and would retain or add more water in their various storage accounts (unless they were all full). As a result, all of Southern California (within the MET system) would be more reliable because of the additional water in MET's storage accounts resulting from the Poseidon Project. Since OC is part of the MET system, OC would be somewhat more reliable with the Poseidon Project. Having these supplies in storage can also help MET (and OC) to stay out of a water supply allocation situation, reduce the allocation reduction or shorten the duration of the shortage situation. As noted above, OC purchases about 20% of MET's supplies, so we could say OC roughly accrues 20% of this benefit.

c. The narrow and broader perspective will be called "direct" and "indirect" benefits in the discussion below. The direct benefits accrue directly to OC while the indirect benefits accrue to the MET service area and hence help out all of MET, including OC.

The average person might expect OC to be more reliable by 56,000 AF **per** year with the Poseidon Project. This is not the case under either of these definitions.

The detailed "how much" answer is somewhat complicated and has several parts:

- During a water shortage allocation by MET, the basis MET uses to provide water allocations to their various member agencies is based on the principle of the "need for MET water" to meet retail demands. This is measured based on the actual use of MET water during agreed upon base years plus current local water supply conditions. If a NEW Ocean Desalination supply project producing 56,000 AF of water is brought into operation, the "need" for MET water in OC is lowered by 56,000 AF of water. This results in a lower allocation from MET. The methodology is structured to always result in a higher reliability for whomever has developed a local project compared to not having developed the local project. However, the higher "direct" reliability is not increased by the entire project yield (in our example 56,000 AF) but only by the percentage of the project yield proportional to the MET allocation level (i.e., the percent reduction in supply).
- Why was the MET water supply allocation developed in such a manner? Beginning in the early 1990's, MET's IRP adopted a more regional, cooperative approach to providing reliable supplies over the long run by the combined actions of MET, their member agencies and the subagencies, rather than MET providing the full reliability for all of Southern California. The IRP depends on MET accomplishing certain water supply actions and depends on local agencies accomplishing certain water supply actions. Collectively, these actions and investments are brought together to provide the overall water supply reliability for Southern California. Under this "cooperative" approach, the goal is to provide regional reliability for all while allowing a certain **additional** level of reliability for those who do more by developing local projects. This philosophy of everybody working together has been characterized as "sharing the pain" under water supply allocation events, but the overriding goal is to be fully reliable which would mean the region would not ever have to utilize water supply allocations.

- As an approximation, the reliability from the project yield under MET's current water supply allocation methodology can be estimated by the following calculation:
    - With a MET allocation reduction of 15%, areas that are 100% dependent on MET have to reduce water use by about 15% in round numbers. In the OCWD service area, with the Basin Production Percentage for groundwater production set at 70%, the overall demand reduction for the groundwater producers would be 15% of 30% or 4.5% (in round numbers). For OC as a whole, being roughly 50% dependent on MET, the overall reliability for a 15% reduction is shown in Table 1 at 92.5%. The reliability GAP would then be 7.5% of demands.
    - The "direct" reliability improvement in acre-feet is approximately equal to the MET regional percentage reduction they have requested in the allocation multiplied by the Project yield (Level 3 Allocation = 15% reduction in supply; 15% x 56,000 AF = 8,400 AF reliability improvement).
    - This means that OC would directly have about 8,400 AF more than they otherwise would have had if they had NOT constructed the Poseidon Project.
    - The other portion of the project yield, 47,600 AF, benefits the MET service area, including OC, because less MET supplies in this amount are required to be delivered in the MET service area.
    - Assuming OC is 20% of MET, the "indirect" benefit is 9,520 AF.
    - The two benefits combined are 17,920 AF or 32% of the Poseidon project yield. The reliability GAP has been reduced from 7.5% to 4.5%, about a 40% reduction.
- Tables 1&2 below are not exact, but provide sample calculations showing that if the Poseidon Project were operational when the baseline calculations were set for the current MET allocations (baseline years = 2012-13 & 2013-14), OC's reliability would be improved by 17,920 AF today. Table 2 extends the estimates and provides the sample calculations for two additional examples.

4. What other issues are related to the water supply reliability discussions?

- The definition of reliability used in this discussion regarding MET's water allocation methodology has been completely undermined by the Governor's 25% reduction scheme. The Governor's emergency reductions are focused solely on demand reduction and do not consider local supply conditions or increases in supply. Adding an additional 20 Poseidon Plants would not help under this situation.

- Under the MET allocation formula, the more unreliable MET is (situations with deeper allocation cutbacks), the more reliability improvement OC receives from having implemented a local project such as Poseidon. At a 50% allocation from MET, OC would have an improved reliability of about 28,000 AF (50% of 56,000 AF).
- Can the MET allocation formula be changed? This aspect of the allocation program has remained unchanged since about 1994. The support for "share the pain" is philosophical in nature and central to MET as a regional organization. The issue has been raised in a number of forums at MET but has never gotten enough support from other member agencies to be changed. It is a highly charged issue and it is perceived that a change would adversely affect many MET agencies and subagencies. The MET allocations are a zero sum game. In an allocation you are limiting the available supply of water. If Agency A receives a higher allocation, other agencies receive a lower allocation.
- Simply focusing on what happens during an allocation does not account for the years when MET is <u>not</u> in an allocation.
    - If OC implements the Poseidon Project, we would simply purchase less MET water, MET's sales will go down and the unsold water will likely be stored in one of MET's storage accounts for subsequent use in dry years. Overall, this would result in MET having more water in storage, being more reliable and Southern California and OC would be in shortage situations less frequently. This is a good thing, but OC is paying more for their water as a result. OC purchases about 20% of MET's supplies and so the additional benefit needs to be accounted for.
    - Some would observe that the MET LRP incentive funds actually result from water purchase payments paid by all of the MET member agencies, including OC. In return for this funding, the MET service area receives improved reliability. Under the LRP, MET would be providing about $400 million over 15 years towards the Poseidon Project; this has been estimated at about 23% of the cost of the Poseidon Project over the 50-year term now being considered (OC has contributed about 20% of the LRP funds to be provided via water rates paid to MET). Some question whether the funding provided by OC ratepayers is commensurate with the return on this investment as an OC investment (OC pays roughly 77% of the costs and receives 32% to 60% of the water supply reliability benefits (Table 2) – this does not account for the SYSTEM reliability benefits discussed below nor for the portion of the LRP payments contributed by OC.)
    - If OC can store the Poseidon water in years when it is not being used to meet demands directly, it becomes a question as to whether the water would result in a <u>significantly</u> higher reliability for OC under those circumstances, without a change in how MET approaches water

allocations. Again, MET looks at the "need" for MET water to meet demands. If local supplies are available, because water was stored in other years, it would likely be counted as "additional local supplies" during a MET allocation in a similar manner to how the Poseidon yield would be counted. OC would likely be better off by only a small percentage.

- One solution to this dilemma is to have MET pursue the project and incorporate the supplies into their water resources mix. The problem with this is that MET has historically evaluated that they have sufficient other supply options, costing less than $1800 per AF, to help meet their demands and to put into their storage accounts during wet years for use during dry years. MET will soon be releasing their 2015 IRP projections; it is possible that MET could determine that it is time to consider ocean desalination and/or other similar supplies to improve their reliability over time. In addition, the OC Water Reliability Study will be modeling MET supplies over the long range to develop our own estimate of MET's reliability and how other supply options might improve MET's or OC's reliability.
- "Extraordinary supplies", as defined by MET, are "deliberate actions taken by member agencies to augment the total regional water supply only when MET is allocating supplies through the Water Supply Allocation Plan (WSAP)". Extraordinary supplies cannot be base-loaded supplies such as the Poseidon Project (i.e., they can't be used except during allocations). The only projects deemed by MET so far to meet this definition come from either the Strand Ranch Project or from transfers entered into only during years when a WSAP applies. The Strand Ranch Project was developed specifically to store wet year water to be used only when MET implements a WSAP. However again, the value of these extraordinary supplies was undermined by the Governor's 25% reduction because they are focused only on demand (use) and not supply.
- **SYSTEM RELIABILITY IMPROVEMENTS:** The entire discussion above has focused on SUPPLY reliability benefits. The other benefit that accrues from developing some local projects is SYSTEM reliability benefits – having the capability to continue supplying water during emergency events such as following damaging earthquakes. If an earthquake knocked out the Diemer Filtration Plant in Yorba Linda, there would be a benefit to having an ocean desalination project in Huntington Beach continuing to produce 77 cubic feet per second (cfs) of supplies into the system. None of the discussions above have placed a value on the peak system capacity provided by the Poseidon Project. This represents 77 cfs of peak capacity that could be of value during an emergency event. There are other ways of providing this amount of system reliability, but the value of having this benefit available should be included in the reliability evaluations. MWDOC is in the process of completing a SYSTEM reliability study under the OC Water Reliability Study and should have results within the next several months. This will enable us to place a value on this benefit.

- This discussion has not included the "economic value" of being reliable. Shortages, whether short-term or longer-term, can have a significant impacts on our economy. The prior work by MWDOC and OCBC from 2004 provided estimates of the cost impacts of "not being reliable", which were quite high.
- IRWD has been heavily involved in the discussions relative to the Poseidon Project, including presentations made to the OCWD Citizens Advisory Committee and in the Groundwater Producer's meetings. For informational purposes only, MWDOC has attempted to summarize the main points they have made (without taking a stance on the statements).
    - Historically, MET has been very reliable, having gone into shortage allocations only in 1976-77, 1991-92, 2008-09, and now 2015-16 (4 times in 40 years). If OC knows MET will be reliable in the future and has water to sell to replenish the groundwater basin, OC should plan on purchasing the water to do so. This would always be our least cost option for OC and if we kept the groundwater basin at a higher level, we would have more protection during future shortages.
    - If MET is reliable, say 8 or 9 years out of 10, this means OC would only need the Poseidon water 1 or 2 years out of 10. However, ocean desalination projects generally cannot be effectively operated only a few years out of 10 as the financial allocation of capital costs to the smaller volume of water produced yields extremely expensive water. Operating the project to provide yield only in a few years out of 10 or simply operating in a manner that results in building up storage in MET's storage accounts also results in a high unit cost of the project in OC, based on the limited reliability improvements available at this time.
    - However, if MET is much less reliable, maybe only 1 or 2 years out of 10, the argument in support of the Poseidon Project makes better sense and OC would receive a greater return on investment.

Table 1
Approximate Direct and Indirect Water Reliability Improvement During a MET 15% Water Allocation Reduction With and Without the Poseidon Project
Acre-Feet (AF)

Row	Category	Current Supplies	With Poseidon	Approximate Reliability Improvement From Poseidon (3)
1	Total OC Demands	600,000	600,000	
2	Existing Local Supplies Today	300,000	300,000	
3	Poseidon Project	0	56,000	
4	Demands on MET	300,000	244,000	
5				
6	Call for a 15% Reduction = Reliability GAP (1)	45,000	36,600	
7	Reduced MET Demands	255,000	207,400	
8	Local supplies remain (2)	300,000	356,000	
9	Total supplies during allocation	555,000	563,400	
10	Reliability = Row 9 % of Row 1	92.5%	93.9%	1.4%
11	Direct Benefit = difference in Row 9			8,400
12	Remaining Poseidon Yield to MET			47,600
13	Assume OC = 20% of MET			9,520
14	Total Direct + Indirect Benefit			17,920
15	Percentage of Poseidon Yield			32.0%
16	Percentage of Reliability GAP Covered by Poseidon			39.8%

(1) Reduction is in demands for MET water

(2) With and without the Poseidon Project

(3) Reliability in acre-feet and % higher supplies under a MET allocation with the Poseidon Project

Table 2
Approximate Direct & Indirect Reliabilty Improvement
From the Poseidon Project Under Three Scenarios

		MET Supply Allocation Reduction Scenarios		
Row		**15%**	**30%**	**50%**
1	Reliability % Without Poseidon	92.5%	85.0%	75.0%
2	% Reliability GAP Without Poseidon	7.5%	15.0%	25.0%
3	Reliability GAP in AF Without Poseidon	45,000	90,000	150,000
4				
5				
6	Direct Poseidon Reliability to OC - AF	8,400	16,800	28,000
7	Direct Poseidon Reliability to MET - AF	47,600	39,200	28,000
8	Portion of MET Poseidon Reliability to OC (20% of MET)	9,520	7,840	5,600
9				
10	Direct + Indirect Poseidon Reliability to OC - AF	17,920	24,640	33,600
11	% of Poseidon Project Yield	32.0%	44.0%	60.0%
12	% Reliability Improvement from Poseidon	3.0%	4.1%	5.6%
13	Remaining Reliability GAP	4.5%	10.9%	19.4%
14				
15	Portion of Reliability GAP Covered by Poseidon	39.8%	27.4%	22.4%

HYDROFOCUS INC.
Solutions for Land and Water Resources

August 19, 2016

Mr. Ray Heimstra
Orange County Coastkeeper
Costa Mesa, CA

Mr. Joe Geever
Residents for Responsible Desalination
Long Beach, CA

Subject: Huntington Beach Seawater Desalination Facility Groundwater Model Evaluation

Dear Mr. Heimstra and Mr. Geever,

Please find enclosed the subject report prepared by HydroFocus. We critically reviewed and analyzed the results from the groundwater-flow model developed by Geosyntec Consultants to help in the evaluation of impacts and feasibility of subsurface intakes for the proposed Huntington Beach Seawater Desalination Facility. We reviewed the model structure, verified model inputs and outputs, assessed groundwater flow patterns, and evaluated the sensitivity of model outputs to model inputs. We ascertained the source of groundwater flowing to the proposed slant wells and groundwater travel times.

Our sensitivity analysis to assess the effects of varying different model inputs on model results revealed that the model outputs were most affected by changes in the aquifer properties of the Talbert Aquifer and the overlying aquitard. Varying these properties produced large changes in model-estimated groundwater-level declines and inland flow to the production wells. These results indicate that more data is needed for these inputs to improve model certainty.

Several additional steps can be taken to improve the model and increase confidence in evaluating impacts of the project. We recommend: (1) aquifer tests to determine properties of the Talbert Aquifer, the overlying sediments, and the wetland sediments; (2) an assessment of the effects of the lateral model boundaries, (3) correction of inconsistencies in model construction, (4) calibration/verification using water level data, and (5) subsidence modeling to preliminarily evaluate the subsidence potential due to slant well pumping. The improved model can then be used to more effectively simulate potential impacts and project feasibility.

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Operation of the slant wells will affect the extent of seawater intrusion in the Talbert Aquifer; pumping will likely increase the gradient from inland areas toward the project wells which will enhance the movement of inland freshwater toward the coast and move the seawater/freshwater interface closer to the coastline.

Thank you for the opportunity to work on this project and be of service. Please contact us if you have any further questions.

Sincerely,

David Leighton
Senior Hydrologist

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Huntington Beach Seawater Desalination Facility
Groundwater Model Evaluation

HydroFocus, Inc., Davis, CA
August 19, 2016

Executive Summary

HydroFocus critically reviewed and analyzed outputs from the groundwater-flow model developed to evaluate the impacts and feasibility of subsurface intakes for the proposed Huntington Beach Seawater Desalination Facility in a coastal lowland area known as the Talbert Gap. The Talbert Gap is part of the Coastal Plain of Orange County Groundwater Basin and the primary water-bearing zone in the Talbert Gap is the Talbert Aquifer. The Orange County Water District operates the Talbert Seawater Intrusion Barrier at the northern edge of the Talbert Gap and a series of coastal marsh and wetland areas exist along the coast in the project area.

Geosyntec Consultants developed a groundwater-flow model to simulate the effects of pumping 127 million gallons per day (MGD) of groundwater from 40 slant wells located along the coast and screened in the Talbert Aquifer. HydroFocus reviewed model structure, ran the model to verify output and assess groundwater flow patterns, and evaluated model sensitivity. We used particle tracking to determine the source of groundwater flowing to the slant wells and evaluate groundwater travel times for various scenarios. We verified that the model geometry, boundary conditions, and aquifer properties generally agreed with information reported by Geosyntec Consultants with some exceptions. The cell dimensions were slightly different than reported and the ocean in model Layer 1 was not represented as constant head in all areas as was reported.

We conducted a model sensitivity analysis to assess the effects of varying model inputs on model results. Specifically, we evaluated the effect on simulated flow to the slant wells from inland groundwater and the wetlands and average water-level decline due to varying model inputs for aquifer transmission properties (i.e. hydraulic conductivity), pumping rates, well location and length, and water levels at the seawater intrusion barrier . The model was most sensitive to changes in the aquifer properties of the Talbert Aquifer and the overlying aquitard. Varying these properties produced large changes in model-estimated groundwater-level drawdowns and inland flow to the slant wells. These results indicate that more data is needed for these inputs to improve model certainty.

Pumping at lower rates will reduce impacts on the groundwater system. Operation of the slant wells will affect the extent of seawater intrusion in the Talbert Aquifer; pumping will likely increase the gradient from inland areas toward the project wells which will enhance the movement of inland freshwater toward the coast and move the seawater/freshwater interface closer to the coastline. This increase in seaward gradient along with capture of seawater by the slant wells will have the effect of reducing the inland migration of seawater.

We identified model limitations and uncertainty that affect the ability of the model to accurately predict impacts of project pumpage. The model was not calibrated or verified using observed water level data. There is very limited information on the water transmitting and storage properties of the aquifers and aquitards in the Talbert Gap on which to base model inputs. Groundwater flow paths suggest that model results may be affected by the lateral boundaries of the model domain. The constant water levels specified for the seawater intrusion barrier assumes that the quantity of injection water will be available to maintain the water levels at the barrier regardless of the impact of the slant well pumping. Variable head cells representing parts of the ocean may result in an inaccurate estimation of the contribution of the ocean to the slant wells.

Several additional steps can be taken to improve the model and increase confidence in evaluating impacts of the project. We recommend (1) aquifer tests to determine properties of the Talbert Aquifer, the overlying sediments, and the wetland sediments; (2) an assessment of the effects of the lateral model boundaries, (3) correction of inconsistencies in model construction, (4) calibration/verification using water level data, and (5) incorporate the MODFLOW Subsidence Package to preliminarily evaluate the subsidence potential due to slant well pumping. The improved model can then be used to more effectively simulate potential impacts and project feasibility.

Huntington Beach Seawater Desalination Facility Groundwater Model Evaluation

HydroFocus, Inc., Davis, CA
August 19, 2016

Contents

Introduction and Background

Geosyntec Consultants (Geosyntec) on behalf of Poseidon Resources (Poseidon) evaluated the feasibility of subsurface intake for the proposed Huntington Beach Seawater Desalination Facility (Desal Facility). Poseidon proposes to locate the Desal Facility site in a coastal lowland area known as the Talbert Gap.

Brief description of hydrogeology

The Talbert Gap is part of the Coastal Plain of Orange County Groundwater Basin identified by the California Department of Water Resources (CDWR).[1] The Talbert Gap is an erosional channel filled with permeable alluvium between Huntington Beach mesa to the northwest and the Newport mesa to the southeast. The primary water-bearing zone in the Talbert Gap is the Talbert Aquifer. The Talbert Aquifer extends offshore and, therefore, allows exchange of groundwater with the ocean. The Talbert Aquifer is overlain by fine-grained sediments and underlain by a zone of fine-grained sediments and deeper aquifers.

The connection of the Talbert Aquifer with the ocean has allowed seawater to intrude into the aquifer as a result of inland pumping. The Orange County Water District operates the Talbert Seawater Intrusion Barrier at the northern edge of the Talbert Gap.[2] The barrier is comprised of 36 wells that inject water into the aquifers to control seawater intrusion and replenish the basin.

A series of coastal marsh and wetland areas exist along the coast in the study area. These wetland areas are hydraulically connected to the open ocean[3]. However, the hydraulic conductivity of the bed sediments in these wetland areas likely differ significantly from the hydraulic conductivity values in shallow sediments in the surrounding area[4].

Groundwater modeling

Geosyntec[5] developed a groundwater-flow model to simulate the effects of pumping groundwater from multiple slant wells along the coast. The model simulates a pumping rate of 127 million gallons per day (MGD) from 40 slant wells screened in the Talbert Aquifer. The model was designed to evaluate the effects on the Talbert Injection Barrier to the northeast and the effects on coastal marsh and wetlands adjacent to the coast.

[1] California Department of Water Resources, California's Groundwater, Bulletin 118 – Update 2003. www.water.ca.gov/groundwater/bulletin118/update_2003.cfm

[2] Orange County Water District Groundwater Management Plan, 2015 Update.

[3] Detwiler, Russel, 2015, Review of groundwater flow modeling developed by Geosyntec to simulate pumping from slant wells beneath the beach in Huntington Beach

[4] ibid

[5] Geosyntec Consultants, 2013, Feasibility Assessment of Shoreline Subsurface Collectors Huntington Beach Seawater Desalination Project Huntington Beach, California.
Thrup, Gordon, 2015, Revision and Sensitivity Analyses of Slant Well SSI Model, Geosyntec Consultants Technical Memorandum to Scott McCreary.

HydroFocus obtained the Geosyntec model versions 6, 7 and 8. The model was developed using the U.S. Geological Survey MODFLOW 2000 code[6]. Model version 6 incorporates several recommended changes from previous versions of the model. This version includes the addition of constant head cells[7] to represent a portion of coastal marsh and wetland areas, and the model grid was refined to provide a larger portion of the coast with finer grid spacing. Model version 6 was used to conduct several sensitivity runs to test the effects of varying aquifer properties and slant well pumping rates. Model versions 7 and 8 are similar to version 6 with the exception of the location of the slant wells. We also obtained the model files used for the sensitivity runs conducted by Geoscience Support Services, Inc. and conducted additional model runs with varying hydraulic conductivity values.

The model consists of 10 layers; Layer 1 represents the ocean only, Layers 2-4 represent fine-grained sediments[8] above the Talbert Aquifer, Layers 5-8 represent the Talbert Aquifer, Layer 9 represents the fine-grained sediments below the Talbert Aquifer, and Layer 10 represents the deep aquifers. The Talbert Aquifer is represented using four layers to allow the pumping wells to be simulated with a slanted configuration increasing in depth as the wells extend away from the coast toward the ocean. Pumping from the slant wells occurs in Layers 5-8.

HydroFocus critically reviewed the model used in the Well Investigation Team Report, performed model runs using varying model input values, assessed the sensitivity of model outputs to variations in model inputs. Our overall objectives were to:

1. Critically review the Geosyntec models;
2. Assess the sensitivity of the model outputs to varying values of model inputs;
3. Assess the effects of the proposed project;
4. Provide recommendations for further data collection, modeling, and assessment of project impacts.

Approach

We reviewed model structure and ran the model to verify output and assess groundwater flow patterns. Model runs with varying input parameters were analyzed to assess the sensitivity of model outputs and thus provide guidance for further data collection and input parameter assessment. The results of these runs, literature review, and the use of particle tracking were used to assess the possible effects of the project. Based on the results of our analyses, we have provided recommendations for data collection and additional modeling, and assessed potential project impacts.

[6] Harbaugh, Arlen W., et al., 2000, MODFLOW-2000, The U.S. Geological Survey Modular Ground-Water Model-Users Guide to Modularization Concepts and The Ground-Water Flow Process.

[7] In constant head model cells, the hydraulic head is specified in advance by the user and remains constant throughout all time steps of the simulation.

[8] Fine-grained sediments typically consist of clays and silts. Coarse-grained sediments typically consist of sands and gravels.

Methods

Model review

The Geosyntec models were provided in the format used by the Visual MODFLOW graphical user interface (GUI). These files included the native MODFLOW input and output files. We used the native MODFLOW input files to run the model to verify that the model produces the same results as those provided by Geosyntec. The Geosyntec models used a propriety solver that is part of the Visual MODFLOW GUI. We ran the model using the USGS MODFLOW 2000 code and the PCG solver. We also imported the model into the Groundwater Vistas GUI to facilitate running the model, visualizing the results, and extracting model output.

We imported model input values including the IBOUND values, layer elevations, and aquifer properties into Geographic Information System (GIS) layers to facilitate mapping and model verification. We evaluated the model geometry, aquifer properties, and stresses (recharge and pumpage) and compared the modeled values to the values reported by Geosyntec.

Sensitivity runs

We tabulated model--calculated groundwater flow to the slant wells from the inland barrier and from the wetlands as reported by Geosyntec and Geoscience for each of the sensitivity runs and for an additional HydroFocus model run. We made one additional model run using the base pumping rate and increasing the hydraulic and vertical hydraulic conductivity of the layers overlying the Talbert Aquifer. Increases to the hydraulic conductivity of these overlying layers had only been tested using lower pumping rates than the base model. We also extracted the water level declines simulated in the Talbert Aquifer (Layers 5-8) and calculated the maximum and mean decline in these layers. For most model runs, the largest water level decline occurred in Layer 8. Therefore, we used the average water level decline for Layer 8 for our analysis of the sensitivity runs. Model inputs and results for all runs are shown in Appendix A. We plotted the flow and water level decline values against the changes in model inputs to graphically display the results of the sensitivity runs.

Groundwater flow paths

We used particle tracking to determine the source of groundwater flowing to the slant wells and evaluate groundwater travel times for various scenarios. We placed eight particles in each cell having a slant well. We used backward particle tracking with a porosity[9] of 20% to generate the pathlines and calculate travel times.

[9] Porosity is the fraction of void space in a given volume of aquifer material.

Results

Model review

Geometry

Geosyntec reported that the model cell dimensions range from 60x60 to 500x500 ft. We found that the grid cell dimensions range from 52 to 869 ft. along the columns (X direction) and from 56 to 672 ft. along the columns (Y direction). It is unlikely that these inconsistencies significantly affect model results. Table 1 lists the minimum, maximum, and mean thickness for the active cells in each layer and the thickness values reported by Geosyntec.

Table 1: Model layer thickness.

Layer	Actual Layer Thickness (ft)			Reported Thickness (ft)	Represents
	Min	Max	Mean		
1	10	132	55	--	Ocean
2	18	58	33	--	Fine-grained Sediments
3	8	51	22	--	
4	3	21	9	--	
5	19	24	22	100	Talbert Aquifer
6	20	25	23		
7	20	25	23		
8	22	27	25		
9	11	49	21	15	Fine-grained Sediments
10	34	149	63	50	Deep Aquifers

Constant Head Cells

Geosyntec reported that a constant head of 0.57 ft. was specified for all cells in the offshore portion of Layer 1. We found two significant areas of Layer 1 offshore along the coast that are represented as variable head cells. In these areas of variable head cells, the simulated head may vary as a result of the slant well pumping, which is not an appropriate way to simulate the ocean.

The Talbert Injection Barrier is represented by constant head cells along the northeast boundary of the model. The head in these cells varies from about 6-10 ft. There is some inconsistency in the spatial distribution of constant head cells between layers, but it likely does not significantly affect model results.

Some of the marsh and wetland areas are represented by constant head cells with the head specified as 0.57 ft. The reasons for the specified distribution of these constant head cells are not reported by Geosyntec and are not clear to us.

Aquifer Properties

Table 2 shows the reported hydraulic conductivities[10] for each layer of the model. In all layers, the vertical hydraulic conductivity was reported to be 1/10th of the horizontal hydraulic conductivity. The horizontal hydraulic conductivity values specified in the model agreed with the reported values in both magnitude and spatial distribution. The vertical hydraulic conductivity was represented in the model by vertical conductance between layers. Vertical conductance is calculated using the vertical hydraulic conductivity and thickness of adjacent layers. We calculated the vertical hydraulic conductivity from the vertical conductance values specified in the model and the calculated vertical hydraulic conductivity values agreed with the reported values.

Table 2. Hydraulic Conductivity values specified in the model.

Layer	Horizontal Hydraulic Conductivity (ft/d)	Vertical Hydraulic Conductivity (ft/d)	Represents
1	1000	100	Ocean
2	1/10	0.1/1	Fine-grained Sediments
3	10	1	
4	10	1	
5	10/300/325	1/30/32.5	Talbert Aquifer
6	10/300/325	1/30/32.5	
7	10/300/325	1/30/32.5	
8	10/300/325	1/30/32.5	
9	10	1	Fine-grained Sediments
10	300	30	Deep Aquifers

Pumping and Recharge

The MODFLOW well file was checked and verified to simulate a pumpage rate of 127 MGD (2,200 gallons per minute, GPM, per well) from the layers representing the Talbert Aquifer (Layers 5-8). Recharge[11] was verified to be 1 inch per year as reported by Geosyntec.

[10] Hydraulic conductivity is a measure of the ability of the aquifer material to transmit water and depends on the size and arrangement of the pores and fractures in the aquifer material. Horizontal hydraulic conductivity represents the transmission of water in the horizontal direction and vertical hydraulic conductivity represents transmission in the vertical direction. Vertical hydraulic conductivity is often less then horizontal hydraulic conductivity due to the nature in which aquifer materials are typically deposited in layers. Heath, Ralph C., 1983, Basic Ground-Water Hydrology, U.S. Geological Survey Water-Supply Paper 2220, 86 pp.

[11] Recharge is the percolation of water through the soil to the water table.

Sensitivity of Model Outputs to Model Inputs

In the following sections, we report the assessed effects on model outputs of varying modeling inputs for hydraulic conductivity, well screen length, pumping rate, barrier water level and slant well location.

Effects of Varying Model Hydraulic Conductivity Values

Figures 1 through 3 illustrate the relative effects of changes in model hydraulic conductivity on model outputs for flow to the slant wells from inland and the wetlands and average water-level decline in Layer 8. The red point on the graphs represents model version 6 and the blue points represent sensitivity model runs in which hydraulic conductivity for different layers were varied. Horizontal and vertical hydraulic conductivity were varied by the same proportion for each run.

Hydraulic Conductivity – Talbert Aquifer

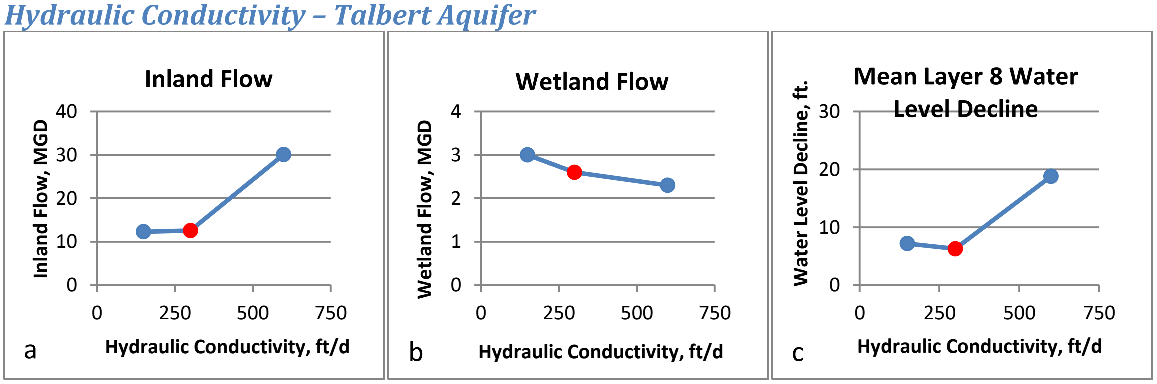

Figure 1. Effects of changes to the Talbert Aquifer hydraulic conductivity on inland flow (a), wetland flow (b), and mean Layer 8 water level decline (c).

Model results are more sensitive to increases in the hydraulic conductivity of the Talbert Aquifer than to decreases. Specifically, a 100% increase in the horizontal and vertical hydraulic conductivity (these parameters were varied together) of the Talbert Aquifer resulted in significant increases in flow from the inland boundary (140%) (Figure 1a) and Layer 8 water level decline (200%)(Figure 1c). Decreasing the horizontal and vertical hydraulic conductivity by 50% had a minimal effect on inland flow and water level decline (-2% and 14%, respectively)(Figures 1a and 1c). Increasing and decreasing the hydraulic conductivity of the Talbert aquifer resulted in minimal changes to the wetland flow (-12 to 15%) (Figure 1b).

Hydraulic Conductivity – Overlying Layers

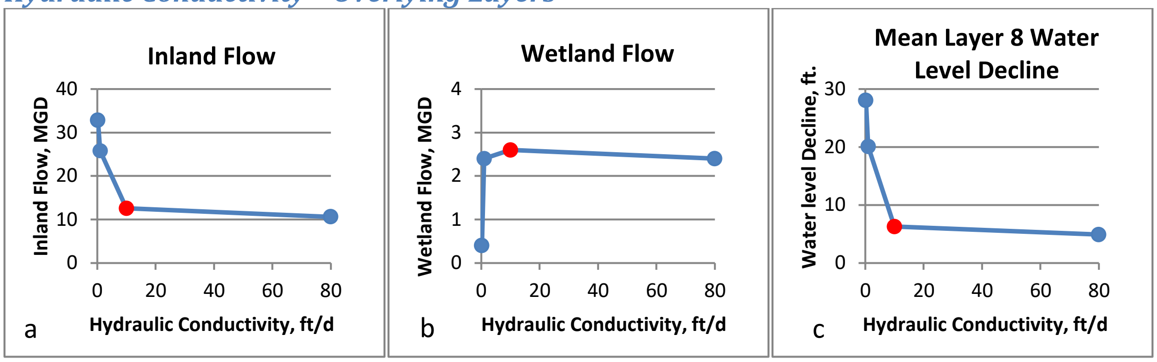

Figure 2. Effects of changes to the hydraulic conductivity in the layers overlying the Talbert Aquifer on inland flow (a), wetland flow (b), and mean Layer 8 water level decline (c).

The horizontal and vertical hydraulic conductivity in the model layers overlying the Talbert Aquifer was decreased (Layer 2-4) and increased (Layers 3-4). Layer 8 water level decline was most sensitive to decreasing the hydraulic conductivity of the overlying layers (220% to 340% change in water level decline) (Figure 2c). Inland flow was also most sensitive to decreasing the hydraulic conductivity. Inland flow changed as much as 160% (Figure 2a) and wetland flow changed as much as -85% (Figure 2b) due to decreasing the hydraulic conductivity from 10 ft/d to 0.2 ft/d. Changes to inland and wetland flow and Layer 8 water level decline were relatively insensitive to increasing hydraulic conductivity.

The results shown in Figures 3 through 6 were for model runs in which the specified pumping rate of was 100 MGD. The horizontal and vertical hydraulic conductivity in the underlying layers (Layers 9-10) was decreased 50%. A 50% decrease in the hydraulic conductivity of the underlying layers resulted in relatively small changes of -24%, 14%, and 20% change in inland flow, wetland flow, and Layer 8 water level decline, respectively (Figures 3a, 3b, and 3c).

Hydraulic Conductivity – Underlying Layers

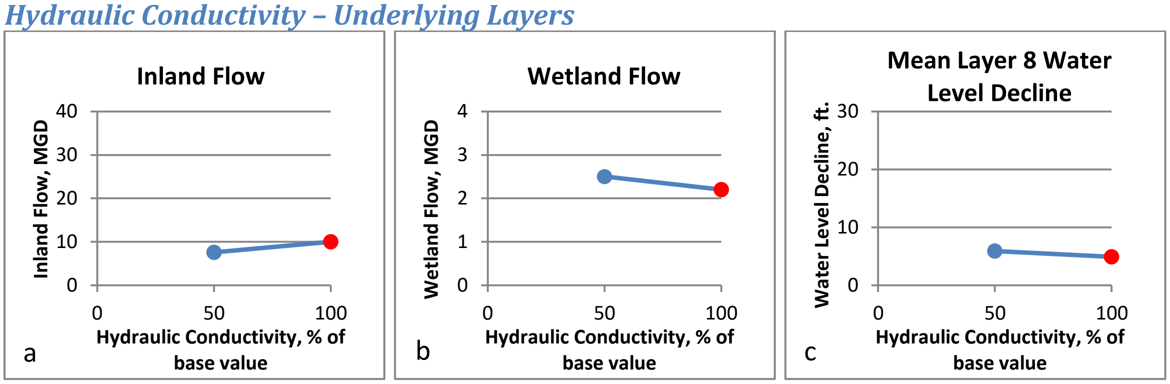

Figure 3. Effects of changes to the hydraulic conductivity in the layers underlying the Talbert Aquifer on inland flow (a), wetland flow (b), and mean Layer 8 water level decline (c).

Effects of Varying Model Slant Well Pumping Rate

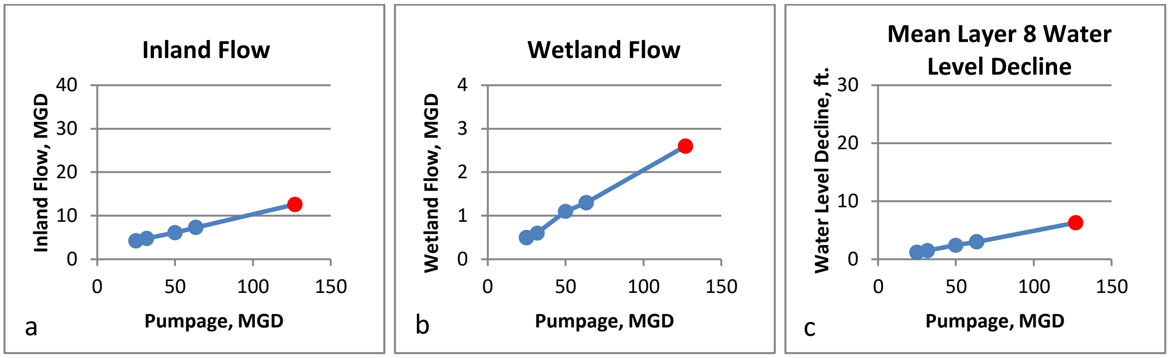

Figure 4. Effects of changes to the slant well pumping rates on inland flow (a), wetland flow (b), and mean Layer 8 water level decline (c).

Inland and wetland flow and Layer 8 water level decline are linearly related to the slant well pumping rate. Decreases in the slant well pumping rate result in corresponding decreases in inland and wetland flow and water level decline. The relative impact of reduced pumping is greater on the wetland flow (Figure 4b) and Layer 8 water level decline (Figure 4c) (up to -81% change) than on inland flow (Figure 4a) (up to -67% change).

Effects of Varying Model Screen Length

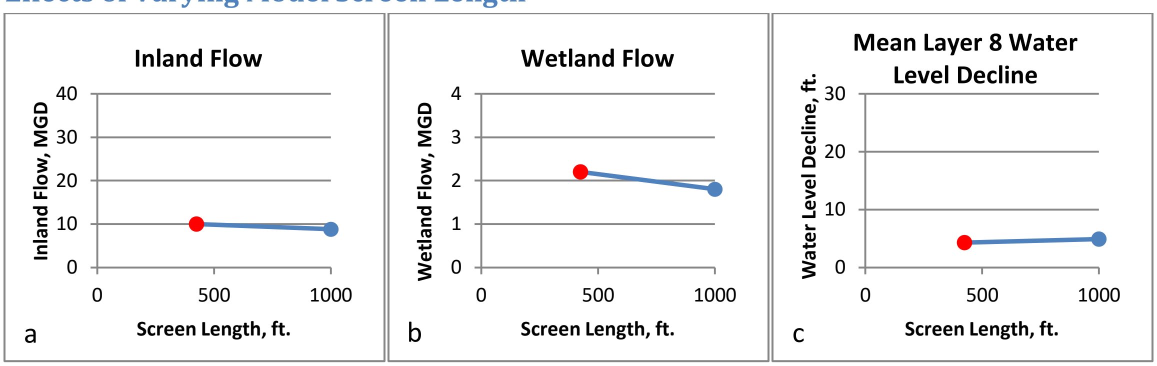

Figure 5. Effects of slant well screen length on inland flow (a), wetland flow (b), and mean Layer 8 water level decline (c).

The slant well screen was lengthened and extended farther offshore than the 425-ft well screens used in the base run. These runs were made using a pumping rate of 100 MGD. A 135% increase in the well screen length resulted in relatively small changes of -12%, -18%, and 14% change in inland flow, wetland flow, and Layer 8 water level decline, respectively (Figures 5a, 5b, and 5c).

Effects of Varying Model Barrier Head Elevation

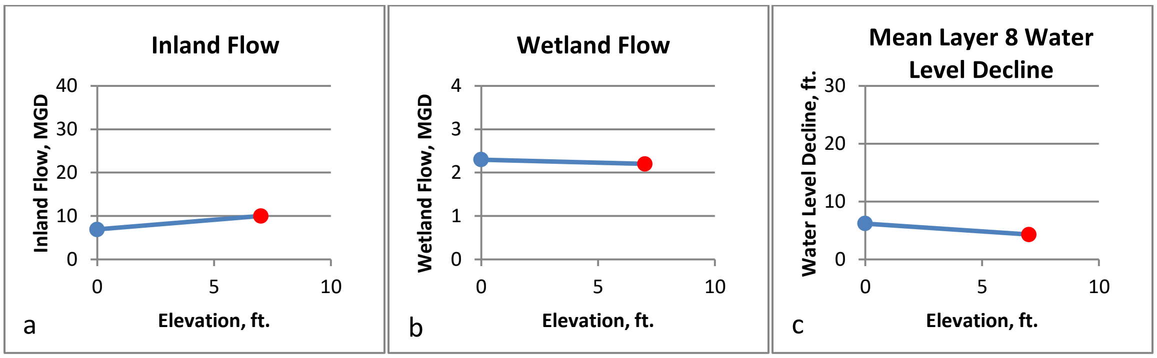

Figure 6. Effects of barrier head elevation on inland flow (a), wetland flow (b), and mean Layer 8 water level decline (c).

The water levels specified in the constant head cells representing the seawater intrusion barrier were reduced from the base value (about 7 ft. in Layers 2-8, 10 ft. in Layers 9-10) to 0 ft. in all layers. Because slant well pumping would create a sea water intrusion barrier, lower water levels at the Talbert Gap seawater intrusion barrier will likely result in an effective barrier[12]. These runs were made using a pumping rate of 100 MGD. The change in the barrier water level resulted in a -31%, -5%, and 44% change in inland flow, wetland flow, and Layer 8 water level decline, respectively (Figures 6a, 6b, and 6c).

Effects of Varying Model Slant Well Location

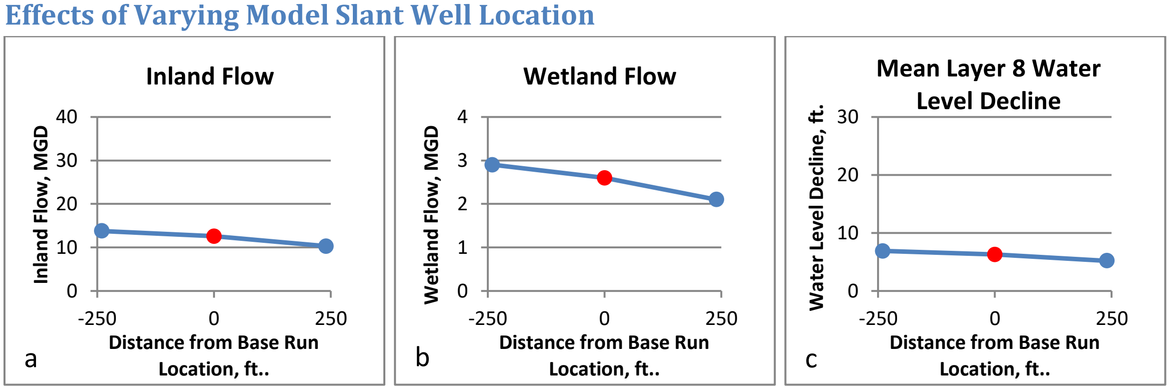

Figure 7. Effects of slant well location on inland flow (a), wetland flow (b), and mean Layer 8 water level decline (c).

The location of the slant wells were moved both farther inland and farther seaward relative to the location used in the base run. The run with the well location farther inland is shown as a negative

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[12] Johnson Yeh, Personal Communication, August 2016, "Based on modeling test runs, the slant well pumping would create an effective barrier if water level at the Talbert Barrier is maintained at zero ft amsl".

distance and the run with the well location farther seaward is shown as a positive distance from the base run location, respectively (Figures 7a, 7b, and 7c). Moving the wells farther inland resulted in relatively small changes of 10%, 12%, and 10% change in inland flow, wetland flow, and Layer 8 water level decline, respectively. Moving the wells farther seaward resulted in relatively small changes of -18%, -19%, and -17% change in inland flow, wetland flow, and Layer 8 water level decline, respectively.

Groundwater flow path analysis

Figure 8 shows the groundwater flow paths to the slant wells (Geosyntec model 6, 127 MGD pumpage rate). Eighty-seven percent of the pathlines originate in the ocean and 13 percent originate inland. This is similar to the percentage of flow to the slant wells from the ocean and from inland (wetlands and intrusion barrier). Average travel time for the pathlines that originate near the intrusion barrier is about 20 years. Using a pumping rate of 63.5 MGD (one-half the base rate) increased the Talbert Aquifer travel time from the barrier to the slant wells to about 37 years. Using the base pumping rate of 127 MGD and setting the barrier constant heads to 0.0 ft. results in an average travel time in the Talbert Aquifer of 24 years.

Many of the pathlines in Figure 8 extend from the slant wells to the northwest and southeast toward the lateral boundaries of the model and turn sharply toward the ocean or the constant head cells representing the barrier. This sharp turn in some pathlines suggest that the simulated groundwater flow paths are being affected by the lateral extent of the model, primarily in Layers 9 and 10.

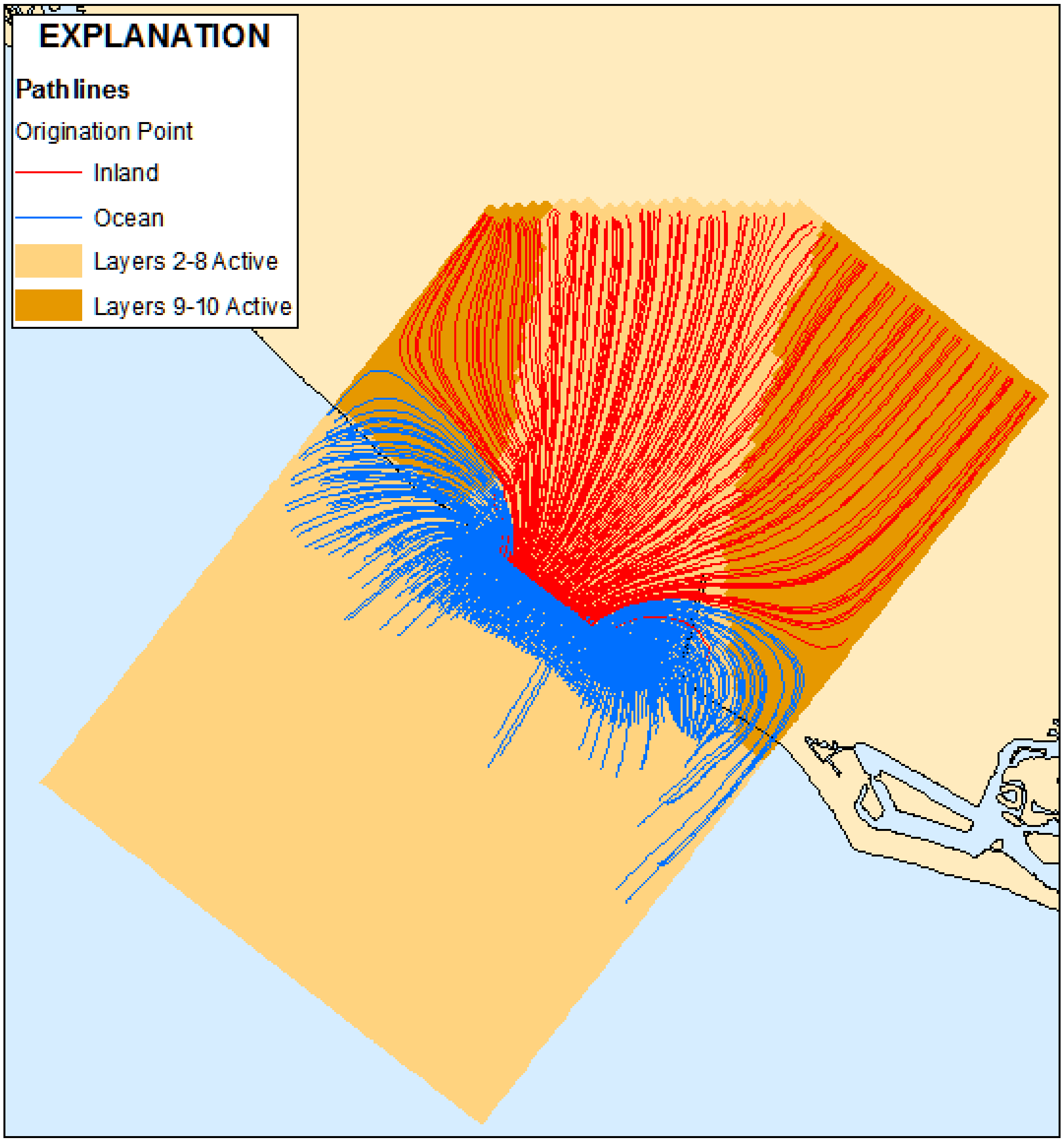

Figure 8. Groundwater flow paths to the slant wells.

Discussion

Model Limitations and Uncertainty

A groundwater-flow model is an approximation of the actual aquifer system. The model relies on estimates of aquifer properties and stress, which have some degree of uncertainty. Our evaluation has identified several limitations and uncertainty in the model.

- The simulated water levels were not compared to observed water level data to evaluate the effectiveness of the model in representing the groundwater-flow system. The Orange County Water District (OCWD) uses a network of observation wells to monitor groundwater levels and water quality in the Talbert Gap. If data from these wells are available, these data should be used to assess the effectiveness of the model and reduce uncertainty in how well the model represents the aquifer system.

- There is limited information on the aquifer properties in the model area. Geosyntec summarized results of previous investigations near the project location.[13] These investigations include limited aquifer tests that provide information on aquifer properties. The aquifer properties used in the model were taken from a regional model and no calibration of the local-scale model was performed. Sensitivity analysis shows that the model is most sensitive to the aquifer properties in the Talbert Aquifer and the overlying aquitard. Additional aquifer tests in the Talbert Gap area will also provide better estimates of aquifer properties.
- Representing the seawater intrusion barrier using constant head cells assumes that the quantity of injection water will be available to maintain the water levels at the barrier regardless of the impact of the slant well pumping. Representing the barrier using injection wells and average injection rates may better represent the effects of slant well pumpage on groundwater flow in the Talbert Aquifer.
- Parts of the ocean represented by Layer 1 are not designated as constant head cells as reported but are designated as variable-head cells. Some of these variable-head cells become dry in the simulation. These dry cells cannot provide water to the slant wells and, therefore, may result in an inaccurate estimation of the contribution of the ocean to the slant wells.
- Groundwater flow paths suggest that the model results may be affected by the lateral extent of the model domain.

Addressing these issues will reduce uncertainty and improve the effectiveness of the model in representing the aquifer system and simulating the impacts of the project. This will increase confidence that the model can be used to effectively evaluate project impacts.

Sensitivity of Model Outputs to Model Inputs and Implications for Project Impacts

Model results are most sensitive to variations in model hydraulic conductivity values for the Talbert Aquifer and the overlying aquitard. Specifically, the magnitude of groundwater level declines can be substantially affected by relatively small changes in hydraulic conductivity. An issue of concern is the potential for groundwater level decline from the slant well pumping to cause subsidence along the coast. Subsidence could impact the Pacific Coast Highway, the project facilities, or other structures in the area. The Talbert Aquifer is overlain by relatively fine-grained sediments both offshore and onshore near the coast.[14] Compaction of fine-grained sediments such as silts and clays due to groundwater withdrawals is a primary cause of subsidence. The CDWR identifies the Coastal Plain of Orange County groundwater basin, including the project area, as having a high estimated potential for future land subsidence[15]. The OCWD reported that historical subsidence has occurred in coastal locations due to land management practices and oil extraction.[16] However, permanent subsidence due to groundwater withdrawals has not been documented since the District began recharge operations in the basin in the

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[13] Geosyntec Consultants, 2013, Feasibility Assessment of Shoreline Subsurface Collectors, Huntington Beach Seawater Desalination Project, Huntington Beach, California, September 2013.

[14] Geosyntec Consultants, 2013, Feasibility Assessment of Shoreline Subsurface Collectors, Huntington Beach Seawater Desalination Project, Huntington Beach, California, September 2013.

[15] CDWR, 2014, Summary of Recent, Historical, and Estimated Potential for Future Land Subsidence in California.

[16] Orange County Water District, 2015, Orange County Water District, Groundwater Management Plan, 2015 Update, June 17, 2015.

late 1950s. The District reports that seasonal temporary fluctuations in land surface are observed that are correlated with groundwater level changes.

Pumping Rate Effects on Barrier Flow to the Slant Wells

The model runs using varying pumping rates may potentially be used to select the optimum pumpage rate to minimize the proportion of pumpage originating as flow from the inland seawater intrusion barrier. The volume of water originating as flow from the inland barrier is directly proportional to the pumping rate (Figure 9a). However, the percent of the pumpage volume that originates as flow from the inland barrier is not directly proportional (Figure 9b). As the pumpage increases, the percentage of the pumpage that originates as inland flow from the barrier decreases. At pumping rates of 63.5 MGD and above, the percentage of pumpage that originates as inland flow does not change significantly.

The sensitivity results show that the specified aquifer properties and other model inputs affect the calculated percent of pumpage that originates as inland flow from the barrier. For example, using a pumping rate of 127 MGD, doubling the hydraulic conductivity of the Talbert Aquifer increased the percent of pumpage that originates as inland flow from 10% to 24%. Likewise, decreasing the hydraulic conductivity of the material overlying the Talbert aquifer up to 98% increased the percent of pumpage that originates as inland flow from 10% to 26%. Using a pumping rate of 100 MGD, increasing the hydraulic conductivity of the material overlying the Talbert Aquifer or decreasing the hydraulic conductivity of the material underlying the Talbert Aquifer decreased the percent of pumpage that originates as inland flow from 10% to 9% and 8%, respectively. Combing several changes to model input (increasing slant well length, increasing the hydraulic conductivity of the overlying material, decreasing the hydraulic conductivity of the underlying material, and lowering the water level maintained at the barrier) decreased the percent of pumpage that originates as inland flow from 10% to 4%.

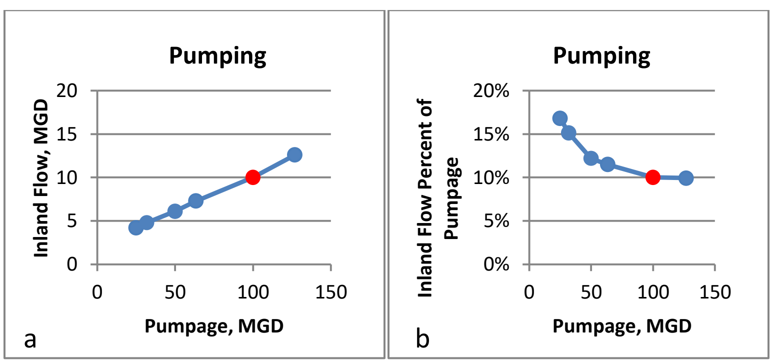

Figure 9. Relation of pumpage rate and inland flow.

Particle Tracking and Groundwater Travel Times

Seawater/Freshwater Interface

Our analysis indicates that the large majority of the water flowing to the slant wells will come from the ocean. Figure 8 indicates that operation of the slant wells will affect the extent of seawater intrusion in the Talbert Aquifer. The OCWD monitors groundwater levels and quality in the Talbert Gap to assess the effectiveness of the seawater intrusion barrier.[17] The OCWD monitoring well OCWD-M26 is

[17] Ibid.

strategically located and screened in the Talbert Aquifer and deeper aquifers for evaluating barrier injection requirements versus seawater intrusion potential. The OCWD has a goal of maintaining the water level in the vicinity of this well at 3 feet above mean sea level to keep brackish water from moving inland in the Talbert Aquifer and migrating downward to deeper aquifers tapped by inland production wells.

Water level declines induced by the slant well pumping may extend inland to the location of this well and, therefore, affect the ability of the OCWD to maintain the desired water levels at this well. Conversely, project pumpage from the slant wells will likely increase the gradient from inland areas toward the project wells. This increase in seaward gradient will enhance the movement of inland freshwater toward the coast and will likely move the seawater/freshwater interface to the west closer to the coastline. This increase in seaward gradient along with capture of seawater by the slant wells will have the effect of reducing the inland migration of seawater and may allow the OCWD to maintain a lower water level in the well while still obtaining the objective of reducing seawater intrusion. Lowering of the head in the barrier wells will likely also result in decreased inland flow to the slant wells (Figure 7).

Summary and Recommendations

Our model review indicates that minor modifications will improve model functioning. Specifically, model calibration and validation using local groundwater and aquifer test data will likely provide insight about project performance and effects. Model boundary conditions and inconsistencies may affect model performance and merit re-examination and evaluation.

Model results indicate that the project will affect ground water levels and gradients in the Talbert Gap. Water level declines will be greatest in the vicinity of the project wells. Most of the water extracted from the project wells comes from the ocean, but some originates at the inland seawater intrusion barrier (about 10%) and some originates in the coastal wetlands (about 2%). Project pumpage will likely impact the operation of the seawater intrusion barrier by increasing hydraulic gradients towards the ocean and reducing the impact of seawater intrusion into the inland portion of the Talbert Aquifer.

The model is most sensitive to the aquifer properties in the Talbert Aquifer and in the overlying aquitard. Sensitivity test show that changes in these aquifer properties result in significant changes to the estimated flow from the inland barrier and the coastal wetlands. Therefore additional data collection and aquifer tests will improve the estimates and uncertainty in the aquifer properties and improve the confidence in the model results. Calibration of the model using water level data would also improve the effectiveness of the model.

Specific recommendations follow.

- Conduct aquifer tests or pilot well pumping to determine hydraulic conductivity values in the Talbert Aquifer and overlying sediments.
- Hydraulic conductivity values of wetland sediments should also be determined.
- Assess effects of lateral model boundary conditions on model results and modify as needed.
- Inconsistencies in model construction (cell size, variable head cells in the ocean, etc.) should be resolved to eliminate any concern that these issues may affect model results.
- Incorporate MODFLOW Subsidence Package to preliminarily evaluate the subsidence potential due to slant well pumping.

- Use revised model to more effectively simulate potential impacts and project feasibility.
- Additional questions that could be answered with an improved model include the following.
    - How will long term pumping likely affect land-surface elevations?
    - How will the project likely affect the presence of intruded seawater and the functioning of the barrier injection wells?
    - What will be the likely withdrawal of inland water by pumping wells? How will this change over time?

Appendix A - Summary of Model Inputs and Model Results for Model Scenarios

Consultant	Model Run	Model Inputs: Project Pumping with Slant Wells, MGD	Length of Slant Well, ft	Relative Location of Slant Wells	Strata Above Talbert Aquifer: Layer 2 Kh/Kv, ft/d	Strata Above Talbert Aquifer: Layer 3 Kh/Kv, ft/d	Strata Above Talbert Aquifer: Layer 4 Kh/Kv, ft/d	Talbert Aquifer: Layers 5-8 Kh/Kv, ft/d	Strata Below Talbert Aquifer: Layer 9 Kh/Kv, ft/d	Strata Below Talbert Aquifer: Layer 10 Kh/Kv, ft/d	Seawater Intrusion Barrier Water Level Elevation at the Talbert Gap, ft amsl	Model Results: Flow Contributed to Slant Well, MGD: Ocean	Wetlands	Areal Recharge	Inland	Flow Contributed to Slant Well, %: Ocean	Wetlands	Areal Recharge	Inland	Average Layer 8 Water Level Decline, feet
Geosyntec	V6	126.7	425	Base	10/1	10/1	10/1	300/30	10/1	300/30	Approximately 7	110.5	2.6	1.0	12.6	87%	2%	1%	10%	6.3
	V6A	126.7	425	Base	**1/0.1**	**1/0.1**	**1/0.1**	300/30	10/1	300/30	Approximately 7	85.6	2.4	1.0	25.8	68%	2%	1%	20%	19.8
	V6B	126.7	425	Base	**0.2/0.02**	**0.2/0.02**	**0.2/0.02**	300/30	10/1	300/30	Approximately 7	56.9	0.4	1.0	32.8	45%	0%	1%	26%	26.1
	V6C	126.7	425	Base	10/1	10/1	10/1	**150/15**	10/1	300/30	Approximately 7	110.5	3.0	1.0	12.3	87%	2%	1%	10%	7.2
	V6D	126.7	425	Base	10/1	10/1	10/1	**600/60**	10/1	300/30	Approximately 7	93.3	2.3	1.0	30.1	74%	2%	1%	24%	18.8
	V6Half	**63.5**	425	Base	10/1	10/1	10/1	300/30	10/1	300/30	Approximately 7	53.7	1.3	1.0	7.3	85%	2%	2%	11%	3.0
	V6Qtr	**31.8**	425	Base	10/1	10/1	10/1	300/30	10/1	300/30	Approximately 7	25.2	0.6	1.0	4.8	79%	2%	3%	15%	1.5
	V7	126.7	425	**240 ft. landward**	10/1	10/1	10/1	300/30	10/1	300/30	Approximately 7	109.0	2.9	1.0	13.8	86%	2%	1%	11%	6.9
	V8	126.7	425	**240 ft. seaward**	10/1	10/1	10/1	300/30	10/1	300/30	Approximately 7	133.3	2.1	1.0	10.3	105%	2%	1%	8%	5.2
Geoscience	Run 100_Ori	**100.0**	425	Base	10/1	10/1	10/1	300/30	10/1	300/30	Approximately 7	86.7	2.2	1.0	10.0	87%	2%	1%	10%	4.9
	Run 100_A	**100.0**	**1,000**	Base	10/1	10/1	10/1	300/30	10/1	300/30	Approximately 7	88.3	1.8	1.0	8.8	88%	2%	1%	9%	4.3
	Run 100_B	**100.0**	425	Base	10/1	**80/8**	**80/8**	300/30	10/1	300/30	Approximately 7	88.3	1.9	1.0	8.8	88%	2%	1%	9%	3.8
	Run 100_C	**100.0**	425	Base	10/1	10/1	10/1	300/30	**5/0.5**	**150/15**	Approximately 7	88.9	2.5	1.0	7.6	89%	3%	1%	8%	5.9
	Run 100_D	**100.0**	425	Base	10/1	10/1	10/1	300/30	10/1	300/30	**0**	89.8	2.3	1.0	6.9	90%	2%	1%	7%	6.2
	Run 100_E	**100.0**	**1,000**	Base	10/1	**80/8**	**80/8**	300/30	**5/0.5**	**150/15**	**0**	93.6	1.9	1.0	3.5	94%	2%	1%	4%	4.2
	Run 50_Ori	**50.0**	425	Base	10/1	10/1	10/1	300/30	10/1	300/30	Approximately 7	41.8	1.1	1.0	6.1	84%	2%	2%	12%	2.4
	Run 50_A	**50.0**	**1,000**	Base	10/1	10/1	10/1	300/30	10/1	300/30	Approximately 7	42.6	0.9	1.0	5.5	85%	2%	2%	11%	2.1
	Run 50_B	**50.0**	425	Base	10/1	**80/8**	**80/8**	300/30	10/1	300/30	Approximately 7	42.5	1.0	1.0	5.5	85%	2%	2%	11%	1.8
	Run 50_C	**50.0**	425	Base	10/1	10/1	10/1	300/30	**5/0.5**	**150/15**	Approximately 7	43.3	1.3	1.0	4.3	87%	3%	2%	9%	2.9
	Run 50_D	**50.0**	425	Base	10/1	10/1	10/1	300/30	10/1	300/30	**0**	44.8	1.2	1.0	2.9	90%	2%	2%	6%	3.7
	Run 50_E	**50.0**	**1,000**	Base	10/1	**80/8**	**80/8**	300/30	**5/0.5**	**150/15**	**0**	46.7	0.9	1.0	1.3	94%	2%	2%	3%	30.0
	Run 25_Ori	**25.0**	425	Base	10/1	10/1	10/1	300/30	10/1	300/30	Approximately 7	19.2	0.5	1.0	4.2	77%	2%	4%	17%	1.2
	Run 25_A	**25.0**	**1,000**	Base	10/1	10/1	10/1	300/30	10/1	300/30	Approximately 7	19.6	0.4	1.0	3.9	79%	2%	4%	16%	1.0
	Run 25_B	**25.0**	425	Base	10/1	**80/8**	**80/8**	300/30	10/1	300/30	Approximately 7	19.5	0.4	1.0	4.0	78%	2%	4%	16%	0.9
	Run 25_C	**25.0**	425	Base	10/1	10/1	10/1	300/30	**5/0.5**	**150/15**	Approximately 7	20.6	0.6	1.0	2.8	82%	2%	4%	11%	1.5
	Run 25_D	**25.0**	425	Base	10/1	10/1	10/1	300/30	10/1	300/30	**0**	22.3	0.6	1.0	1.1	89%	2%	4%	4%	2.5
	Run 25_E	**25.0**	**1,000**	Base	10/1	**80/8**	**80/8**	300/30	**5/0.5**	**150/15**	**0**	23.2	0.5	1.0	0.3	93%	2%	4%	1%	2.1
HydroFocus	HF R1	126.7	425	Base	10/1	**80/8**	**80/8**	300/30	10/1	300/30	Approximately 7	111.8	2.4	1.0	10.6	89%	2%	1%	8%	4.9

Bold indicates model input that was changed from inputs specified in the base run (V6)

Kh = Horizontal Hydraulic Conductivity

Kv = Vertical Hydraulic Conductivity

MGD = Million Gallons per Day

Geosyntec - Geosyntec Technical Memorandum, November 9, 2015.

Geoscience - Sensitivity runs conducted by Geoscience Support Services, Inc., received from Joe Geever, Residents for Responsible Desalination, June 2016.

Average layer 8 water level decline calculated by Hydrofocus using model results.

HYDROFOCUS INC.
Solutions for Land and Water Resources

March 10, 2020

Mr. Ray Heimstra
Orange County Coastkeeper
Costa Mesa, CA

Mr. Joe Geever
Residents for Responsible Desalination
Long Beach, CA

Subject: Huntington Beach Seawater Desalination Facility - Assessment of Effects of Varying Water-Level Elevations in the Seawater Intrusion Barrier Wells on Sources of Groundwater to Slant Wells

Dear Mr. Heimstra and Mr. Geever,

Please find enclosed the subject report prepared by HydroFocus. We used the groundwater-flow model developed by Geosyntec Consultants to assess the effects of varying groundwater elevations in the seawater intrusion barrier wells. Results from the simulations with the Geosyntec model with varying inputs for slant-well pumping rates and groundwater-level elevations in the seawater intrusion barrier wells indicated that for all pumping rates, the simulated percentage of ocean water increased with lower water-level elevations in the seawater intrusion barrier wells.

Moreover, the particle tracking results indicate that a greater percentage of ocean water flows to the slant wells for lower water-level elevations in the seawater intrusion barrier wells. The simulated ocean-water percentage approaches or equals 90% for all slant-well pumping rates when the water-level elevations in the seawater intrusion barrier wells are close to sea level.

The model simulations demonstrate that slant well pumping will result in inland groundwater to flow towards the slant wells and the groundwater-level elevation in the seawater intrusion barrier wells influences groundwater flow towards the slant wells such that the greater the elevation in the barrier wells, the greater the percentage of inland groundwater that is captured by slant wells. Because the slant wells would lower the groundwater elevation near the ocean and cause inland groundwater flow towards the ocean, the model results point to a lessened need for maintenance of elevated groundwater levels in the seawater intrusion barrier wells with the implementation of slant-well pumping.

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www.hydrofocus.com

As noted in our previous report, however, the model should be calibrated with groundwater data and a test slant well, similar to what was done for the proposed seawater slant-well desalination facility in Monterey.

Thank you for the opportunity to work on this project and be of service. Please contact us if you have any further questions.

Sincerely,

Steven Deverel, Ph.D., P.G., C.HG.
Principal Hydrologist

PROFESSIONAL GEOLOGIST
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Assessment of Effects of Varying Water-Level Elevations in the Seawater Intrusion Barrier Wells on Sources of Groundwater to Slant Wells

HydroFocus, Inc., Davis, CA
March 10, 2020

Contents

Introduction and Background

Geosyntec Consultants (Geosyntec) on behalf of Poseidon Resources (Poseidon) evaluated the feasibility of subsurface intake for the proposed Huntington Beach Seawater Desalination Facility (Desal Facility). Poseidon proposes to locate the Desal Facility site in a coastal lowland area known as the Talbert Gap. HydroFocus previously evaluated the model and performed an analysis of the factors influencing the simulated percentage of ocean water captured by the slant wells. Herein, we present the results of additional work to assess the effect of varying water levels in the Talbert Seawater Intrusion Barrier at the northern edge of the Talbert Gap operated by Orange County Water District.

Brief description of hydrogeology

The Talbert Gap is part of the Coastal Plain of Orange County Groundwater Basin identified by the California Department of Water Resources (CDWR).[1] The Talbert Gap is an erosional channel filled with permeable alluvium between Huntington Beach mesa to the northwest and the Newport mesa to the southeast. The primary water-bearing zone in the Talbert Gap is the Talbert Aquifer. The Talbert Aquifer extends offshore and, therefore, allows exchange of groundwater with the ocean. The Talbert Aquifer is overlain by fine-grained sediments and underlain by a zone of fine-grained sediments and deeper aquifers.

The connection of the Talbert Aquifer with the ocean has allowed seawater to intrude into the aquifer as a result of inland pumping. The Orange County Water District operates the Talbert Seawater Intrusion Barrier at the northern edge of the Talbert Gap.[2] The barrier is comprised of 36 wells that inject water into the aquifers to control seawater intrusion and replenish the basin.

Groundwater modeling

Geosyntec[3] developed a groundwater-flow model to simulate the effects of pumping groundwater from multiple slant wells along the coast. The model simulated a pumping rate of 127 million gallons per day (MGD) from 40 slant wells screened in the Talbert Aquifer. The model was designed to evaluate the effects of pumping the proposed slant wells.

HydroFocus obtained Geosyntec model versions 6, 7 and 8 in July 2016. The model was developed using the U.S. Geological Survey MODFLOW 2000 code[4]. Model version 6 incorporates several recommended changes from previous versions of the model. This version includes the addition of constant head cells[5]

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[1] California Department of Water Resources, California's Groundwater, Bulletin 118 – Update 2003. www.water.ca.gov/groundwater/bulletin118/update_2003.cfm

[2] Orange County Water District Groundwater Management Plan, 2015 Update.

[3] Geosyntec Consultants, 2013, Feasibility Assessment of Shoreline Subsurface Collectors Huntington Beach Seawater Desalination Project Huntington Beach, California.
Thrup, Gordon, 2015, Revision and Sensitivity Analyses of Slant Well SSI Model, Geosyntec Consultants Technical Memorandum to Scott McCreary.

[4] Harbaugh, Arlen W., et al., 2000, MODFLOW-2000, The U.S. Geological Survey Modular Ground-Water Model-Users Guide to Modularization Concepts and The Ground-Water Flow Process.

[5] In constant head model cells, the hydraulic head is specified in advance by the user and remains constant throughout all time steps of the simulation.

to represent a portion of coastal marsh and wetland areas, and the model grid was refined to provide a larger portion of the coast with finer grid spacing. Model version 6 was used to conduct several sensitivity runs to test the effects of varying aquifer properties and slant well pumping rates. Model versions 7 and 8 are similar to version 6 with the exception of the location of the slant wells.

The model consists of 10 layers; Layer 1 represents the ocean only, Layers 2-4 represent fine-grained sediments[6] above the Talbert Aquifer, Layers 5-8 represent the Talbert Aquifer, Layer 9 represents the fine-grained sediments below the Talbert Aquifer, and Layer 10 represents the deep aquifers. The Talbert Aquifer is represented by four layers to allow the pumping wells to be simulated with a slanted configuration increasing in depth as the wells extend away from the coast toward the ocean. Pumping from the slant wells occurs in Layers 5-8.

Previous Evaluation of the Model

Previously, HydroFocus reviewed the model used in the Well Investigation Team Report, performed model runs using varying model input values, assessed the sensitivity of model outputs to variations in model inputs. Water level declines will be greatest in the vicinity of the slant wells. The model results indicate that the majority of the water extracted from the slant wells will come from the ocean, but some groundwater will originate inland and some will originate in the coastal wetlands. The HydroFocus report concluded that pumping of slant wells would likely have a positive impact on the operation of the seawater intrusion barrier by increasing hydraulic gradients towards the ocean and reducing the impact of seawater intrusion into the inland portion of the Talbert Aquifer. However, we found that the model should be calibrated with groundwater data, similar to what was done for the proposed slant-well seawater desalination facility in Monterey.

Further, in both the Geosyntec and our model runs, the water levels in the seawater intrusion barrier were simulated by specifying the water-level elevation at about 7 feet above mean sea level (MSL). Modifying this specified assumption is the focus of this study.

Objective

By conducting additional model runs, HydroFocus assessed the interaction of slant well pumping and water levels in the Orange County Water District Talbert Seawater Intrusion Barrier at the northern edge of the Talbert Gap.[7] Our objective was to determine the effects of varying pumping rates and groundwater elevations in the barrier wells on the simulated sources of groundwater to the slant wells.

Methods

HydroFocus used the Geosyntec model version 6 using MODFLOW-2005 to assess the effects of varying slant well pumping rates and groundwater levels in the Talbert Seawater Intrusion Barrier wells. The scenarios are summarized in Table 1. In the original model, the Talbert Seawater Intrusion Barrier is represented by a distribution of constant-head boundary cells with groundwater elevations ranging

[6] Fine-grained sediments typically consist of clays and silts. Coarse-grained sediments typically consist of sands and gravels.
[7] Orange County Water District Groundwater Management Plan, 2015 Update.

from 6 to 10 ft. For the HydroFocus model simulations, the specified heads in these cells were multiplied by a constant factor to result in lower values for groundwater elevations during the model simulations. Therefore, the values reported for water level in Table 1 correspond to the approximate new average of the groundwater level distribution for each scenario.

Table 1. Scenarios considered in sensitivity analysis with their respective slant wells pumping rates Talbert Barrier constant heads.

Model Run identification	Pumping rate in million gallons per day (MGD)	Specified water level in Talbert Seawater Intrusion Barrier wells (feet above MSL)
Run 25_D	25	0
Run 25_2ft	25	Approximately 2
Run 25_5ft	25	Approximately 5
Run 25_Ori	25	Approximately 7
Run 50_D	50	0
Run 50_2ft	50	Approximately 2
Run 50_5ft	50	Approximately 5
Run 50_Ori	50	Approximately 7
Run 100_D	100	0
Run 100_2ft	100	Approximately 2
Run 100_5ft	100	Approximately 5
Run 100_Ori	100	Approximately 7

To assess the sources of water to the simulated slant wells, the ZONEBUDGET post-processing[8] program was used by HydroFocus personnel to estimate the contributions (ocean, wetlands, surface recharge and inland) to the volume pumped by the slant wells.

HydroFocus personnel performed particle tracking using the program MODPATH 6[9] following the procedure described in the HydroFocus 2016 report. From these analyses, simulated path lines of water particles pumped by the slant wells were mapped. The path lines were classified into two categories, those which originated inland, and those which originated in the ocean. The same particle starting locations used in the HydroFocus 2016 report[10] were employed.

[8] Harbaugh, A.W., 1990, A computer program for calculating subregional water budgets using results from the U.S. Geological Survey modular three-dimensional ground-water flow model: U.S. Geological Survey Open-File Report 90-392, 46 p.
[9] Pollock, D.W., 2012, User Guide for MODPATH Version 6—A Particle-Tracking Model for MODFLOW: U.S. Geological Survey Techniques and Methods 6–A41, 58 p.
[10] *Ibid.* [3]

Results

Contributions to slant wells

Table 2 and Figure 1 illustrate how the different zones of the model contribute to the volume of water pumped by the slant wells for the different scenarios. These data provide insight on how the slant-well pumping rate and the groundwater level elevation at the seawater intrusion barrier would likely interact to influence the composition of the pumped groundwater. Table 2 and Figure 1 illustrate that for each pumping rate ranging from 25 to 100 MGD, the simulated volume of ocean water captured by the slant well increased with decreasing groundwater elevations in the seawater intrusion barrier wells. For all simulations using the Geosyntec model results, the ocean water percentage approaches or equals 90% when elevations in the seawater intrusion barrier wells are near sea level. The simulated groundwater flow paths show the simulated movement to the slant wells.

Table 2. Results of model simulations with varying pumping rates and seawater intrusion barrier elevations.

Model Run	Project Pumping with Slant Wells, MGD	Project Pumping with Slant Wells, AFY	Length of Slant Well, ft	Seawater Intrusion Protective Elevation at the Talbert Gap, ft msl	Flow Contributed to Slant Well, %			
					Ocean	Wetlands	Areal Recharge	Inland
Geosyntec Run V6*	126.7	141900	425	Approximately 7	87%	2%	1%	**10%**
Run 100_Ori	100.0	112000	425	Approximately 7	87%	2%	1%	**10%**
Run 100_5ft	100.0	112000	425	Approximately 5	87%	2%	1%	**10%**
Run 100_2ft	100.0	112000	425	Approximately 2	88%	2%	1%	**9%**
Run 100_D	100.0	112000	425	0	90%	2%	1%	**7%**
Run 50_Ori	50.0	56000	425	Approximately 7	84%	2%	2%	**12%**
Run 50_5ft	50.0	56000	425	Approximately 5	85%	2%	2%	**11%**
Run 50_2ft	50.0	56000	425	Approximately 2	87%	2%	2%	**9%**
Run 50_D	50.0	56000	425	0	90%	2%	2%	**6%**
Run 25_Ori	25.0	28000	425	Approximately 7	77%	2%	4%	**17%**
Run 25_5ft	25.0	28000	425	Approximately 5	80%	2%	4%	**14%**
Run 25_2ft	25.0	28000	425	Approximately 2	84%	2%	4%	**10%**
Run 25_D	25.0	28000	425	0	89%	2%	4%	**4%**

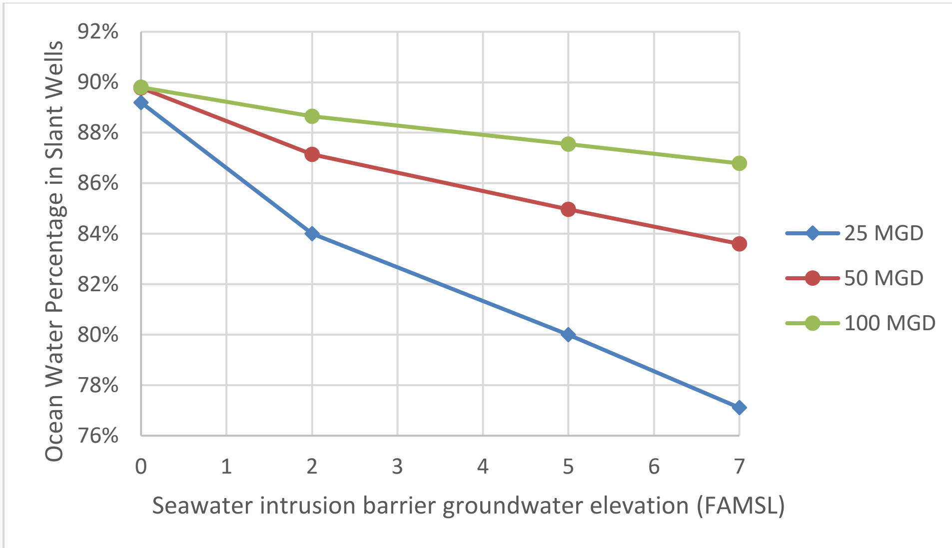

Figure 1. Inland and Ocean contributions to slant wells pumping for different values of seawater intrusion protection at the Talbert Gap.

Groundwater flow paths

Using the backward tracking feature in MODPATH, particle tracking results were calculated for the scenarios to visualize simulated groundwater flow paths. Path lines were classified according to their origin either inland or the ocean. Figure 2 displays example path lines for 25 MGD of slant well pumping. Maps for the rest of the scenarios are presented in Appendix B. Particle-tracking counts and percentual distributions of path lines according to the origin of the particles are summarized in Table 3. Similar to the water budget calculation described above, the simulated proportion of flow from inland areas decreased with decreased water-level elevations in the seawater intrusion barrier wells. Moreover, flow paths indicate inland groundwater flow towards the ocean for all scenarios.

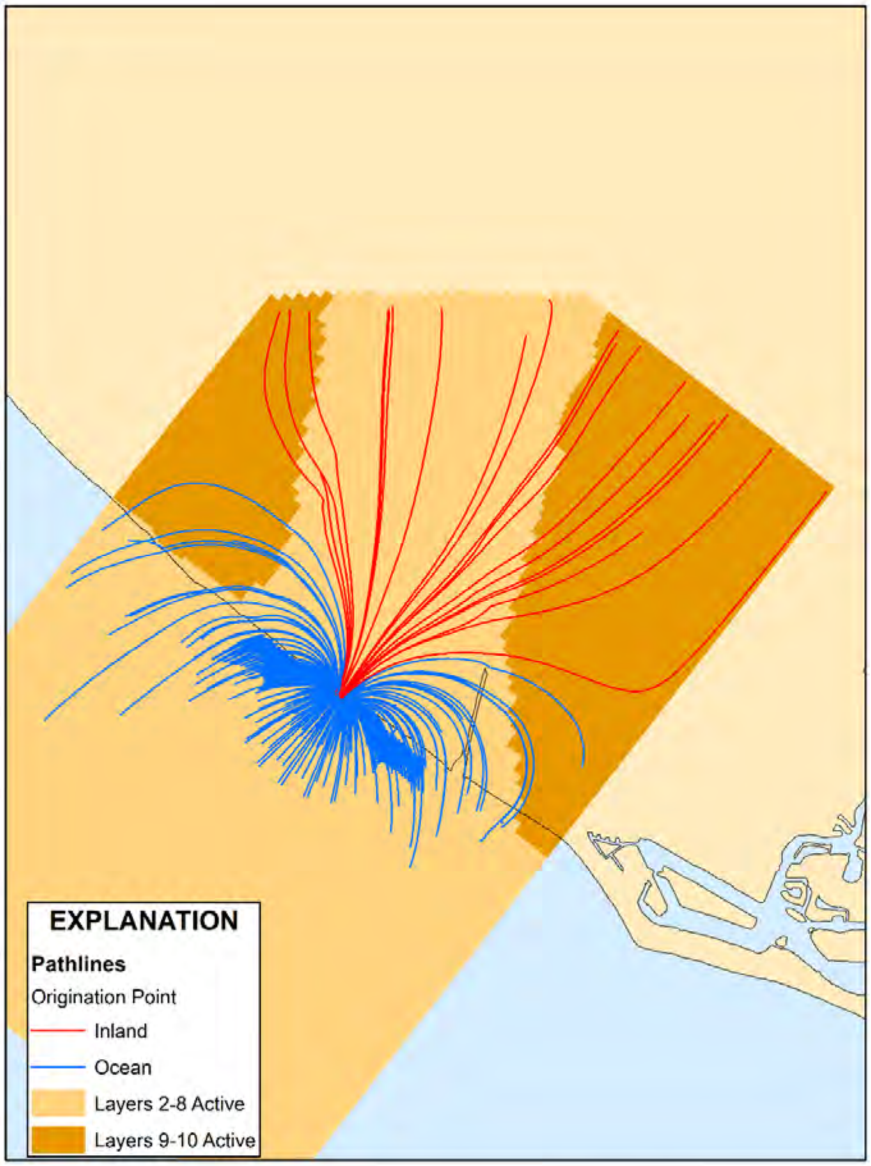

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Figure 2. Example backwards particle tracking analyses for scenario 25 MGD of pumping from slant wells and 0 ft of head at saline control barrier. Blue lines represent path lines for water parcels that originated in the ocean, while red lines represent path lines for water parcels originated inland.

Table 3. Classification of path lines according to their origin for modeled scenarios

Slant Wells Pumping (MGD)	Barrier Head (ft)	Path lines Originated in the Ocean Zone (count)	Path lines Originated Inland (count)	Path lines Originated in the Ocean Zone (%)	Path lines Originated Inland (%)
100	7	1168	128	90.1	9.9
100	5	1175	121	90.7	9.3
100	2	1189	107	91.7	8.3
100	0	1206	90	93.1	6.9
50	7	1217	79	93.9	6.1
50	5	1227	69	94.7	5.3
50	2	1238	58	95.5	4.5
50	0	1252	44	96.6	3.4
25	7	1233	63	95.1	4.9
25	5	1237	59	95.4	4.6
25	2	1254	42	96.8	3.2
25	0	1270	26	98.0	2.0

Summary

Results from the Geosyntec model with varying inputs for slant-well pumping rates and groundwater-level elevations in the seawater intrusion barrier wells indicated that for all pumping rates, the simulated percentage of ocean water increased with lower water-level elevations in the seawater intrusion barrier wells. Moreover, the particle tracking results indicate that more ocean water flows to the slant wells for lower water-level elevations in the seawater intrusion barrier wells. The simulated ocean-water percentage approaches or equals 90% for all slant-well pumping rates when the water-level elevations in the seawater intrusion barrier wells are close to sea level.

The model simulations demonstrate that slant well pumping will cause inland groundwater to flow towards the slant wells. The groundwater-level elevation in the seawater intrusion barrier wells influences groundwater flow towards the slant wells such that the greater the elevation in the barrier wells, the greater the percentage of inland groundwater that is captured by slant wells. Because the pumping from the slant wells would lower the groundwater elevation near the ocean and cause inland groundwater flow towards the ocean, the model results point to a lessened need for maintenance of elevated groundwater levels in the seawater intrusion barrier wells with the implementation of slant-well pumping.

Appendix A

For this end, zone budgets obtained from HF runs were classified into contributions to slant wells from the ocean, wetland, inland, and recharge, according to the following criteria:

$$Q_{ocean} = CH_{in}^{ocean} - CH_{out}^{ocean} \quad (1)$$

$$Q_{wetland} = CH_{in}^{wetland} - CH_{out}^{wetland} \quad (2)$$

$$Q_{inland} = CH_{in}^{rest} - CH_{out}^{rest} + CH_{in}^{barrier} - CH_{out}^{barrier} \quad (3)$$

$$Q_{rech} = R^{rest} + R^{ocean} + R^{wetland} + R^{barrier} \quad (4)$$

Where:

Q_{ocean}: Contribution to slant wells from ocean constant head boundaries

$Q_{wetland}$: Contribution to slant wells from wetland and lagoon constant head boundaries

Q_{inland}: Contribution to slant wells from inland constant head boundaries

Q_{rech}: Contribution to slant wells from surface recharge

CH_{in}^{ocean}: Constant head boundary flow into the model in the ocean (zone 2)

CH_{out}^{ocean}: Constant head boundary flow out of the model in the ocean (zone 2)

$CH_{in}^{wetland}$: Constant head boundary flow into the model in the wetland (zone 3)

$CH_{out}^{wetland}$: Constant head boundary flow out of the model in the wetland (zone 3)

CH_{in}^{rest}: Constant head boundary flow into the model in the rest of the domain (zone 1)

CH_{out}^{rest}: Constant head boundary flow out of the model in the rest of the domain (zone 1)

$CH_{in}^{barrier}$: Constant head boundary flow into the model in the barrier (zone 4)

$CH_{out}^{barrier}$: Constant head boundary flow out of the model in the barrier (zone 4)

R^{rest}: Surface recharge flow into the model in the rest of the domain (zone 1)

R^{ocean}: Surface recharge flow into the model in the ocean (zone 2)

$R^{wetland}$: Surface recharge flow into the model in the wetland (zone 3)

$R^{barrier}$: Surface recharge flow into the model in the barrier (zone 4)

With the aforementioned contributions, HF personnel reproduced the table given by Geoscience in the tab "tableupdated" from the workbook. Flows were converted from CFD to MGD and AFY using the following factors:

$$1\ CFD = 7.48 * 10^{-6} MGD$$

$$1\ CFD = \ 1120.14406\ MGD$$

Afterwards, HF personnel reproduced the table delivered by Geoscience in the tab "PctOceanVsBarrierElev_Chart" using Q_{inland} as "Freshwater Flow Contributed to Slant Well from Inland".

Appendix B

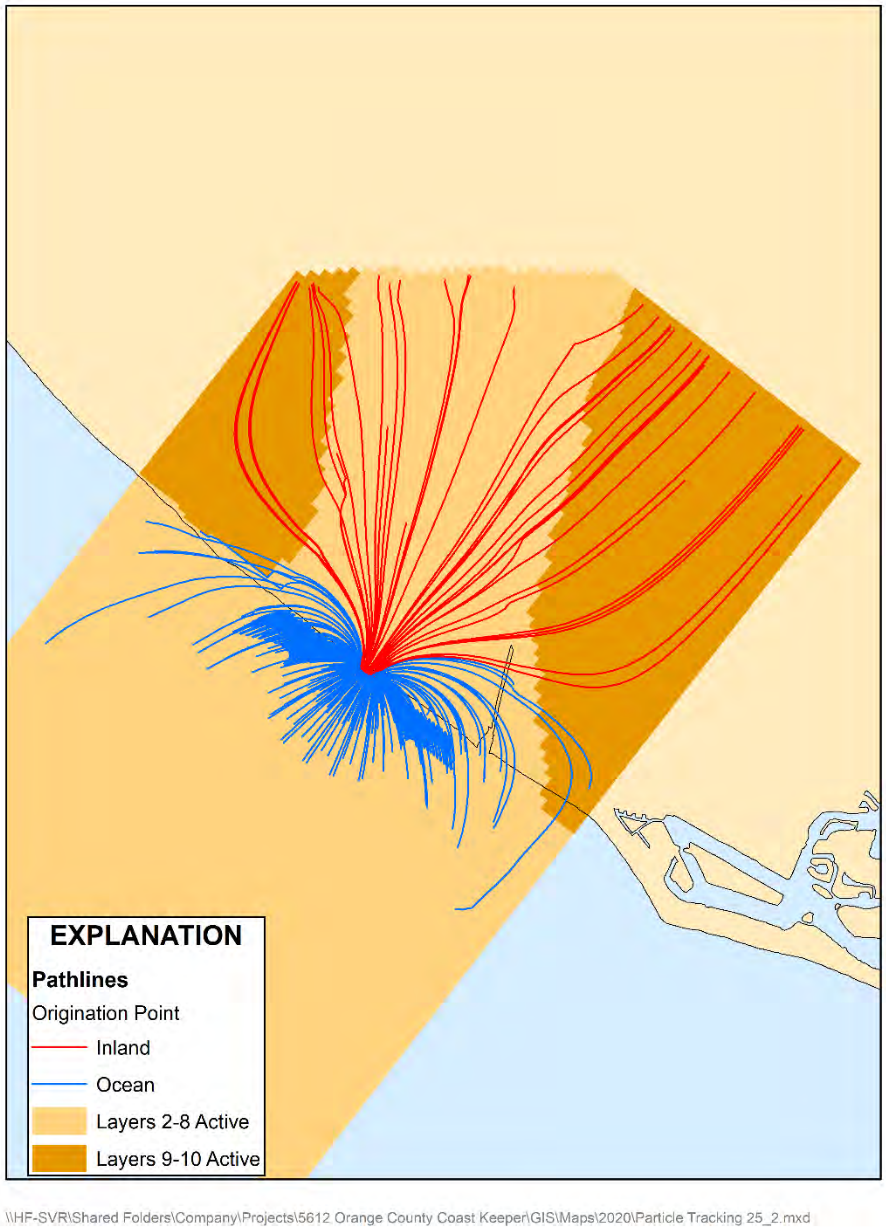

Figure B 1. Backwards particle tracking analyses for scenario 25 MGD of pumping from slant wells and 2 ft of head at saline control barrier. Blue lines represent pathlines for water parcels originated in the ocean zone, while red lines represent pathlines for water parcels originated inland.

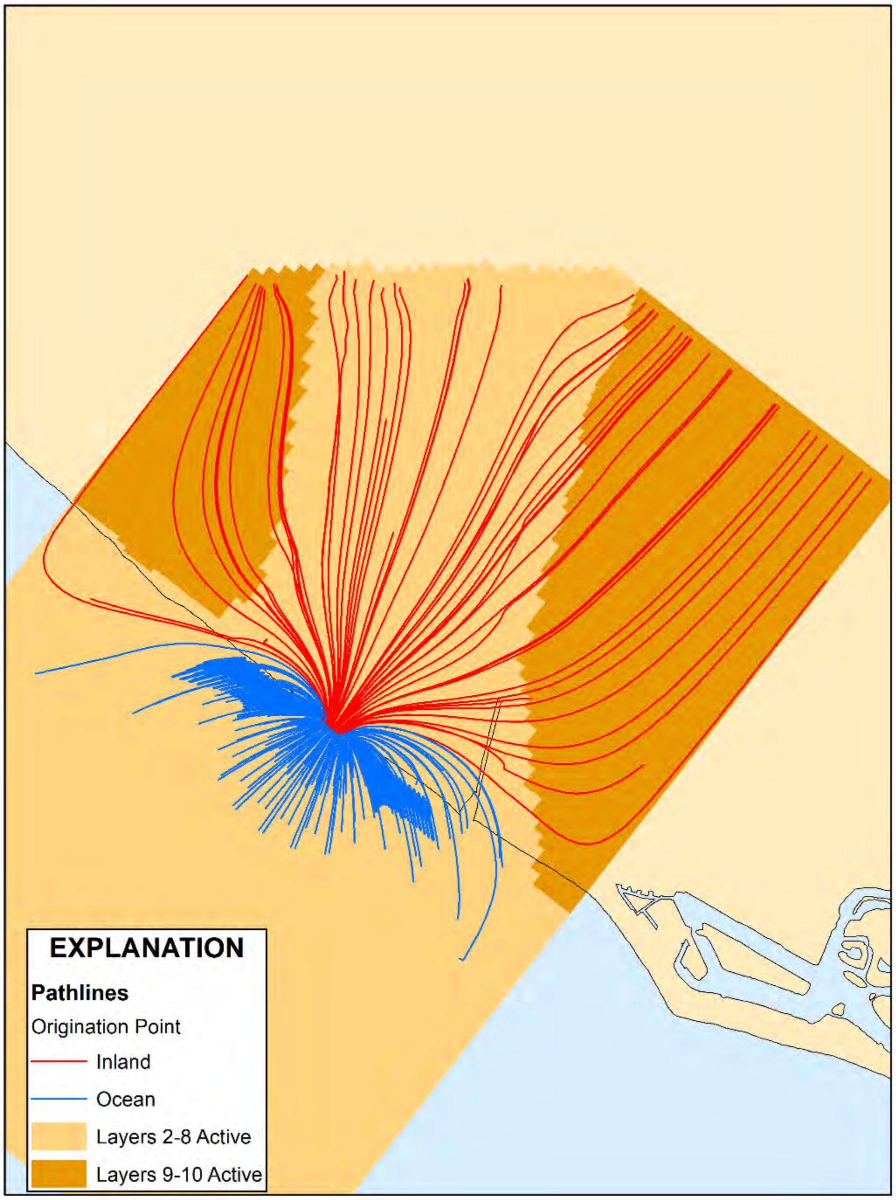

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Figure B 2. Backwards particle tracking analyses for scenario 25 MGD of pumping from slant wells and 5 ft of head at saline control barrier. Blue lines represent pathlines for water parcels originated in the ocean zone, while red lines represent pathlines for water parcels originated inland.

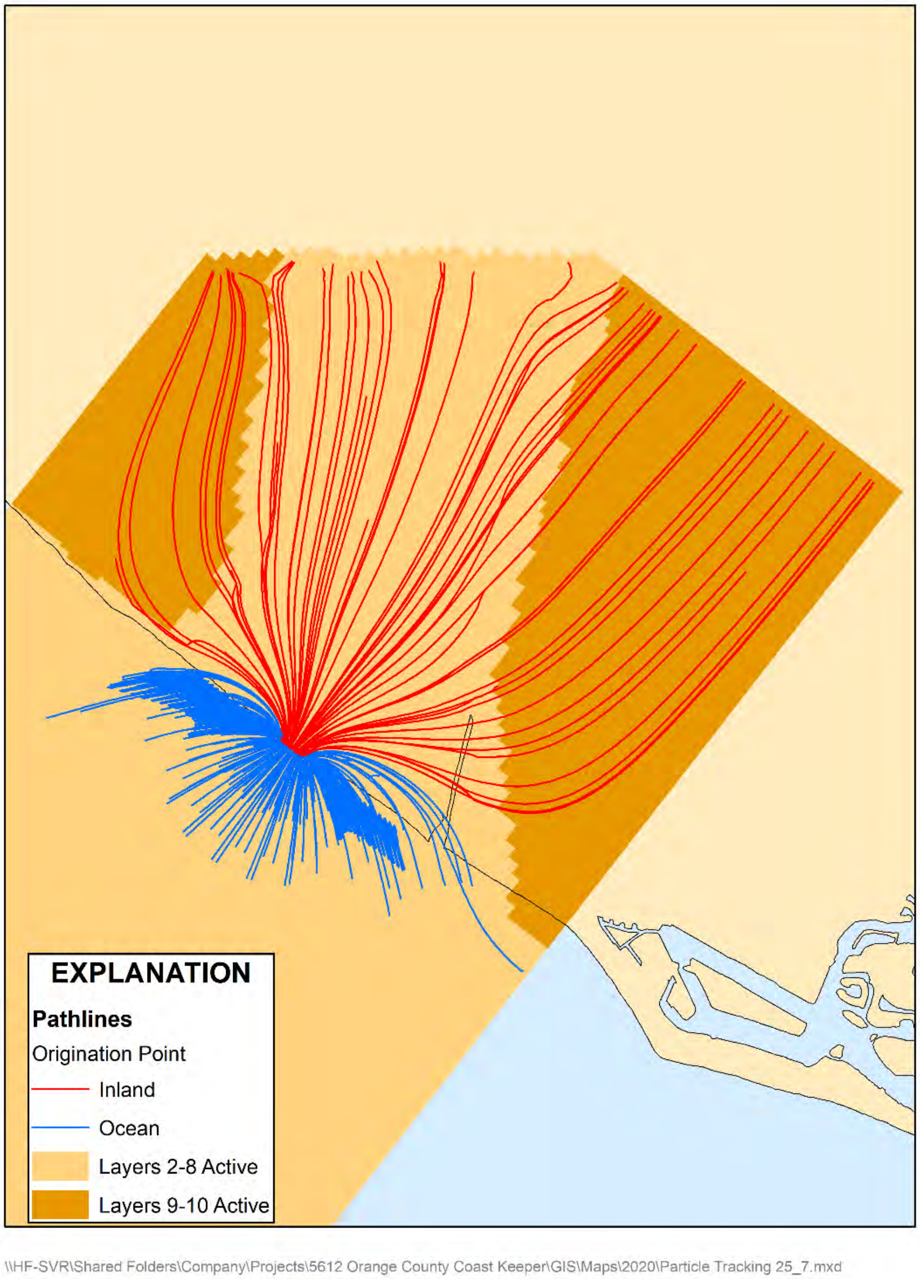

Figure B 3. Backwards particle tracking analyses for scenario 25 MGD of pumping from slant wells and 7 ft of head at saline control barrier. Blue lines represent pathlines for water parcels originated in the ocean zone, while red lines represent pathlines for water parcels originated inland.

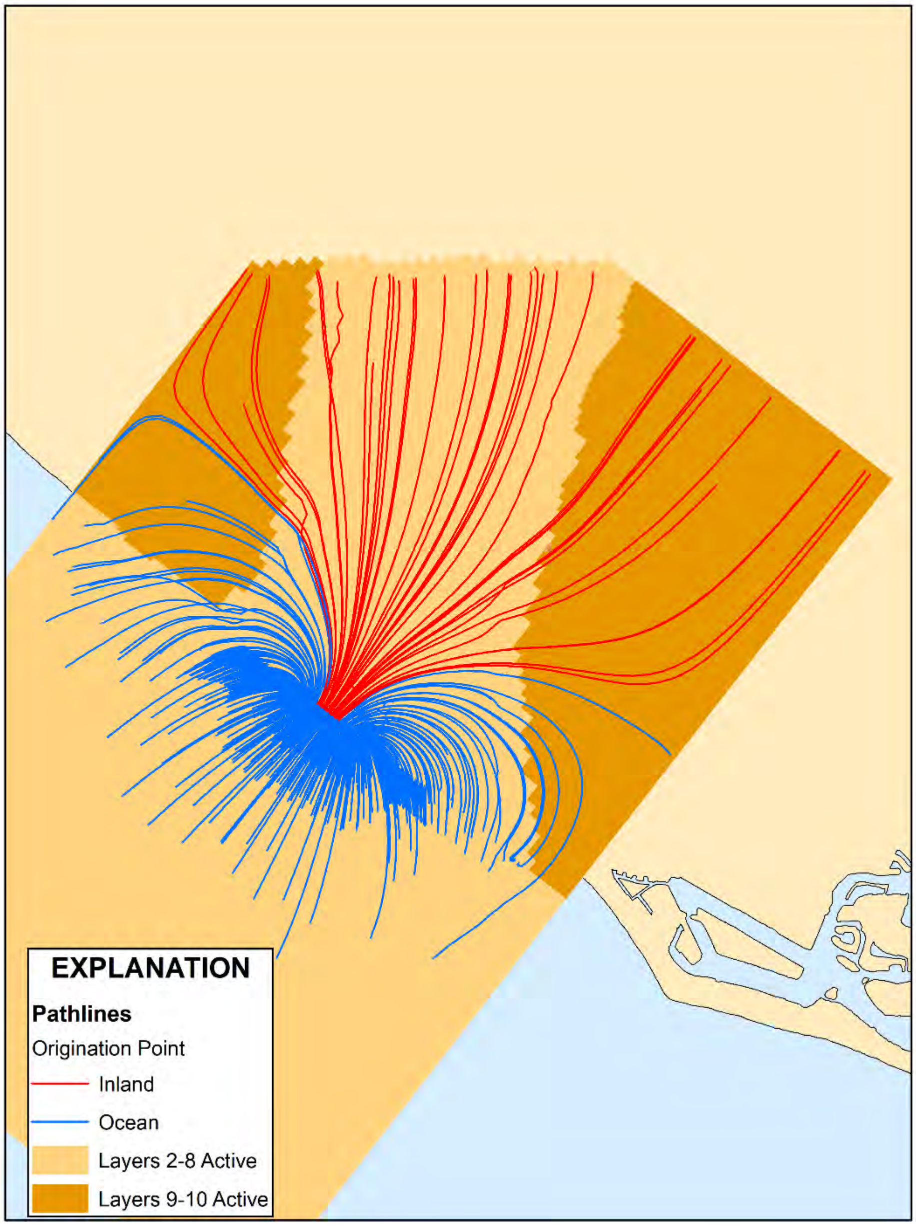

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Figure B 4. Backwards particle tracking analyses for scenario 50 MGD of pumping from slant wells and 0 ft of head at saline control barrier. Blue lines represent pathlines for water parcels originated in the ocean zone, while red lines represent pathlines for water parcels originated inland.

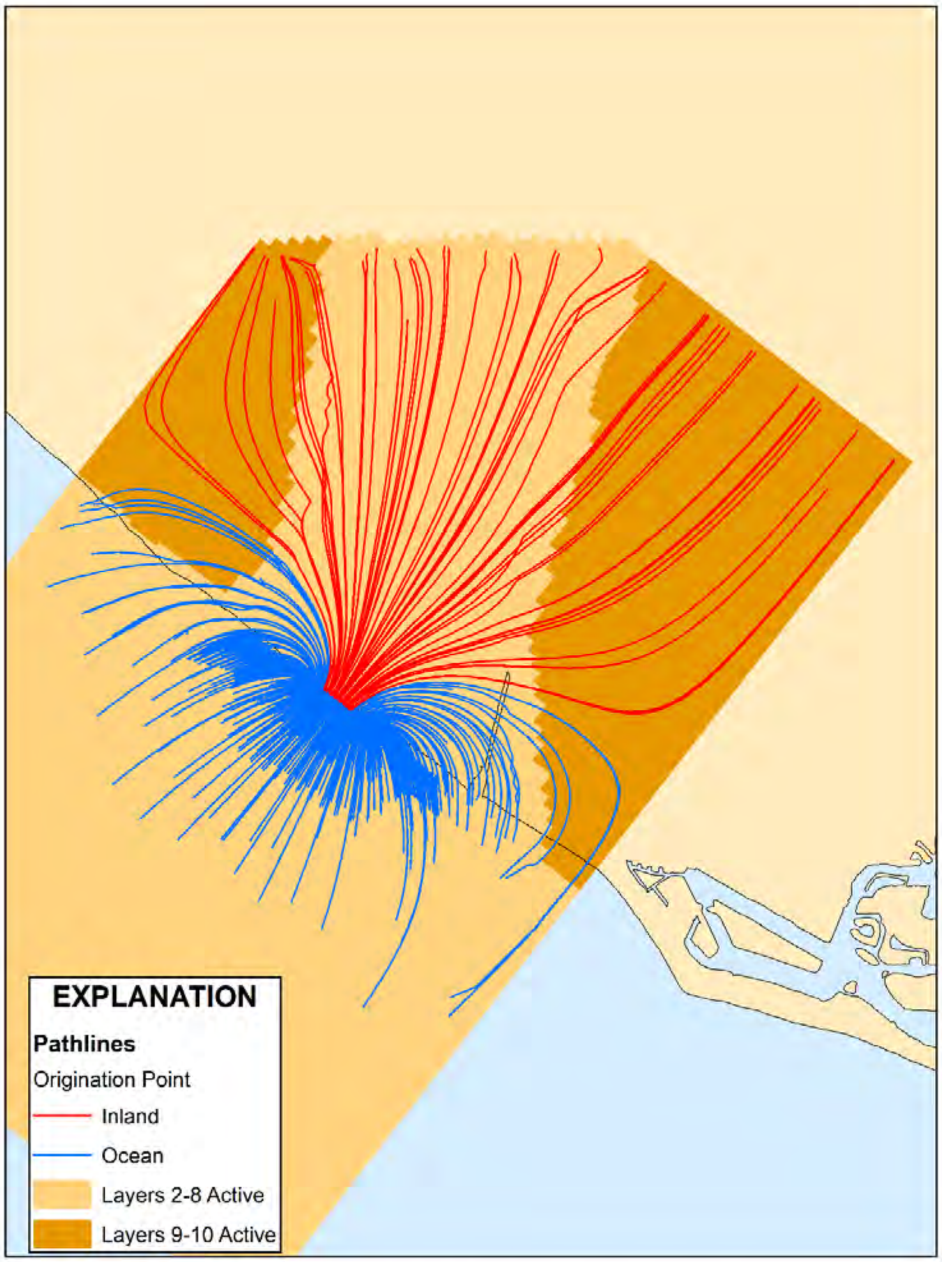

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Figure B 5. Backwards particle tracking analyses for scenario 50 MGD of pumping from slant wells and 2 ft of head at saline control barrier. Blue lines represent pathlines for water parcels originated in the ocean zone, while red lines represent pathlines for water parcels originated inland.

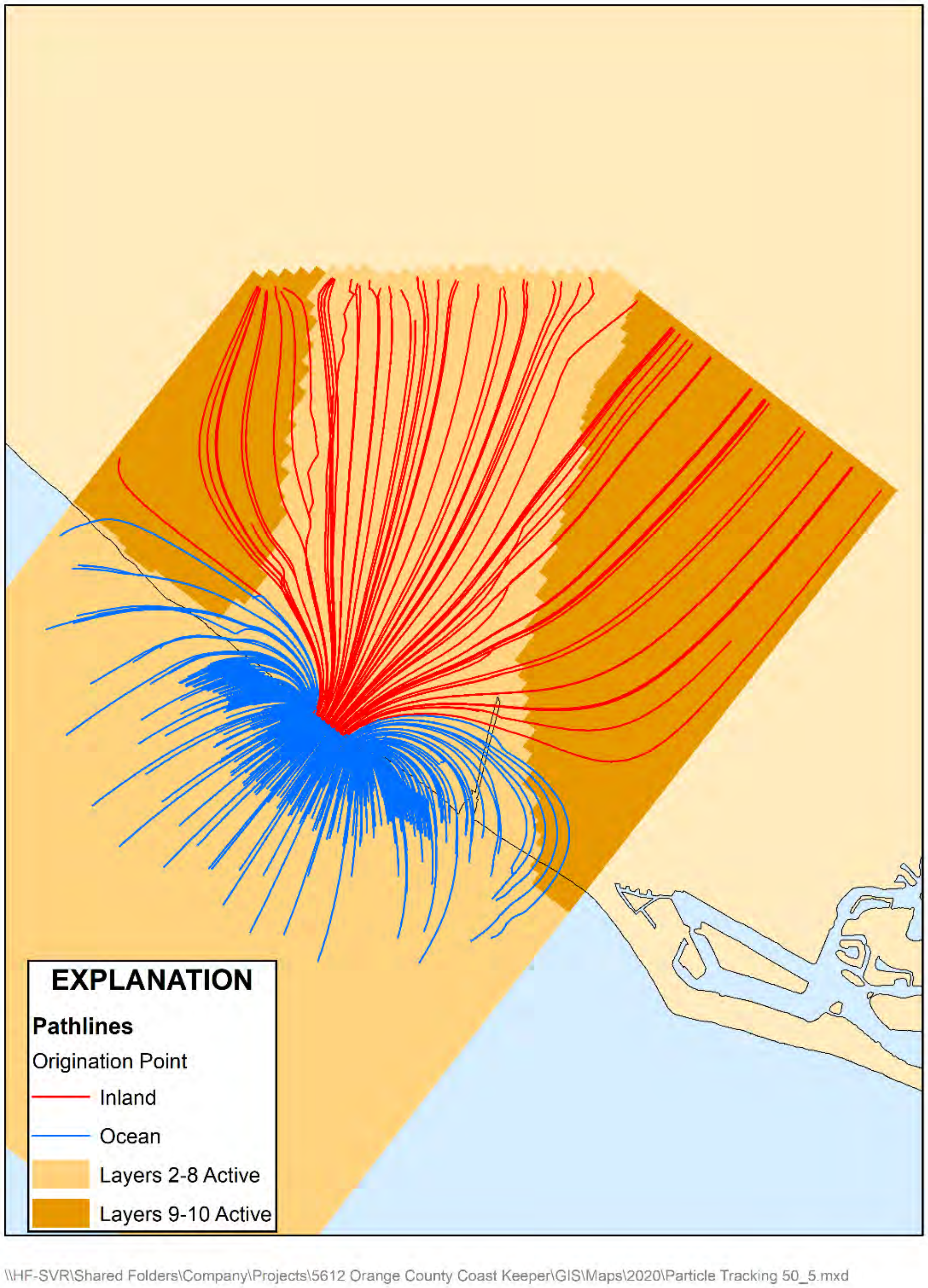

Figure B 6. Backwards particle tracking analyses for scenario 50 MGD of pumping from slant wells and 5 ft of head at saline control barrier. Blue lines represent pathlines for water parcels originated in the ocean zone, while red lines represent pathlines for water parcels originated inland.

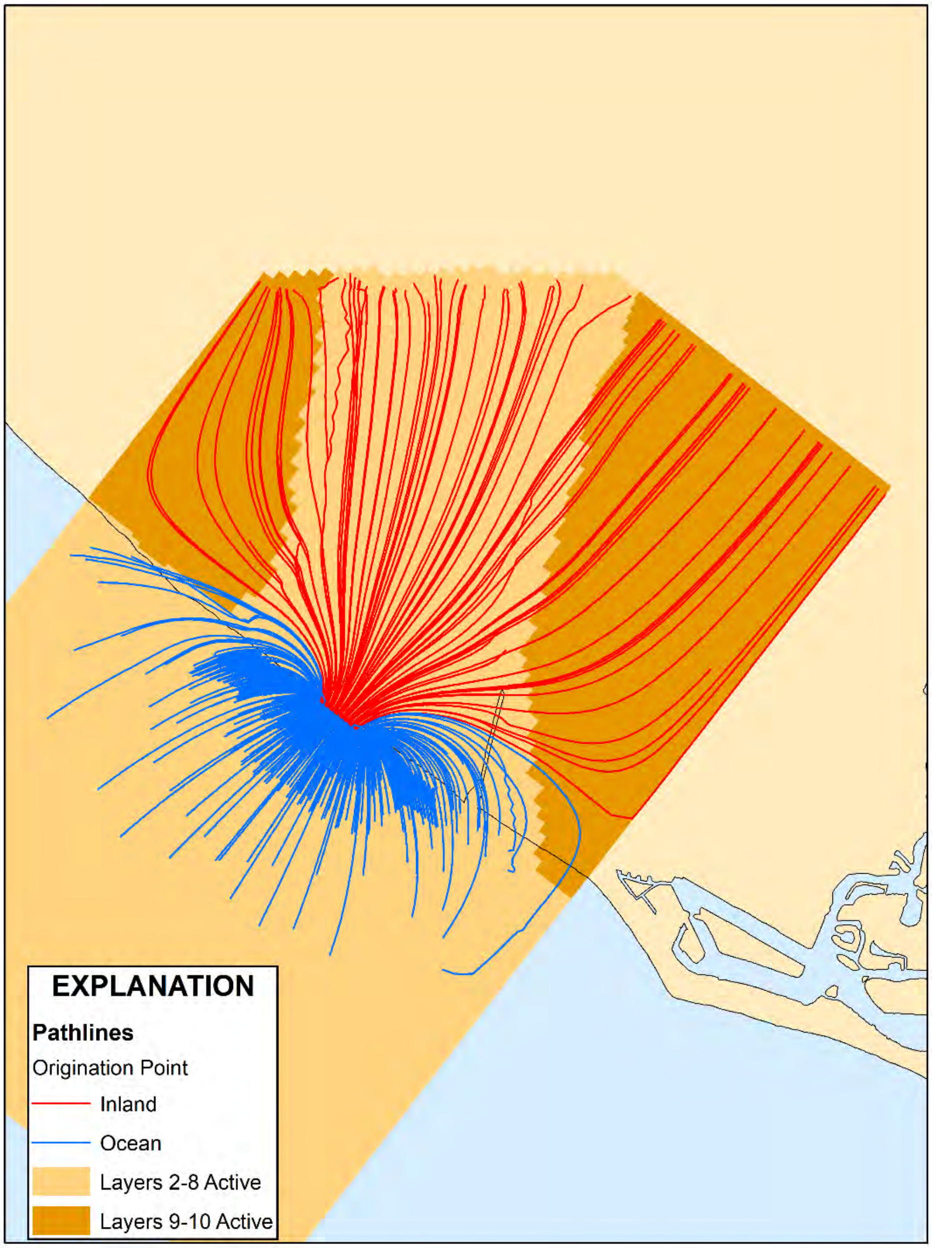

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Figure B 7. Backwards particle tracking analyses for scenario 50 MGD of pumping from slant wells and 7 ft of head at saline control barrier. Blue lines represent pathlines for water parcels originated in the ocean zone, while red lines represent pathlines for water parcels originated inland.

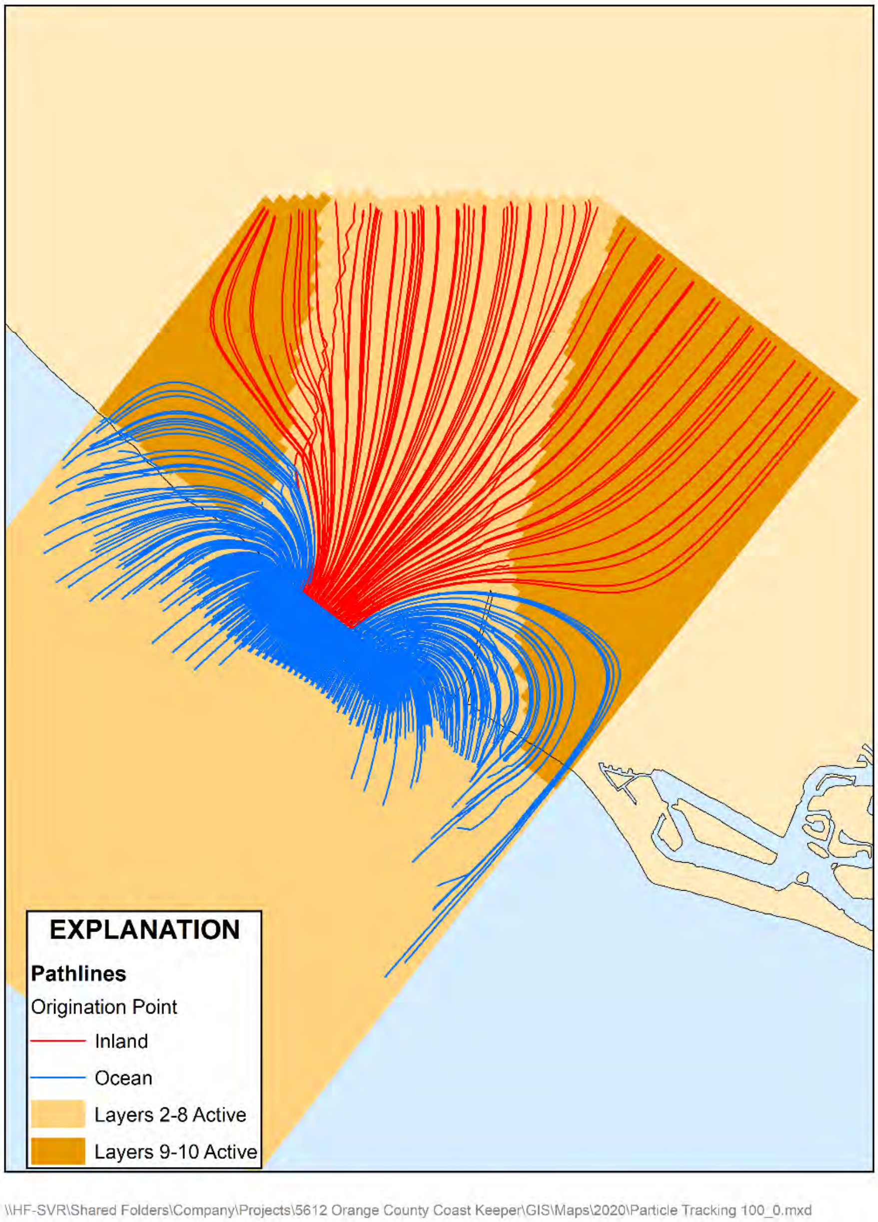

Figure B 8. Backwards particle tracking analyses for scenario 100 MGD of pumping from slant wells and 0 ft of head at saline control barrier. Blue lines represent pathlines for water parcels originated in the ocean zone, while red lines represent pathlines for water parcels originated inland.

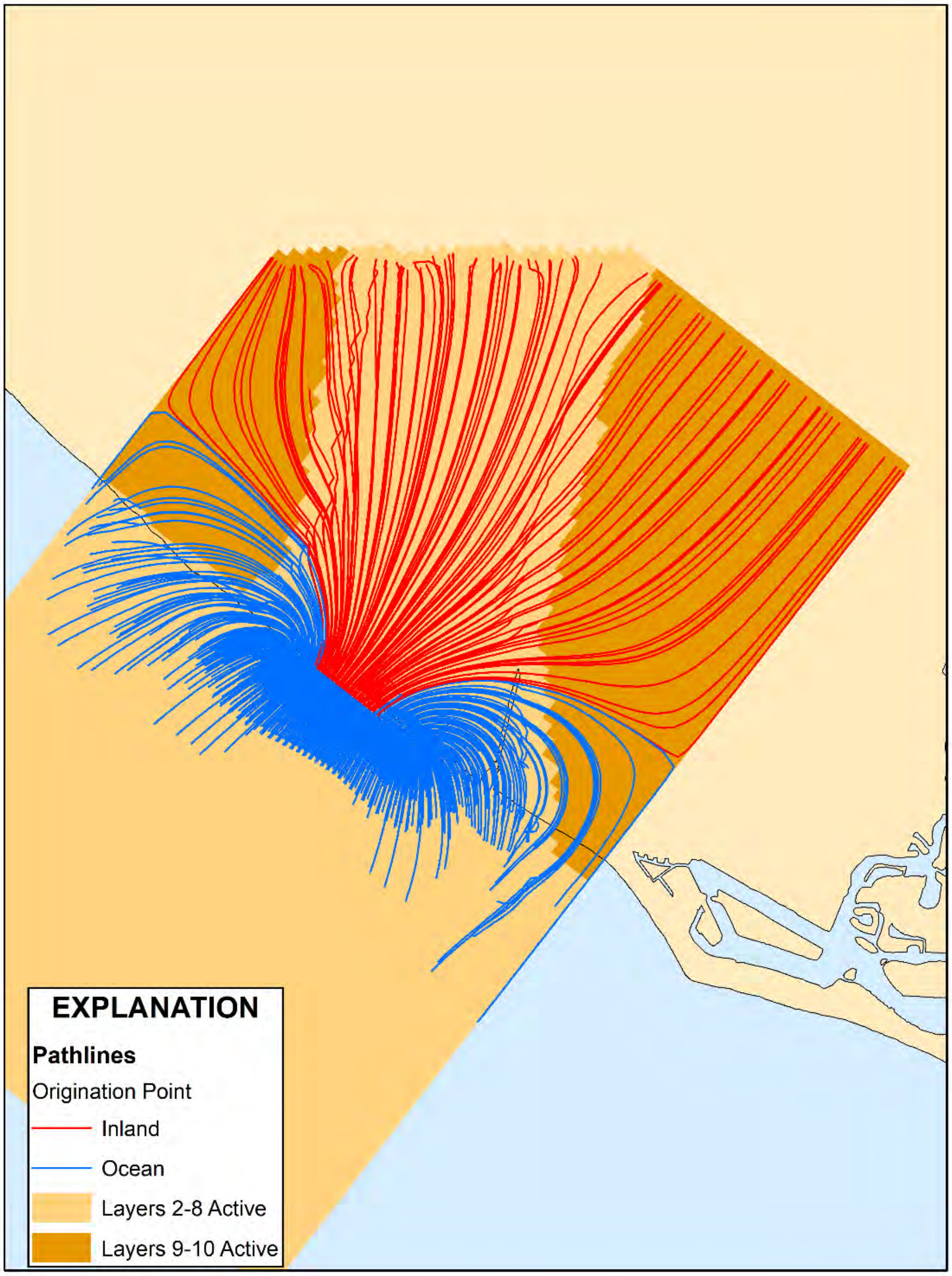

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Figure B 9. Backwards particle tracking analyses for scenario 100 MGD of pumping from slant wells and 2 ft of head at saline control barrier. Blue lines represent pathlines for water parcels originated in the ocean zone, while red lines represent pathlines for water parcels originated inland.

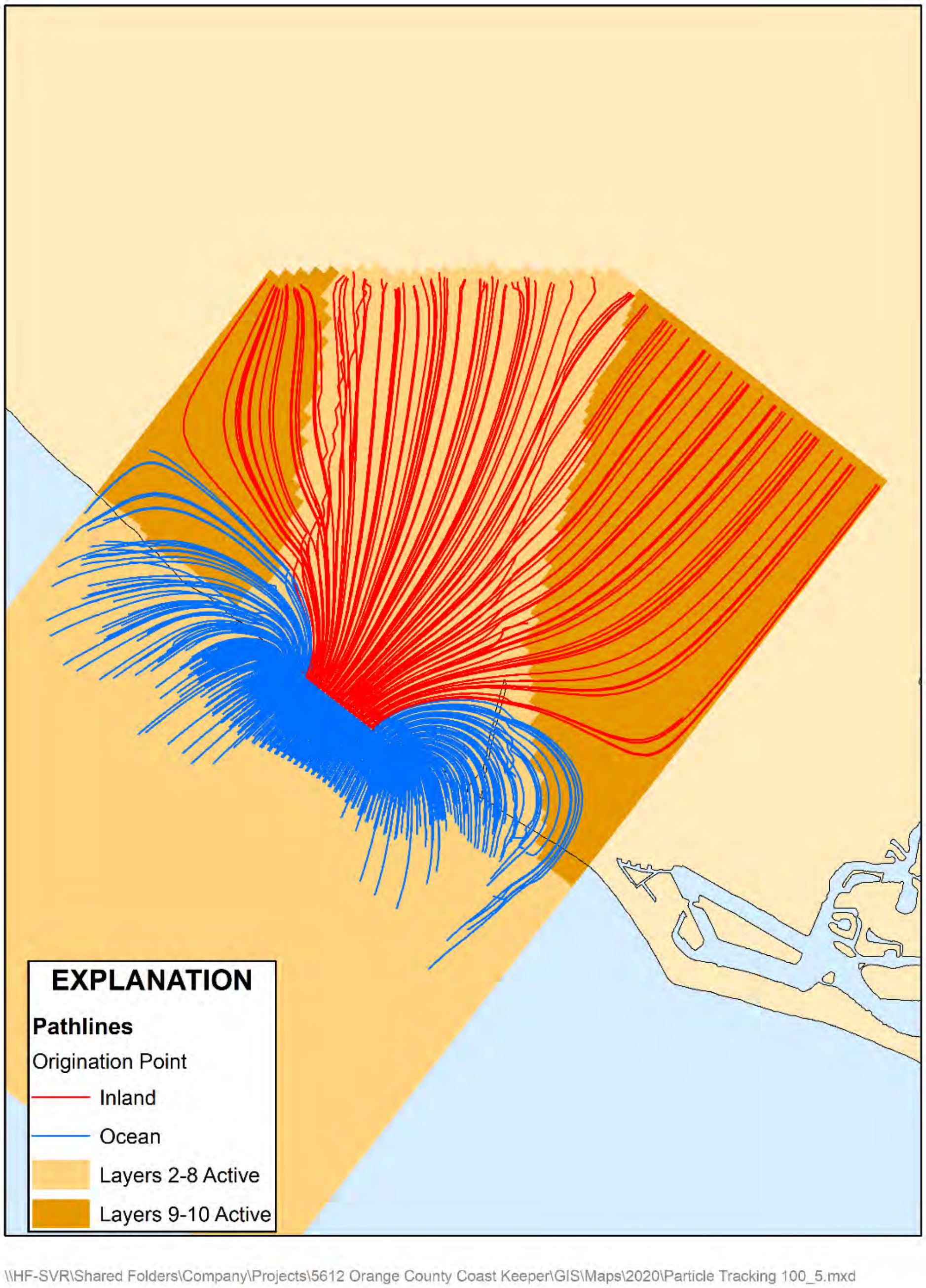
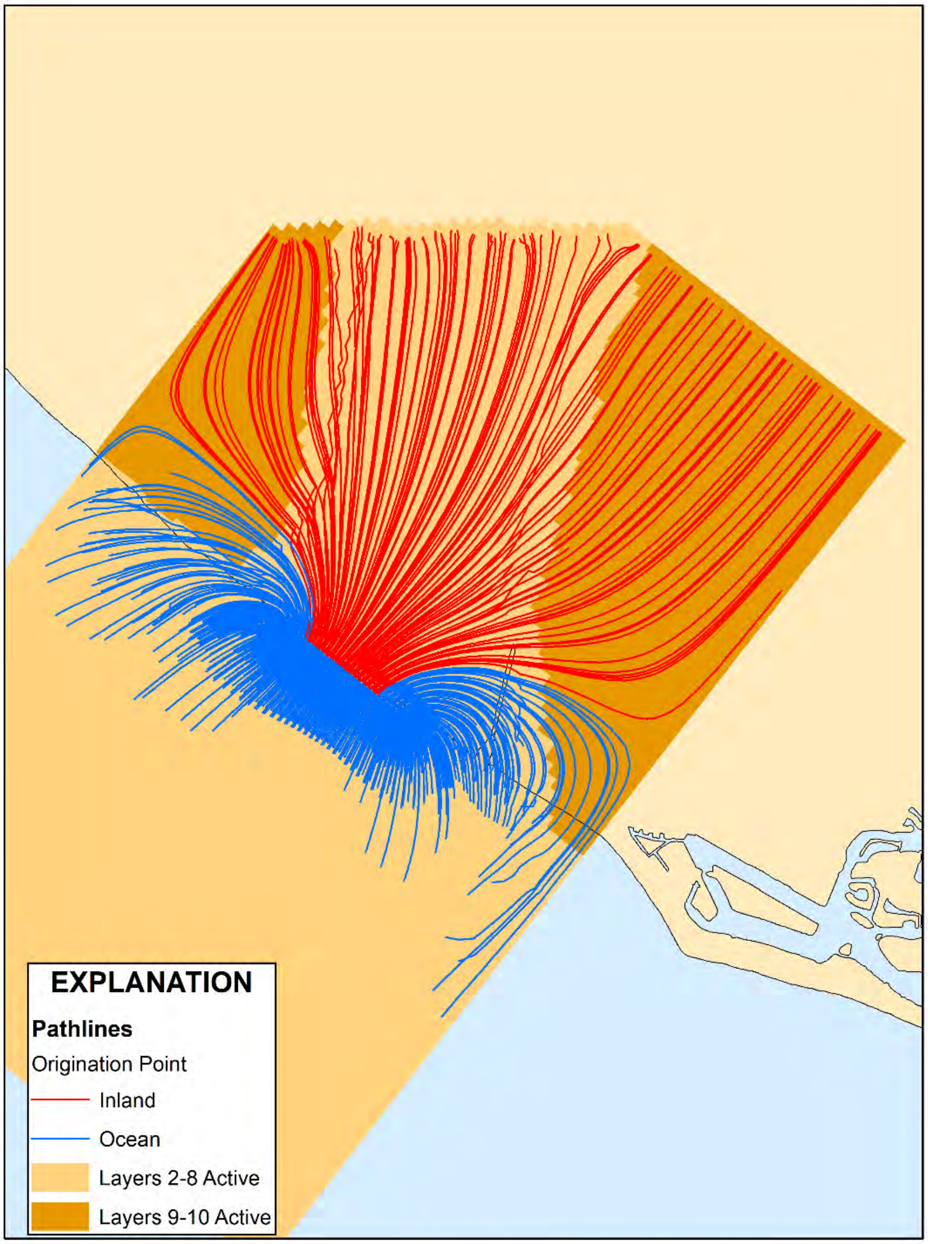


Figure B 10. Backwards particle tracking analyses for scenario 100 MGD of pumping from slant wells and 5 ft of head at saline control barrier. Blue lines represent pathlines for water parcels originated in the ocean zone, while red lines represent pathlines for water parcels originated inland.



\\HF-SVR\Shared Folders\Company\Projects\5612 Orange County Coast Keeper\GIS\Maps\2020\Particle Tracking 100_7.mxd

Figure B 11. Backwards particle tracking analyses for scenario 100 MGD of pumping from slant wells and 7 ft of head at saline control barrier. Blue lines represent pathlines for water parcels originated in the ocean zone, while red lines represent pathlines for water parcels originated inland.

Desalination – a White Paper on the Garden Grove Perspective

OBJECTIVE

To provide the City Council with information and analysis regarding an ocean water desalination facility in Huntington Beach being proposed by the Poseidon Resources Corporation, a private company. The analysis will present costs and benefits as the project relates to the City of Garden Grove (City).

BACKGROUND

The Poseidon ocean water desalination project located at the AES power plant in Huntington Beach will deliver a maximum of 53,000 acre feet (AF) of water per year. Poseidon began soliciting interest from local water agencies for commitments to purchase desalinated water from the Huntington Beach Plant several years ago. In fact, the City entered into a non-disclosure agreement with Poseidon in 2010 to receive information on the project. Over the last few years, the City participated in a working group with other agencies interested in the Huntington Beach project. The group met on a regular basis at the Municipal Water District of Orange County (MWDOC) to review project study results and to discuss the proposed attributes and costs of the proposed project. Garden Grove participated in this process for a couple of years and announced its resignation in 2012 due to the high costs of the water from the project. The working group ended in 2013 with limited interest among agencies to participate in the project. Since then, the Orange County Water District (OCWD) has been exploring the project and is now in contract discussions.

Earlier this month the OCWD approved a non binding term sheet that establishes the framework of a contract that is due by December 31, 2016. The term sheet provides sufficient information to determine the financial impact to the City.

DISCUSSION

Desalination

The desalting or desalination process separates saline water into two streams: fresh water and water containing concentrated salts, or brine. Although there are many technologies that can be considered for desalination, the two most widely used desalting technologies are thermal (distillation) processes and membrane (filtration) processes, such as reverse osmosis (RO). Poseidon uses RO.

RO is a process where pressure is used to force water through a semi-permeable membrane that filters and removes up to 99% of the solids in the seawater, including the salts. Of all the available technologies, RO is considered the best available technology for desalination, due to high salt removal rate, lower waste stream volume, and lower energy consumption and capital costs. Following desalination treatment, the product water requires further post-treatment (pH stabilization and disinfection) to meet potable water standards and to be non-corrosive.

There are many applications of RO, including treatment of brackish and waste water and the costs for producing water from these sources is equal or below the cost for water from traditional sources. Advances in RO membrane and energy recovery system technologies have significantly reduced the capital and operating costs of seawater desalination projects over the past 30 years. However, the costs of desalting seawater remain significantly higher than more traditional water sources. Because of its high costs, large scale ocean desalination has only been used in areas where water supplies are extremely limited and expensive to procure. Continued dramatic cost reductions for RO treatment are not expected to continue because it appears that the most significant technological advances have already occurred in the membrane industry.

The following is a list of similar seawater reverse osmosis (SWRO) desalination projects that are currently in operation, under construction, or are being considered/proposed in the United States during the last decade:

- Marina Coast Water District, CA - 0.3 million gallons per day (MGD) in operation.
- Tampa Bay, FL - 25 MGD in operation.
- Cambria Community Services District, CA - 0.5 MGD in design, on hold
- Marin Municipal Water District, CA - considered 5 to 10 MGD, halted due to the voter approval requirement.
- Honolulu Board of Water Supply, HI - proposed 5 MGD, on hold due to conservation efforts.
- Long Beach, CA - proposed 9 MGD, determine not be cost effective.
- Carlsbad, CA – construction is nearing completion of 50 MGD. This is a Poseidon project.

City Water Program

The City is reliant on two primary sources of water, pumped and imported. On average, we are pumping 70% of our water from 13 City owned wells and we purchase import water for the remaining 30% from the Municipal Water District of Orange County (MWDOC). Our wells draw water from a basin that is under the management of the Orange County Water District (OCWD) and they are responsible for setting the pumping percentage, which is why we pump about 70%. The City wells are capable of delivering 100% of our water supply for limited periods of time, and we are one of two agencies that can pump all of our needs.

The City currently pays **$294** per AF to OCWD for pumped water and we pay MWDOC **$923** per AF for imported water. If the City were to pump over the set percentage we will have to pay **$614** per AF from OCWD on the extra water making it equal to the cost of MWDOC imported water.

The Orange County Basin contains about 38 million AF of water. The OCWD has determined that the maximum dry storage (empty volume) of the basin should be limited to 500,000 AF. OCWD's goal is to operate the basin with 200,000 AF of dry storage which is within the safe operating range of 100,000 to 434,000 AF of available dry storage. Currently, the basin has 380,000 AF of dry storage available.

Last year the City used approximately **25,100** AF of water, which is down from a peak of **30,000** AF in 2005. The reason the City's usage has dropped lies in two recent pieces of legislation. Senate Bill x7-7 for water conservation, seeks to achieve a 20% statewide reduction in urban per capita water use by December 31, 2020, and an interim 10% goal by 2015. Additionally, Governor Brown has issued an emergency mandate for the City to reduce our water use by 28% of our 2013 water usage. Therefore, the City needs to reduce our usage by just over **7,000** AF by February of 2016. Consequently, the most pressing need for the City's water program at this time is the implementation of water conservation measures to achieve this goal and avoid any state fines for non-compliance.

Fiscal Analysis

The total fiscal impact to Garden Grove's rate payers is difficult to assess at this time because of the following unresolved issues:

- The cost to distribute water - injected into the basin or distributed in upsized pipes to retailers. This cost is borne by the OCWD in the term sheet.
- Final disposition of MWDOC Local Resources Program (LRP) - a subsidy that will be passed to Posiedon thus lowering the cost to OCWD, thus lowering the cost to OCWD for the early years of the 50 year commitment.
    - Three options are available for payment. Currently Poseidon is leaning towards the largest that covers the first fifteen year of the project operation.
    - MWDOC could require a reduction in demand which in effect would cause OCWD to exchange high cost Posiedon water with MWDOC import.
- Additional costs that may be required for environmental mitigation, such as a new underground intake system.
- Financing for the project is not in place.

These preceding issues are important and have the ability to significantly increase the proposed cost of water detailed on the Posiedon term sheet. OCWD's independent financial analysis of the Poseidon estimates that groundwater pumping costs will increase 32.7% to cover the cost of the project. Using our existing pumping amounts and the additional amount of desalinated water available to use, we can determine that Garden Grove can expect to add between just over $1M to just under $2M per year in water costs. This will increase the average residential rate payer bill by $6 to $12 or from 6% -12%.

Alternatives

There are a few alternatives being suggested at this time. The following are possible fiscal impacts of Poseidon and of the recharging option being proposed by the Irvine Ranch Water District (IRWD):

- Purchase MWDOC water during "good times" and recharge the basin with 280,000 acre feet of water (equals Poseidon output for about 5 years and 3 months). These "good times" in the past included all but two years during nearly the last thirty years. This IRWD option would have provided a full basin at the beginning of this year at a ten year cost of over $500 Million less that the Poseidon project and is environmentally friendly.
- Expand OCWD's Ground Water Replenishment System (GWRS) again or construct a new facility. The successful ground water recharge system using treated sewage is already expanding and will be online by the end of 2015. The $142.7 million project will create an additional 30 million gallons per day of new water supplies as compared to the Poseidon project that may produce 50 million gallons per day at an estimated cost of $1 billion.
- Conservation and the price and impact to the environment are negligible and this option is immediately available to us with state and regional funds available to implement. It should be noted that this option will also assist the City in meeting our mandatory reduction mandate from the State.
- Construct additional measures within and adjacent to the local storm channel that will infiltrate storm water into the basin.
- Expand the recycled water system. This is the "purple line" that uses partially treated sewage to provide non-potable water for uses like irrigation. This option will also help the City meet our mandatory reduction goals.

Summary of Findings

Due to high capital and operational costs, and currently a non-existent need for additional water, desalination is not an option for immediate City water supply needs. Desalination may play a part in long-range planning (2025 -2035 timeframe), but probably under the circumstance that the project can obtain significant state and federal funding assistance. The proposed site is likely to remain available into the future.

The following are the advantages and disadvantages of a desalination program as compared to other options, such as a GWRS program.

Advantages of a Desalination Facility:

- Less significant distribution pipeline system required when compared to non-potable water sources
- Desalination is a new source of potable water, which increases the City's flexibility for using this supply for any potable, irrigation or industrial use

Disadvantages of a Desalination Facility:

- Extensive environmental review process (full EIR) and permits still required with uncertain mitigations.
- Potential additional treatment for certain emerging contaminants due to the mixing of desalinated water with existing imported and groundwater supplies.
- Increased brine discharges to the ocean.
- Very high capital and operating costs and financial risk in the event of default, if OCWD finances the distribution system.
- Significant timeline for implementation (5-7 years from initiation).

OCWD already has implemented a recycled water and water conservation program. While the effectiveness of the conservation program is yet to be determined, the GWRS is recognized as an industry leading example.

SUMMARY

The City was hopeful when we entered into the 2010 agreement with Poseidon for a desalination water supply that could provide increased reliability to the City, especially during times of a drought. Unfortunately, the original promise of a new water supply at the same cost as imported water has been replaced with a project that will provide water at double the cost of imported water. The cost escalation is similar to the Poseidon project in San Diego. When compared to other options, a desalination facility is a relatively expensive option for a new potable water supply for the City of Garden Grove and will not immediately resolve the City water's conservation mandate.

However, the City should continue to be open to new sources of water and new ideas and urges OCWD to fully explore less expensive options currently available before proceeding with ocean desalination. In time, a project such as Poseidon may become economically viable and environmentally sound and it is unlikely that a decision to forego its implementation at this time will preclude its future use.

MWDOC

ARCADIS

Maddaus Water Management Inc.

June 2021

2020 Urban Water Management Plan

2020 URBAN WATER MANAGEMENT PLAN

Sarina Sriboonlue, PE
Project Manager

Prepared for:

Municipal Water District of Orange County

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Fax 714 730 9345

Our Ref:

30055240

Date:

June 2021

MESSAGE FROM THE BOARD OF DIRECTORS

Since the Municipal Water District of Orange County's (MWDOC) formation in 1951, MWDOC has remained steadfast in its commitment to provide a reliable supply of high-quality water for Orange County at a reasonable rate.

Through leadership, representation at the Metropolitan Water District of Southern California (MET), and collaboration with our retail agencies, MWDOC seeks opportunities to improve Orange County's water resources and reliability. By integrating local planning challenges and regional stakeholder partnerships, MWDOC maximizes water system reliability and overall system efficiencies. MWDOC works to expand Orange County's water supply portfolio by providing planning and local resource development in the areas of recycled water, groundwater, ocean water desalination, and water-use efficiency.

DIRECTORS

Division 1 Al Nederhood

Brea, Buena Park, portions of Golden State Water Company, La Habra, La Palma, Yorba Linda Water District.

Division 2 Larry D. Dick

Garden Grove, Orange, Tustin and Villa Park, and unincorporated North Tustin.

Division 3 Robert R. McVicker

Cypress, Fountain Valley, Los Alamitos, Stanton, Westminster, the western portion of Garden Grove, and nearby portions of unincorporated Orange County

Division 4 Karl W. Seckel, P.E.

Huntington Beach, Seal Beach, and portions of Costa Mesa, Irvine and Newport Beach.

Division 5 Sat Tamaribuchi

Newport Beach, Laguna Woods, portions of Irvine, Lake Forest, Laguna Hills, Aliso Viejo, and parts of Mission Viejo.

Division 6 Jeffery M. Thomas

Tustin and Rancho Santa Margarita, portions of Irvine, Lake Forest, Mission Viejo, San Juan Capistrano, and San Clemente.

Division 7 Megan Yoo Schneider, P.E.

Aliso Viejo, Dana Point, Laguna Beach, Laguna Hills, Laguna Niguel, Mission Viejo, San Clemente, and San Juan Capistrano.

MISSION STATEMENT

"To provide reliable, high-quality supplies from Metropolitan Water District of Southern California and other sources to meet present and future needs, at an equitable and economical cost, and to promote water use efficiency for all of Orange County."

CONTENTS

TABLES

FIGURES

APPENDICES

ACRONYMS AND ABBREVIATIONS

%	Percent
20x2020	20% water use reduction in GPCD by year 2020
ACWRF	Aliso Creek Water Reclamation Facility
ADU	Accessory Dwelling Unit
AF	Acre-Feet
AFY	Acre-Feet per Year
AVEK	Antelope Valley-East Kern
AWTP	Advanced Water Treatment Plant
AWWA	American Water Works Association
Base	Marine Corps Base, Camp Pendleton
Basin 8-1	Orange County Grounwater Basin
BEA	Basin Equity Assessment
Biops	Biological Opinions
BMP	Best Management Practice
BPP	Basin Production Percentage
BPOU	Baldwin Park Operable Unit
CDR	Center for Demographic Research
CDWC	California Domestic Water Company
CLWUE	Comprehensive Landscape Water Use Efficiency
CII	Commercial/Industrial/Institutional
COA	Coordinated Operation Agreement
CRA	Colorado River Aqueduct
CTP	Coastal Treatment Plant
CUP	Conjunctive Use Program
CVP	Central Valley Project
CWRP	Chiquita Water Reclamation Plant
DATS	Deep Aquifer Treatment System
DDW	Division of Drinking Water
Delta	Sacramento-San Joaquin River Delta
DLR	Detection Limit for Purposes of Reporting
DMM	Demand Management Measure
DOF	Department of Finance
DRA	Drought Risk Assessment
DPR	Direct Potable Reuse
DVL	Diamond Valley Lake
DWR	California Department of Water Resources
EBSD	Emerald Bay Services District
EIR	Environmental Impact Report

EOCWD	East Orange County Water District
ESA	Endangered Species Act
ET	Evapotranspiration
ETWD	El Toro Water District
FIRO	Forecast Informed Reservoir Operations
FY	Fiscal Year
GAC	Granular Activated Carbon
GAP	Green Acres Project
GIS	Geographic Information System
GPCD	Gallons per Capita per Day
GPD	Gallons per Day
GRF	Groundwater Recovery Facility
GRP	Groundwater Reliability Plan
GSA	Groundwater Sustainabiltiy Agency
GSP	Groundwater Sustainability Plan
GSWC	Golden State Water Company
GWRP	Groundwater Recovery Plant
GWRS	Groundwater Replenishment System
GWRSFE	Groundwater Replenishment System Final Expansion
HEN	High Efficiency Sprinkler Nozzle
HET	High Efficiency Toilet
ICS	Intentionally Created Surplus
IPR	Indirect Potable Reuse
IRP	Integrated Water Resources Plan
IRWD	Irvine Ranch Water District
ITP	Incidental Take Permit
JADU	Junior Accessory Dwelling Unit
LAWRP	Los Alisos Water Recycling Plant
LBCWD	Laguna Beach County Water District
LRP	Local Resources Program
M&I	Municipal and industrial
MAF	Million Acre-Feet
MAF	Million Acre-Feet per Year
MCL	Maximum Contaminant Level
Mesa Water	Mesa Water District
MET	Metropolitan Water District of Southern California
MF	Microfiltration
MGD	Million Gallons per Day
MNWD	Moulton Niguel Water District
MTBE	Methyl Tert-Butyl Ether

MWDOC	Municipal Water District of Orange County
MWRF	Mesa Water Reliability Facility
MWRP	Michelson Water Recycling Plant
NDMA	N-nitrosodimethylamine
OC Basin	Orange County Groundwater Basin
OC San	Orange County Sanitation District
OCWD	Orange County Water District
OCWRP	Oso Creek Water Reclamation Plant
OSY	Operating Safe Yield
PFAS	Per- and Polyfluoroalkyl Substances
PFOA	Perfluorooctanoic Acid
PFOS	Perfluorooctane Sulfonate
Plan	Urban Water Management Plan
Poseidon	Poseidon Resources LLC
PPCP	Pharmaceuticals and Personal Care Product
PPB	Parts per Billion
PPT	Parts Per Trillion
RA	Replenishment Assessment
RDA	Resource Development Assessment
RHNA	Regional Housing Needs Assessment
RO	Reverse Osmosis
RoC on LTO	Reinitiation of Consultation for Long-Term Operations
RRWTP	Robinson Ranch Wastewater Treatment Plant
RTP	Regional Treatment Plant
RWQCB	Regional Water Quality Control Board
SARCCUP	Santa Ana River Conservation and Conjunctive Use Program
SBx7-7	Senate Bill 7 as part of the Seventh Extraordinary Session, Water Conservation Act of 2009
SCAB	South Coast Air Basin
SCAG	Southern California Associations of Governments
SCWD	South Coast Water District
SDCWA	San Diego County Water Authority
SDP	Seawater Desalination Program
Serrano	Serrano Water District
SJBA	San Juan Basin Authority
SMWD	Santa Margarita Water District
SNWA	Southern Nevada Water Authority
SOCWA	South Orange County Wastewater Authority
SWP	State Water Project
SWRCB	California State Water Resources Control Board

TAZ	Traffic Analysis Zone
TCWD	Trabuco Canyon Water District
TDS	Total Dissolved Solids
TVMWD	Three Valleys Municipal Water District
USACE	United States Army Corps of Engineers
USBR	United States Bureau of Reclamation
USGVMWD	Upper San Gabriel Valley Municipal Water District
UV	Ultraviolet
UWMP	Urban Water Management Plan
UWMP Act	Urban Water Management Planning Act of 1983
VOC	Volatile Organic Compounds
WRD	Water Replenishment District of Southern California
WRF	Water Research Foundation
WRP	Water Recycling Plant
WSAP	Water Supply Allocation Plan
WSCP	Water Shortage Contingency Plan
YLWD	Yorba Linda Water District

EXECUTIVE SUMMARY

INTRODUCTION AND UWMP OVERVIEW

The Municipal Water District of Orange County (MWDOC) prepared this 2020 Urban Water Management Plan (UWMP) to submit to the California Department of Water Resources (DWR) to satisfy the UWMP Act of 1983 (UWMP Act or Act) and subsequent California Water Code (Water Code) requirements. MWDOC is a wholesale water supplier that provides water to 28 retail water suppliers in Orange County using imported water supplies obtained from its regional wholesaler, Metropolitan Water District of Southern California (MET).

UWMPs are comprehensive documents that present an evaluation of a water supplier's reliability over a long-term (20-25 year) horizon. This 2020 UWMP provides an assessment of the present and future water supply sources and demands within the MWDOC's service area. It presents an update to the 2015 UWMP on the MWDOC's water resource needs, water use efficiency programs, water reliability assessment and strategies to mitigate water shortage conditions. It also presents a new 2020 Water Shortage Contingency Plan (WSCP) designed to prepare for and respond to water shortages. This 2020 UWMP contains all elements to meet compliance of the new requirements of the Act as amended since 2015.

UWMP PREPARATION

MWDOC coordinated the preparation of this 2020 UWMP with other key entities, including MET (regional wholesaler for Southern California and the direct supplier of imported water to MWDOC), Orange County Water District (OCWD) (Orange County Groundwater Basin [OC Basin] manager and provider of recycled water in north Orange County), and retail water suppliers in Orange County which include MWDOC's 28 member agencies and the three cities which are direct members of MET – Anaheim, Fullerton, and Santa Ana. MWDOC also coordinated with other entities which provided valuable data for the analyses prepared in this UWMP, such as the Center for Demographic Research (CDR) at California State University Fullerton for population projections.

SYSTEM DESCRIPTION

MWDOC was formed by Orange County voters in 1951 under the Municipal Water District Act of 1911 to provide imported water to inland areas of Orange County. Governed by an elected seven-member Board of Directors, MWDOC is MET's third largest member agency based on assessed valuation. Today, MWDOC manages all of Orange County's imported water supply except for water imported to the cities of Anaheim, Fullerton, and Santa Ana. MWDOC is committed to ensuring water reliability for more than 2.34 million residents in its 600-square-mile service area. Although MWDOC does not own water facilities and does not have jurisdiction over local supplies, it works to ensure the delivery of reliable water supplies to the region. MWDOC focuses on sound planning and appropriate investments in water supply, water use efficiency, regional delivery infrastructure, and emergency preparedness.

WATER USE CHARACTERIZATION

MWDOC is the wholesale provider of treated and untreated imported water from MET for municipal and industrial (M&I) uses (i.e., direct uses) and non-M&I (indirect uses e.g., groundwater recharge) within its service area.

MWDOC's service area M&I water use has consistently exceeded 400,000 acre-feet per year (AFY) until recently. Since fiscal year (FY) 2013-14, as a result of drought, retail water usage (including recycled water) began to trend downward. FY 2015-16 was the first year that water use in the MWDOC's service area dropped below 400,000 AF due to large-scale water efficiency efforts undertaken by MWDOC and member agencies.

25-year Water Use Projection

MWDOC's total service area water demands are expected to gradually increase between now and 2023 due to projected growth in M&I demands. The bulk of the increases between 2023 and 2025 are due to indirect imported demands for groundwater replenishment returning in those years 2024 and 2025. The current regulatory impacts of PFAS in the OC Basin has reduced the need for purchasing any imported groundwater replenishment water, due to reductions in groundwater pumping expected to last until 2023. Over the next 25 years, total water demands within the MWDOC service area are projected to increase by about 17% from approximately 428,000 acre-feet (AF) in 2020 to approximately 501,000 AF by 2045. This demand projection considers such factors as current and future demographics, future conservation measures, and ground and surface water needs.

CONSERVATION TARGET COMPLIANCE

MWDOC in collaboration with all its retail member agencies as well as the Cities of Anaheim, Fullerton, and Santa Ana, created the Orange County 20x2020 Regional Alliance to assist retail agencies in complying with the requirements of Water Conservation Act of 2009, also known as SBx7-7 (Senate Bill 7 as part of the Seventh Extraordinary Session). Signed into law on February 3, 2010, it requires the State of California to reduce urban water use by 20% by 2020.

Retail water suppliers are required to comply with SBx7-7 individually or as a region in collaboration with other retail water suppliers, in order to be eligible for water related state grants and loans. As a wholesale water supplier, MWDOC is not required to establish a baseline or set targets for daily per capita water use itself. Orange County, as a region, had a 2020 target water use of 159 gallons per capita per day (GPCD). The actual water use in 2020 was 109 GPCD which is well below its target. This is indicative of the collective efforts of MWDOC and retail agencies in reducing water use in the region.

WATER SUPPLY CHARACTERIZATION

Imported water from MET accounts for about 33% of MWDOC's service area water use. The other 67% is from various other sources, including groundwater from the OC Basin, groundwater from other smaller groundwater basins such as the Main San Gabriel Basin, and recycled water. The Orange County Sanitation District (OC San) and South Orange County Wastewater Authority (SOCWA) are the wastewater providers of North county and South county agencies, respectively. A few MWDOC member agencies produce their own recycled water.

WATER SERVICE RELIABILITY AND DROUGHT RISK ASSESSMENT

Every urban water supplier is required to assess the reliability of their water service to its customers under a normal year, a single dry year, and multiple dry water years. The water service reliability assessment compares projected supply to projected demand for three long-term hydrological conditions: a normal year, a single dry year, and a drought period lasting five consecutive years. MWDOC as an imported water provider relies on its wholesaler's water reliability assessments which concluded that it will be able to meet MWDOC's service area demands for imported water under normal, single-dry, and five-year consecutive dry conditions over the next 25 years (2020 – 2045).

Overall, MWDOC's service area depends on a combination of imported and local supplies to meet its service area water demands. MWDOC has taken numerous steps to ensure its member agencies have adequate supplies. Development of numerous local sources augment the reliability of the imported water system. The water supplies available to the MWDOC service area are projected to meet full-service demands based on the findings by MET in its 2020 UWMP starting 2021 through 2045 during normal years, single dry year, and five consecutively dry years.

WATER SHORTAGE CONTINGENCY PLANNING

Water shortage contingency planning is a strategic planning process that MWDOC engages to prepare for and respond to water shortages. A water shortage, when water supply available is insufficient to meet the normally expected customer water use at a given point in time, may occur due to a number of reasons, such as water supply quality changes, climate change, drought, and catastrophic events (e.g., earthquake). The MWDOC WSCP provides a water supply availability assessment and structured steps designed to respond to actual conditions. This level of detailed planning and preparation will help maintain reliable supplies and reduce the impacts of supply interruptions.

The WSCP serves as the operating manual that MWDOC will use to prevent catastrophic service disruptions through proactive, rather than reactive, mitigation of water shortages. The WSCP contains the processes and procedures that will be deployed when shortage conditions arise so that the MWDOC governing body, its staff, and its retail agencies can easily identify and efficiently implement pre-determined steps to mitigate a water shortage to the level appropriate to the degree of water shortfall anticipated.

DEMAND MANAGEMENT MEASURES

MWDOC has demonstrated its commitment to water use efficiency through multi-faceted and holistic water use efficiency programs. As a wholesaler, MWDOC facilitates implementation of DMM throughout Orange County. MWDOC's efforts focus on the following three areas: Regional Program Implementation, Local Program Assistance, and Research and Evaluation. MWDOC develops, obtains funding for, and implements regional water savings programs on behalf of all retail water agencies in Orange County. This approach minimizes confusion to consumers by providing the same programs with the same participation guidelines, maintains a consistent message to the public to use water efficiently, and provides support to retail water agencies by acting as program administrators for the region. MWDOC provides assistance on a variety of local programs including, but not limited to Water Loss Control and Management Program, Public Outreach, and Choice K-12 School Programs.

1 INTRODUCTION AND UWMP OVERVIEW

MWDOC prepared this 2020 UWMP to submit to the California Department of Water Resources (DWR) to satisfy the UWMP Act of 1983 (UWMP Act or Act) and subsequent California Water Code (Water Code) requirements. MWDOC is a wholesale water supplier that provides water to 28 water suppliers in Orange County using imported water supplies obtained from its regional wholesaler, Metropolitan Water District of Southern California (MET). MWDOC, as one of MET's 26 member agencies, has prepared this 2020 UWMP in collaboration with MET and its own member agencies.

UWMPs are comprehensive documents that present an evaluation of a water supplier's reliability over a long-term (20-25 year) horizon. In response to the changing climatic conditions and regulatory updates since the 2015 UWMP, MWDOC has been assisting its member agencies to manage both their water supplies and demands. The water loss audit program, water conservation measures, and efforts for increased self-reliance in order to reduce dependency on imported water from the Sacramento-San Joaquin Delta (the "Delta") are some of the water management actions that MWDOC has taken to maintain the reliability of water supply for its service area.

This 2020 UWMP provides an assessment of the present and future water supply sources and demands within the MWDOC's service area. It presents an update to the 2015 UWMP on the MWDOC's water resource needs, water use efficiency programs, water reliability assessment and strategies to mitigate water shortage conditions. It also presents a new 2020 Water Shortage Contingency Plan (WSCP) designed to prepare for and respond to water shortages. This 2020 UWMP contains all elements to meet compliance of the new requirements of the Act as amended since 2015.

1.1 Overview of Urban Water Management Plan Requirements

The UWMP Act enacted by California legislature requires every urban water supplier (Supplier) providing water for municipal purposes to more than 3,000 customers or supplying more than 3,000 acre-feet (AF) of water annually to prepare, adopt, and file an UWMP with the DWR every five years in the years ending in six and one.

For this 2020 UWMP cycle, DWR placed emphasis on achieving improvements for long term reliability and resilience to drought and climate change in California. Legislation related to water supply planning in California has evolved to address these issues, namely Making Conservation a Way of Life [Assembly Bill (AB) 1668 and Senate Bill (SB) 606] and Water Loss Performance Standards - SB 555. New UWMP requirements in 2020 are a direct result of these new water regulations. Two complementary components were added to the 2020 UWMP. First is the WSCP to assess the Supplier's near term 5-year drought risk assessment (DRA) and provide a structured guide for the Supplier to deal with water shortages. Second is the Annual Water Supply Demand Assessment (WSDA) to assess the current year plus one dry year i.e., short-term demand/supply outlook. Analyses over near- and long-term horizons together will provide a more complete picture of Supplier's reliability and will serve to inform appropriate actions it needs to take to build up capacity over the long term.

The various key new additions in the 2020 UWMP included as a result of the most recent water regulations are:

- **Water Shortage Contingency Plan (WSCP) –** WSCP helps a Supplier to better prepare for drought conditions and provides the steps and water use efficiency measures to be taken in times of water shortage conditions. WSCP now has more prescriptive elements, including an analysis of water supply reliability; the water use efficiency measures for each of the six standard water shortage levels that correspond to water shortage percentages ranging from 0 – 10 percent to greater than 50 pecrcent; an estimate of potential to close supply gap for each measure; protocols and procedures to communicate identified actions for any current or predicted water shortage conditions; procedures for an annual water supply and demand assessment; monitoring and reporting requirements to determine customer compliance; and reevaluation and improvement procedures for evaluating the WSCP.
- **Drought Risk Assessment –** Suppliers are now required to compare their total water use and supply projections and conduct a reliability assessment of all their sources for a consecutive five-year drought period beginning 2021.
- **Five Consecutive Dry-Year Water Reliability Assessment** - The three-year multiple dry year reliability assessment in previous UWMPs has now been extended from three to five consecutive dry years to include a more comprehensive assessment of the reliability of the water sources to improve preparedness of Suppliers for extended drought conditions.
- **Seismic Risk –** The UWMP now includes a seismic risk assessment of the water supply infrastructure and a plan to mitigate any seismic risks on the water supply assets.
- **Groundwater Supplies Coordination –** The UWMP should be in accordance with the Sustainable Groundwater Management Act of 2014 and consistent with the Groundwater Sustainability Plans (GSPs), wherever applicable.
- **Lay Description** – To provide a better understanding of the UWMP to the general public, a lay description of the UWMP is included, especially summarizing the Supplier's detailed water service reliability assessment and the planned management steps and actions to mitigate any possible shortage scenarios.

1.2 UWMP Organization

This UWMP is organized into 10 main sections aligned with the DWR Guidebook recommendations. The subsections are customized to tell MWDOC's story of water supply reliability and plans to overcome any water shortages over a planning horizon of the next 25 years.

Section 1 Introduction and UWMP Overview gives an overview of the UWMP fundamentals and briefly describes the new additional requirements passed by the Legislature for 2020 UWMP.

Section 2 UWMP Preparation identifies this UWMP as an individual planning effort of MWDOC, lists the type of year and units of measure used and introduces the coordination and outreach activities conducted by MWDOC to develop this UWMP.

Section 3 System Description gives a background on MWDOC and its climate characteristics, population projections, demographics, socioeconomics, and predominant current and projected land uses of its service area.

Section 4 Water Use Characterization provides historical, current, and projected water use by customer category for the next 25 years for MWDOC and the projection methodology used by MWDOC to develop the 25-year projections**.**

Section 5 Conservation Target Compliance reports data of the Orange County Regional Alliance, which is administered by MWDOC to track the SB X7-7 water use conservation target compliance of all the retail agencies in Orange County, i.e., the member agencies of MWDOC and the cities of Anaheim, Fullerton, and Santa Ana.

Section 6 Water Supply Characterization describes the current water supply portfolio of MWDOC as well as the planned and potential water supply projects and water exchange and transfer opportunities.

Section 7 Water Service Reliability and Drought Risk Assessment assesses the reliability of MWDOC's water supply service to its customers for a normal year, single dry year and five consecutive dry years scenarios. This section also includes a DRA of all the supply sources for a consecutive five-year drought period beginning 2021.

Section 8 Water Shortage Contingency Planning is a brief summary of the standalone WSCP document which provides a structured guide for MWDOC to deal with water shortages, incorporating prescriptive information and standardized action levels, lists the appropriate actions and water use efficiency measures to be taken to ensure water supply reliability in times of water shortage conditions, along with implementation actions in the event of a catastrophic supply interruption.

Section 9 Demand Management Measures provides a description of the MWDOC's current and planned measures and programs to help the retail customers in its service area comply with their SB X7-7 water use conservation targets.

Section 10 Plan Adoption, Submittal, and Implementation provides a record of the process MWDOC followed to adopt and implement its UWMP.

2 UWMP PREPARATION

MWDOC's 2020 UWMP is an individual UWMP for MWDOC to meet the California Water Code (Water Code) compliance as a wholesale water supplier. While MWDOC opted to prepare its own UWMP and meet Water Code compliance individually, the development of this UWMP involved close coordination with its member agencies, its wholesale supplier MET, along with other key entities within the region.

2.1 Individual Planning and Compliance

MWDOC opted to prepare its own UWMP (Table 2-1) and comply with the Water Code individually, while closely coordinating with MET and various key entities as discussed in Section 2.2 to ensure regional integration. The UWMP Checklist was completed to confirm the compliance of this UWMP with the Water Code (Appendix A). All of DWR standardized tables are provided in Appendix B.

Generally, MWDOC and the majority of its retail member agencies selected to report demands and supplies using fiscal year as the basis (Table 2-2).

Table 2-1: Plan Identification

<table>
<tr><th colspan="4">DWR Submittal Table 2-2: Plan Identification</th></tr>
<tr><th>Select Only One</th><th colspan="2">Type of Plan</th><th>Name of RUWMP or Regional Alliance</th></tr>
<tr><td>☑</td><td colspan="3">Individual UWMP</td></tr>
<tr><td rowspan="2"></td><td>☐</td><td>Water Supplier is also a member of a RUWMP</td><td></td></tr>
<tr><td>☑</td><td>Water Supplier is also a member of a Regional Alliance</td><td>Orange County 20x2020 Regional Alliance</td></tr>
<tr><td>☐</td><td colspan="2">Regional Urban Water Management Plan (RUWMP)</td><td></td></tr>
<tr><td colspan="4">NOTES:</td></tr>
</table>

Table 2-2: Supplier Identification

DWR Submittal Table 2-3: Supplier Identification	
Type of Supplier (select one or both)	
☑	Supplier is a wholesaler
☐	Supplier is a retailer
Fiscal or Calendar Year (select one)	
☐	UWMP Tables are in calendar years
☑	UWMP Tables are in fiscal years
If using fiscal years provide month and date that the fiscal year begins (mm/dd)	
7/1	
Units of measure used in UWMP *	
Unit	AF
**** Units of measure (AF, CCF, MG)*** *must remain consistent throughout the UWMP as reported in Table 2-3.*	
NOTES: The energy intensity data is reported in calendar year consistent with the Greenhouse Gas Protocol.	

2.2 Coordination and Outreach

2.2.1 Integration with Other Planning Efforts

MWDOC, as the wholesale water supplier, coordinated this UWMP preparation with other key entities, including MET (regional wholesaler for Southern California and the direct supplier of imported water to MWDOC), Orange County Water District (OCWD) (OC Groundwater Basin [OC Basin or “Basin 8-1”] manager and provider of recycled water in north OC), and retail water suppliers in OC which include MWDOC’s 28 member agencies and the three cities which are direct members of MET – Anaheim, Fullerton, and Santa Ana. MWDOC also coordinated with other entities which provided valuable data for the analyses prepared in this UWMP, such as the Center for Demographic Research (CDR) at California State University Fullerton for population projections.

Some of the key planning and reporting documents that were used to develop this UWMP are:

- **MET's 2020 Integrated Water Resources Plan (IRP)** (In progress) is a long-term planning document to ensure water supply availability in Southern California and provides a basis for water supply reliability in Orange County.
- **MET's 2020 UWMP** was developed as a part of the 2020 IRP planning process and was used by MWDOC as another basis for the projections of supply capability of the imported water received from MET.
- **MET's 2020 WSCP** provides a water supply availability assessment and guide for MET's intended actions during water shortage conditions, which determine MWDOC's shortage conditions.
- **MWDOC's 2020 WSCP** provides a water supply availability assessment and structured steps designed to respond to actual conditions that will help maintain reliable supplies and reduce the impacts of supply interruptions.
- **2021 OC Water Demand Forecast for MWDOC and OCWD Technical Memorandum (Demand Forecast TM)** provides the basis for water demand projections for the MWDOC's service area.
- **OCWD's Groundwater Reliability Plan (GRP)** (to be finalized after July 2021) provides the latest information on groundwater management and supply projection for the OC Basin, the primary source of groundwater for 19 retail water suppliers in OC.
- **OCWD's 2019-20 Engineer's Report** provides information on the groundwater conditions and basin utilization of the OC Basin.
- **2017 Basin 8-1 Alternative** is an alternative to the GSP for the OC Basin and provides significant information related to sustainable management of the basin in the past and hydrogeology of the basin, including groundwater quality and basin characteristics.
- **Hazard Mitigation Plan** provides the basis for the seismic risk analysis of the water system facilities.
- **Orange County Local Agency Formation Commission's 2020 Municipal Service Review for MWDOC Report** provides comprehensive review of the municipal services provided by MWDOC.
- **Water Master Plans and Sewer Master Plans** of the cities and counties serving within the MWDOC's service area provide information on water infrastructure planning projects and plans to address any required water system improvements.
- **Groundwater Management Plans** provide the groundwater sustainability goals for the basins in the MWDOC's service area and the programs, actions, and strategies activities that support those goals.

Statewide Water Planning

In addition to regional coordination with various agencies described above, MWDOC as a MET member agency is currently a part of MET's statewide planning effort to reduce reliance on the water imported from the Delta.

It is the policy of the State of California to reduce reliance on the Delta in meeting California's future water supply needs through a statewide strategy of investing in improved regional supplies, conservation, and water use efficiency. This policy is codified through the Delta Stewardship Council's Delta Plan Policy WR P1 and is measured through Supplier reporting in each Urban Water Management Planning cycle. WR P1 is relevant to water suppliers that plan to participate in multi-year water transfers, conveyance facilities, or new diversions in the Delta.

Through significant local and regional investment in water use efficiency, water recycling, advanced water technologies, local and regional water supply projects, and improved regional coordination of local and regional water supply efforts, MWDOC has demonstrated a reduction in Delta reliance and a subsequent improvement in regional self-reliance. For a detailed description and documentation of MWDOC's consistency with Delta Plan Policy WR P1 see Section 7.4 and Appendix C.

2.2.2 Wholesale and Retail Coordination

All MWDOC retail member agencies developed their UWMPs in conjunction with MWDOC's UWMP. Per the Water Code requirements to help its retail customers develop their own UWMPs, MWDOC facilitated the projections of the water demand by retail agency and supply that will be available from MWDOC over the next 25 years. Table 2-3 lists these retail water suppliers.

As the local wholesale supplier of imported water, MWDOC represents the interests of all but three OC retail water suppliers at MET and administers various regional programs and measures to help its retail customers meet various State requirement compliance, such as the OC Regional Alliance for SB x7-7 compliance, regional water loss program for SB 555 compliance, and regional water use efficiency programs. Sections 5 and 9 provide detailed information on these programs. While MWDOC assists retail member agencies in meeting requirements, the agencies also administer and operate their own programs to meet State requirement compliance, with more detail on these programs to be found in their respective UWMPs.

Table 2-3: Wholesale: Water Supplier Information Exchange

DWR Submittal Table 2-4 Wholesale: Water Supplier Information Exchange	
☑	Supplier has informed more than 10 other water suppliers of water supplies available in accordance with Water Code Section 10631. Completion of the table below is optional. If not completed, include a list of the water suppliers that were informed.
Section 3-2 (Page 3-5)	**Provide page number for location of the list.**
☐	Supplier has informed 10 or fewer other water suppliers of water supplies available in accordance with Water Code Section 10631. **Complete the table below.**
NOTES:	

2.2.3 Public Participation

For further coordination with other key agencies and to encourage public participation in the review and update of this Plan, MWDOC held a public hearing and notified key entities and the public per the Water Code requirements. Sections 10.2 and 10.3 describe these efforts in detail. In addition, due to the diverse population that MWDOC serves, there was a Spanish translator available at the public hearing to assist any members of the public wishing to participate in the public hearing process that may need that service.

3 SYSTEM DESCRIPTION

MWDOC was formed by Orange County voters in 1951 under the Municipal Water District Act of 1911 to provide imported water to inland areas of Orange County. Governed by an elected seven-member Board of Directors, MWDOC is MET's third largest member agency based on assessed valuation.

MWDOC is a regional water wholesaler and resource planning agency, managing all of OC's imported water supply except for water imported to the cities of Anaheim, Fullerton, and Santa Ana. MWDOC is committed to ensuring water reliability for more than 2.34 million residents in its 600-square-mile service area. To that end, MWDOC focuses on sound planning and appropriate investments in water supply, water use efficiency, regional delivery infrastructure, and emergency preparedness.

Lying in the South Coast Air Basin (SCAB), its climate is characterized by southern California's "Mediterranean" climate with mild winters, warm summers and moderate rainfall. In terms of land use, MWDOC's service area in the North OC is almost built out with predominantly residential units with pockets dedicated to commercial, institutional, governmental uses and open space and parks and the existing vacant lots in South OC are gradually transitioning to residential and commercial mixed-use areas. The current population of 2,342,740 is projected to increase by 8% over the next 25 years.

3.1 Agency Overview

This section provides information on the formation and history of MWDOC, its organizational structure, roles, and objectives.

3.1.1 Formation and Purpose

Orange County was settled around areas of surface water. San Juan Creek supplied the mission at San Juan Capistrano. The Santa Ana River supplied the early Cities of Anaheim and Santa Ana. The Santa Ana River also provided water to a large aquifer underlying the northern half of the county, enabling settlers to move away from the river's edge and still obtain water by drilling wells.

By the early 1900s, Orange County residents understood that their water supply was limited, the rivers and creeks did not flow all year long, and the aquifer would eventually be degraded or even dry up if the water was not replenished on a regular basis.

In 1928, the Cities of Anaheim, Santa Ana, and Fullerton joined with 10 other southern California cities to form MET. Their objective was to build an aqueduct from the Colorado River to provide the additional water necessary to sustain the growing southern California economy and its enviable lifestyle.

OCWD was formed in 1933 to protect the County's water rights on the Santa Ana River. Later that mission was expanded to manage the underground aquifer, optimizing use of local supplies and augmenting those with imported supplies provided through the MET's member agencies in Orange County.

It was not long before other parts of Orange County also saw the need for supplemental supplies. A severe drought in the late 1940s further emphasized this need for coastal communities from Newport Beach to San Clemente. In 1948, coastal communities from Newport Beach south to the San Diego county line formed the Coastal Municipal Water District as a way to join in the benefits provided by MET. Three years later, MWDOC was formed by Orange County voters in 1951 under the Municipal Water District Act of 1911 to provide imported water to inland areas of Orange County. To improve services and reduce cost, the Coastal Municipal Water District became a part of MWDOC in January 2001.

Today, MWDOC is MET's third largest member agency, providing and managing the imported water supplies used within its service area.

3.1.2 MWDOC Board of Directors

MWDOC is governed by an elected seven-member Board of Directors, with each board member elected from a specific area of the County and elected to a four-year term by voters who reside within that part of the MWDOC service area. The Board of Directors map is shown on Figure 3-1.

Each director is a member of at least one of the following standing committees: Planning and Operations; Administration and Finance; and Executive. Each committee meets monthly. The full Board convenes for its regular monthly meeting on the third Wednesday of the month and holds a Board workshop on MET issues the first Wednesday of the month.

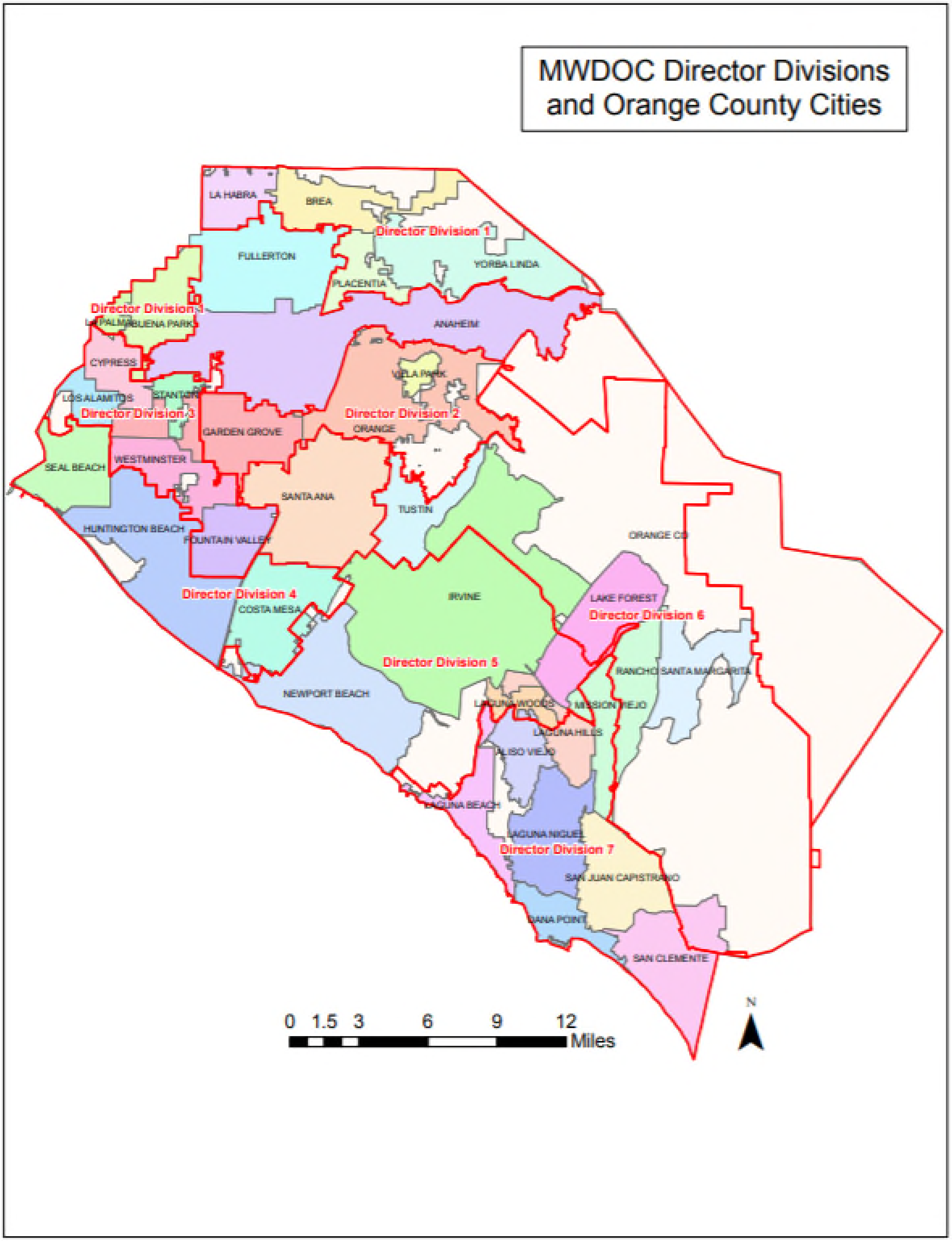


Figure 3-1: MWDOC Board of Directors Map, by Director Division

3.1.3 Relationship to MET

MWDOC became a member agency of MET in 1951 to bring supplemental imported water supplies to parts of Orange County. MET is a consortium of 26 cities and water agencies that provides supplemental water supplies to parts of Los Angeles, Orange, San Diego, Riverside, San Bernardino, and Ventura Counties. MET's two main sources of supply are the Colorado River and the Delta. Supplies from these sources are delivered to southern California via the Colorado River Aqueduct (CRA) and the State Water Project (SWP). MWDOC purchases imported water from these sources from MET and sells the water to its 28 member agencies, which provide retail water services to the public.

3.1.4 Goals and Objectives

MWDOC's Mission Statement is "*To provide reliable, high-quality supplies from Metropolitan Water District of Southern California and other sources to meet present and future needs, at an equitable and economical cost, and to promote water use efficiency for all of Orange County.*"

MWDOC's related water management goals and objectives are to:

- Represent the interests of the public within its jurisdiction;
- Appoint its representative directors to the Board of MET;
- Inform its directors and its retail agencies about MET issues;
- Collaborate with MET in its planning efforts and act as a resource of information and advocate for our retail agencies;
- Purchase water from MET and represent the interest of our service area at MET;
- Work together with Orange County water agencies and others to focus on solutions and priorities for improving Orange County's future water supply reliability;
- Cooperate with and assist OCWD and other agencies in coordinating the balanced use of the area's imported and native surface and groundwater;
- Plan and manage the allocation of imported water to its retail agencies during periods of shortage;
- Coordinate and facilitate the resolution of water issues and development of joint water projects among its retail agencies;
- Represent the public and assist its retail agencies in dealing with other governmental entities at the local, regional, state, and federal levels on water-related issues; and
- Inform its retail agencies and inform and educate the general public on matters affecting present and future water use and supply.

As a regional wholesaler, MWDOC has roles that are broadly applicable to all of its retail agencies. A key goal of MWDOC is to provide broad reaching services and programs at an economy-of-scale that the retail agencies cannot reasonably provide as single entities.

Since 1991, MWDOC has offered educational classes, water use surveys, and a variety of consumer incentives for indoor and outdoor water-efficient devices for all residents and businesses throughout Orange County. Through the program, MWDOC provides a wide variety of water saving rebates and programs to residential, commercial, industrial, and institutional customers. MWDOC's programs have resulted in the conservation of more than 17.1 billion gallons of water each year.

For nearly five decades, MWDOC's Water Education programs have reached millions of Orange County K-12 students. The programs are offered on behalf of and in coordination with MWDOC's retail agencies, designed to increase the public's understanding of current water issues and challenges, opportunities, and associated costs involved in securing a reliable supply of high-quality water. Additionally, as part of its multi-faceted public education effort, MWDOC sponsors the Orange County Boy Scout Council's Soil & Water Conservation Merit Badge and Orange County Girl Scouts Water Resources and Conservation Patch. These two programs, designed and hosted by MWDOC Public Affairs staff, are presented as hands-on educational clinics, reaching hundreds of children each year with impactful water-centric education.

MWDOC also develops and coordinates a substantial number of public information, education, and outreach programs and activities for adults to elevate stakeholders' awareness of current water issues that affect the region's water supply's health and reliability. These programs emphasize and encourage efficient water use and water-saving practices and offer insight into proposed policy and water reliability investments in the region's best interest.

3.2 Water Service Area

MWDOC serves more than 2.34 million residents in a 600-square-mile service area (Figure 3-2). Although MWDOC does not have its own water facilities and does not have jurisdiction over local supplies, it works to ensure the delivery of reliable water supplies to the region.

MWDOC serves imported water in Orange County to 28 water agencies. These entities, comprised of cities and water districts, are referred to as MWDOC member agencies and provide water to approximately 2.34 million customers. MWDOC retail agencies include:

- City of Brea
- City of Buena Park
- City of Fountain Valley
- City of Garden Grove
- City of Huntington Beach
- City of La Habra
- City of La Palma
- City of Newport Beach
- City of Orange
- City of San Clemente
- City of San Juan Capistrano
- East Orange County Water District (EOCWD)
- El Toro Water District (ETWD)
- Emerald Bay Services District (EBSD)
- Irvine Ranch Water District (IRWD)
- Golden State Water Company (GSWC)
- Laguna Beach County Water District (LBCWD)
- Mesa Water District (Mesa Water)
- Moulton Niguel Water District (MNWD)
- Orange County Water District (OCWD)
- Santa Margarita Water District (SMWD)
- Serrano Water District (Serrano)

- City of Seal Beach
- City of Tustin
- City of Westminster
- South Coast Water District (SCWD)
- Trabuco Canyon Water District (TCWD)
- Yorba Linda Water District (YLWD)

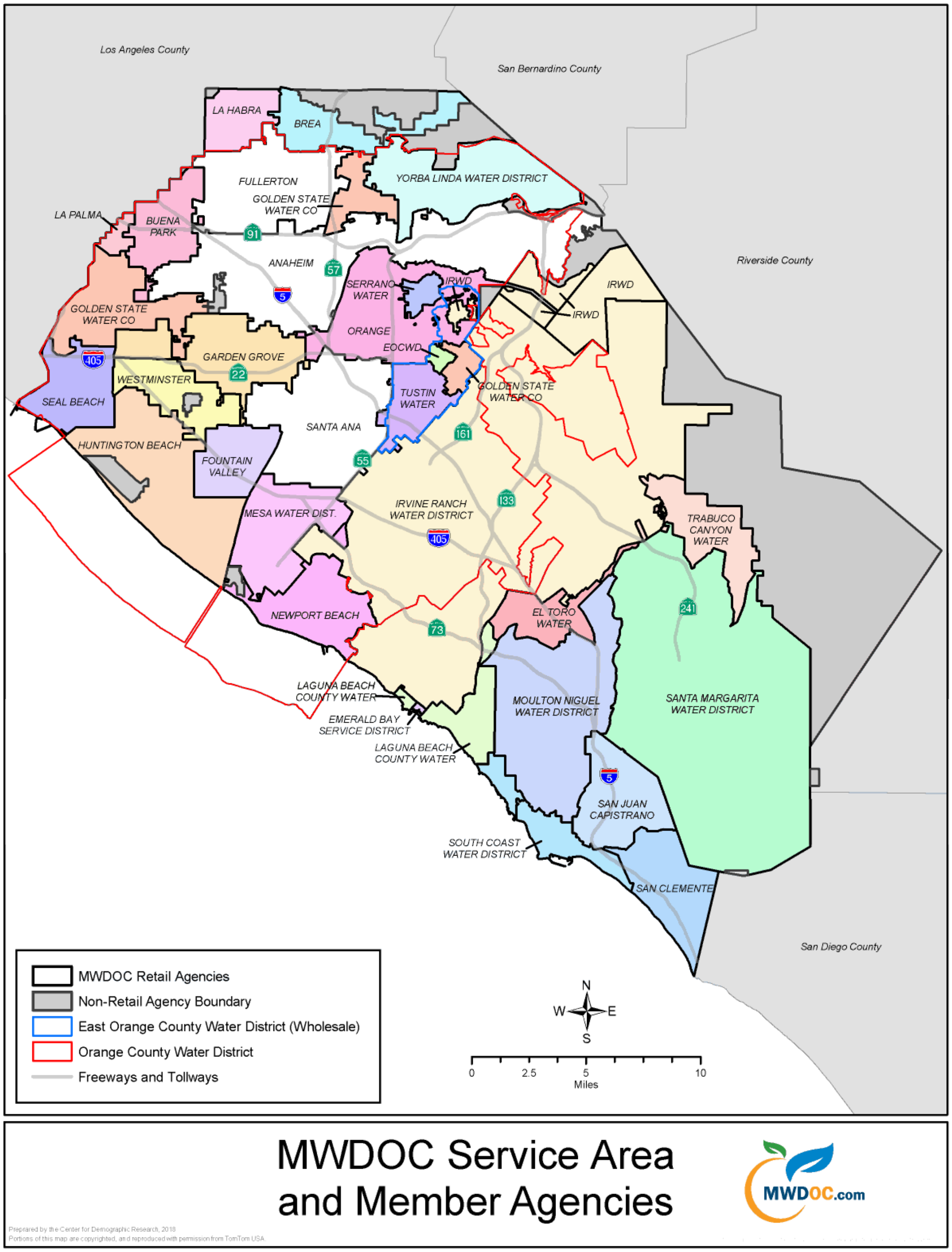


Figure 3-2: MWDOC's Water Service Area by Retail Agency

3.3 Climate

MWDOC's service area is located within the SCAB that encompasses all of OC, and the urban areas of Los Angeles, San Bernardino, and Riverside counties. The SCAB climate is characterized by southern California's "Mediterranean" climate: a semi-arid environment with mild winters, warm summers, and moderate rainfall.

Local rainfall and temperature greatly influence water usage in the service area. The biggest variation in annual water demand is due to changes in rainfall and temperature. In Orange County, the average daily temperatures range from 58.2 ˚F in December and January to 75.2 ˚F in August (Table 3-1). The average annual precipitation is 13.1 inches, although the region is subject to significant variations in annual precipitation (Table 3-2). The average evapotranspiration (ET_0) is above 40 inches per year (Table 3-3) which is greater than three times the annual average rainfall.

Table 3-1: OC 30-Year Average Temperature

Orange County 30-Year Average (1991-2020) Temperature													
Orange County Temperature (°F)	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**
Average Daily High Temperature	70.3	70.3	72.2	74.2	75.7	78.6	83.6	85.5	84.7	80.4	75.1	69.2	76.6
Average Daily Temperature	59.2	59.5	61.7	63.9	66.6	69.7	73.9	75.2	74.1	69.7	63.7	58.2	66.3
Average Daily Low Temperature	48.2	48.9	51.3	53.6	57.6	60.8	64.2	64.8	63.5	58.9	52.2	47.3	55.9
Source: NOAA Weather Station (Santa Ana Fire Station #135)													

Table 3-2: OC 30-Year Average Precipitation Orange County 30-Year Average Precipitation

Orange County 30-Year Average (1991-2020) Precipitation													
Orange County Average Precipitation (Inches)	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**
Central Orange County	3.1	3.2	1.8	0.7	0.3	0.1	0.0	0.0	0.1	0.6	0.8	2.3	13.1
Source: County of Orange Santa Ana Rainfall Station #121 (Santa Ana Crime Lab)													

Table 3-3: OC Evapotranspiration

Orange County Evapotranspiration													
Orange County ET_o	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**
Laguna Beach	2.2	2.7	3.4	3.8	4.6	4.6	4.9	4.9	4.4	3.4	2.4	2.0	43.3
Irvine	2.2	2.5	3.7	4.7	5.2	5.9	6.3	6.2	4.6	3.7	2.6	2.3	49.9
NOTE: ET_o values are from Model Water Efficient Landscape Ordinance, September 10, 2009, Appendix A: Reference ET_o Table													

Although service area demands are influenced by local rainfall and temperature, the imported water supply that MWDOC provides to its member agencies is not. It should also be noted that MET's core water supplies from the SWP and the CRA are largely influenced by climate conditions in northern California and the Colorado River Basin, respectively. Both regions have variable hydrologic conditions that can significantly impact MET's water supplies. This past decade we have seen dramatic swings in annual precipitation and temperatures on the SWP. In 2014, California saw the lowest ever "Table A" State Project Water Allocation of contract supplies and two years later in 2017, experienced the highest SWP allocation since 2006. In a similar way the Colorado River Basin also experienced annual swings in hydrology; however, the multi-year drought conditions due to record low precipitation has largely been mitigated through the large volume of water Basin States have been storing in Lake Mead to maintain the system.

3.4 Population, Demographics, and Socioeconomics

3.4.1 Service Area Population

MWDOC serves a 2020 population of 2,342,740 according to CDR. MWDOC's population is composed of the sum of its 28 member agencies populations. Overall, the population is projected to increase 8 percent by 2045. Table 3-4 shows the population projections in five-year increments out to the year 2045 within MWDOC's service area.

Table 3-4: Wholesale: Population - Current and Projected

DWR Submittal Table 3-1 Wholesale: Population - Current and Projected						
Population Served	2020	2025	2030	2035	2040	2045
	2,342,740	2,411,727	2,473,392	2,518,117	2,532,393	2,530,621
NOTES: Source - Center for Demographic Research at California State University, Fullerton, 2020						

3.4.2 Demographics and Socioeconomics

Generally, housing within MWDOC's service area is becoming denser with addition of new residential units. This is apparent in many of the cities located in the northern and central areas of MWDOC's service area. Whereas in South Orange County, the southern portion of MWDOC's service area, there still remains open land suitable for further development and growth. As shown below in Table 3-5, the total number of dwelling units in the MWDOC service area is expected to increase by 7.4 percent in the next 25 years from 870,800 in 2020 to 934,984 in 2045.

Table 3-5: MWDOC Service Area Dwelling Units by Type

MWDOC Service Area Dwelling Units by Type						
Dwelling Units	2020	2025	2030	2035	2040	2045
Total	**870,800**	**894,953**	**906,206**	**921,751**	**927,884**	**934,984**
Single Family	435,011	438,288	440,878	444,562	445,293	445,872
All Other*	435,789	456,665	465,328	477,189	482,591	489,112
Source: Center for Demographic Research at California State University, Fullerton, 2020 *Includes duplex, triplex, apartment, condo, townhouse, mobile home, etc. Yachts, houseboats, recreational vehicles, vans, etc. are included if is primary place of residence. Does not include group quartered units, cars, railroad box cars, etc.						

In addition to the types and proportions of dwelling units, various socio-economic factors such as age distribution, education levels, general health status, income and poverty levels affect MWDOC's water management and planning. Based on the U.S. Census Bureau's QuickFacts, OC has about 15.3 percent of population of 65 years and over, 21.7 percent under the age of 18 years and 5.8 percent under the age of 5 years. 85.5 percent of the OC's population with an age of more than 25 years has a minimum of high school graduate and 40.6 percent of this age group has at least a bachelor's degree.

3.4.3 CDR Projection Methodology

MWDOC contracts with CDR to update the historic population estimates for 2010 to the current year and provide an annual estimate of population served by each of its retail water suppliers within its service area. CDR uses geographic information system (GIS) mapping and data from the 2000 and 2010 U.S. Decennial Censuses, State Department of Finance (DOF) population estimates, and the CDR annual population estimates. These annual estimates incorporate annual revisions to the DOF annual population estimates, often for every year back to the most recent Decennial Census. As a result, all previous estimates were set aside and replaced with the most current set of annual estimates. Annexations and boundary changes for water suppliers are incorporated into these annual estimates.

In the summer of 2020, projections by water supplier for population and dwelling units by type were estimated using the 2018 Orange County Projections dataset. Growth for each of the five-year increments was allocated using GIS and a review of the traffic analysis zones (TAZ) with a 2019 aerial photo.
The growth was added to the 2020 estimates by water supplier.

3.5 Land Uses

3.5.1 Current Land Uses

Land use within the service area of MWDOC is primarily residential. Based on the zoning designation collected and aggregated by Southern California Association of Governments (SCAG) in 2018 the current land use within the MWDOC's service area can be categorized as follows:

- Single family residential – 23.6%
- Multi-family residential – 7.3%
- Agriculture – 1.6%
- Commercial – 5.6%
- Industrial – 4.1%
- Institutional/Governmental – 7.1%
- Open space and parks – 32.6%
- Other – 17.2% (e.g., Undevelopable or Protected Land, Water, and Vacant)
- No land use designations – 0.9%

3.5.2 Projected Land Uses

Land uses in North OC and South OC are both predominantly residential. North OC is substantially built out, with a majority residential land uses with some mixed-use areas dedicated to commercial, institutional, and governmental uses. Future developments planned in North OC are mainly redevelopment and infill projects. South OC has a greater potential for development, with vacant areas gradually transitioning to residential and commercial mixed-use areas.

Moving forward, the following requirements and changes in laws will impact the future land use in OC:

- **Regional Housing Needs Assessment (RHNA)** - State law requires jurisdictions to provide their share of the RHNA allocation. SCAG determines the housing growth needs by income for local jurisdictions through RHNA. The cities will continue planning to meet their RHNA allocation requirements.
- **Accessory Dwelling Units (ADUs)** – ADUs are separate small dwellings embedded within residential properties. There has been an increase in the construction of ADUs in California in response to the rise in interest to provide affordable housing supply. The Legislature updated the ADU law effective January 1, 2020 to clarify and improve various provisions to promote the development of ADUs. (AB-881, "Accessory dwelling units," and AB-68, "Land use: accessory dwelling units") These include:
    - allowing ADUs and Junior Accessory Dwelling Units (JADUs) to be built concurrently with a single-family dwelling. JADUs max size is 500 sf.
    - opening areas where ADUs can be created to include all zoning districts that allow single-family and multi-family uses
    - maximum size cannot be less than 850 sf for a one-bedroom ADU or 1,000 sf for more than one bedroom (California Department of Housing and Community Development, 2020)

About 92% of the ADUs in California are being built in the single-family zoned parcels (University of California Berkeley, 2020). The increase in ADUs implies an increase in number of people per dwelling unit which translates to higher water demand.

4 WATER USE CHARACTERIZATION

4.1 Water Use Overview

One of the main objectives of this UWMP is to provide an insight into MWDOC's service area's future water demands. This section describes MWDOC's service area's current and future water demands (direct and indirect), factors that influence demands, and the methodology used to forecast of future water demands over the next 25 years.

As shown in Figure 4-1 and Table 4-1, MWDOC's service area's total water use was 427,701AF in Fiscal Year (FY) 2019-20. MWDOC is the wholesale provider of imported water that provides treated and untreated water from MET for municipal and industrial (M&I) (direct uses) and non-M&I (indirect uses) within its service area. MWDOC member agencies also use water from various other sources, including the OC Basin (managed by OCWD) and other smaller groundwater basins such as the Main San Gabriel Basin. OC San and South Orange County Wastewater Authority (SOCWA) are the wastewater providers of North county and South county agencies, respectively. A few MWDOC member agencies produce their own recycled water.

4.2 Past and Current Water Use

As shown below, MWDOC's service area's retail M&I total water usage has consistently exceeded 400,000 AFY until recently (Figure 4-1). Since FY 2013-14, retail water usage (including recycled water) has begun to trend downward, and FY 2015-16 was the first year that water use dropped below 400,000 AF. Nevertheless, MWDOC's service area population has continued to grow over the past 30 years (Figure 4-1). This trend is likely due to large-scale water efficiency efforts undertaken by MWDOC and its member agencies.

Note that FYs 2011-12 to 2015-16 represent the driest five-consecutive year historic sequence for MWDOC's service area water supply. This period included the driest four-year statewide precipitation on record (2012-15) and the smallest Sierra-Cascades snowpack on record (2015, with 5 percent of average). It was marked by extraordinary heat: 2014, 2015 and 2016 were California's first, second and third warmest year in terms of statewide average temperatures. Locally, Orange County rainfall for the five-year period totaled 36 inches, the driest on record. As a result, State mandated conservation goals were issued to retail water agencies throughout the state with the aim of reducing statewide water use by 25% as compared to the FY 2013-14 baseline.

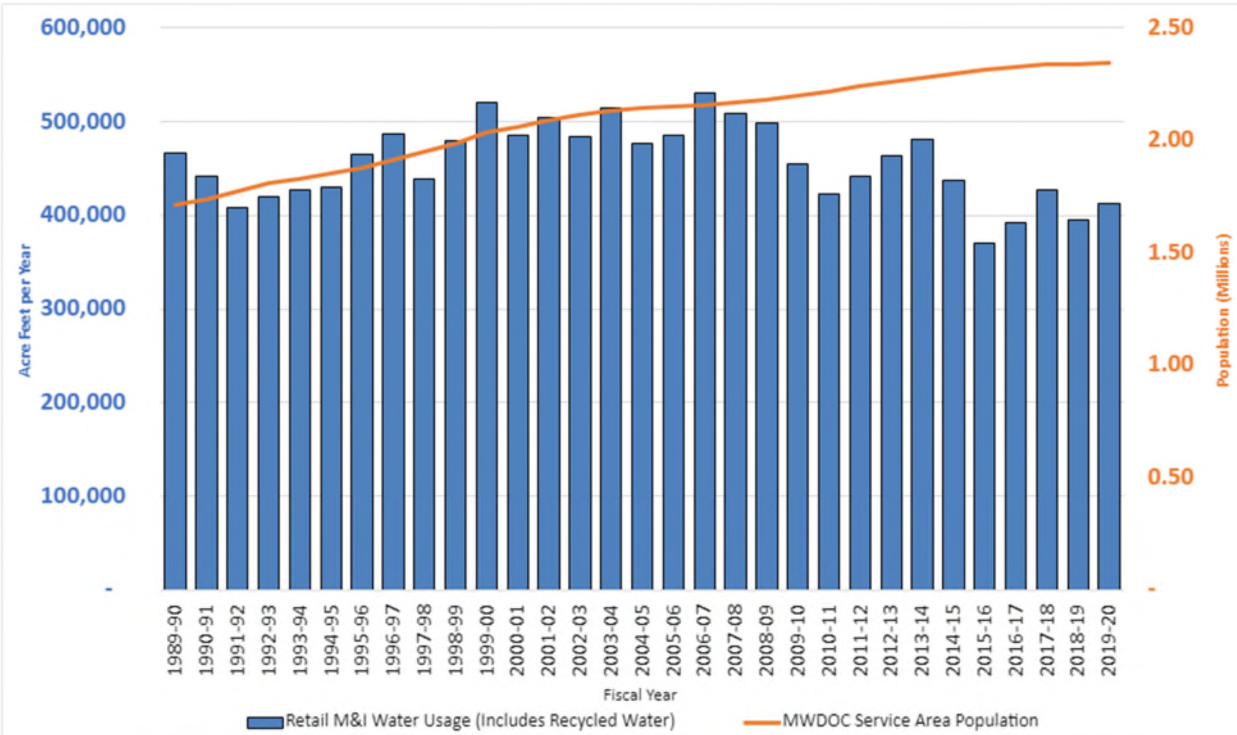


Figure 4-1: MWDOC's Service Area Historical Water Use and Population

Integrating M&I (direct) and non-M&I (indirect) usages of water in the planning process can be confusing and misleading and does not necessarily reflect the actual level of consumptive water demand in the region. In practice, the two types of water usage are often shown separately. Table 4-1 presents MWDOC's service area existing and future water use by source for these two types of uses separately. MWDOC's service area total water usage in FY 2019-20 was 427,701 AF; direct (M&I) usage accounted for 409,025 AF of that total (95.6%), while indirect (non M&I) uses accounted for the remainder (Table 4-1). The total usage was met through a combination of groundwater, imported water, surface water, and recycled water (Table 4-1**).** In FY 2019-20, about 45% of the total demand was met through OC Basin ground water.

Of note, while total water usage of all water sources is important to understand, MWDOC is the wholesale provider of only imported (untreated & treated) water from MET. In FY 2019-20, 161,555 AF of the total water demand was water from MET used for either direct or indirect uses (Table 4-2).

M&I treated and untreated imported water accounts for 33.4% of MWDOC's service area's total water use. 9.9% of total water use is recycled (non-potable) water that retail agencies use directly for M&I uses. Non M&I applications of MET water include groundwater replenishment (18,027 AF in FY 2019-20) and Irvine Lake fill (649 AF in FY 2019-20). Remaining contributions are detailed in Table 4-1.

Based on the Demand Forecast TM (Appendix H) methodology, MWDOC's service area's total water demands (by source) for the next 25 years are also shown in Table 4-1. By 2045, total water demand is projected to be 501,394 AF, a 17.2% increase (as compared to 2020 actuals). OC Basin groundwater is expected to continue providing a notable percentage of total water demand between 2020 and 2045 (roughly 47.1% in 2045).

Table 4-1: MWDOC's Service Area Existing and Future Water Use by Source

MWDOC Service Area Water Supply Projections (AF)						
Water Source	**2020**	**2025**	**2030**	**2035**	**2040**	**2045**
OCWD Basin GW[1]	192,652	231,936	236,430	236,506	236,280	236,274
Non-OCWD GW[1]	21,267	22,734	24,747	24,763	24,740	24,890
Recycled Water[1]	42,330	52,017	53,891	56,926	57,043	57,094
Surface Water[1]	9,897	4,700	4,700	4,700	4,700	4,700
MET (Retail M&I)[2]	142,879	119,743	120,573	123,502	123,107	122,819
Total M&I Demand	**409,025**	**431,130**	**440,341**	**446,397**	**445,870**	**445,777**
MET Irvine Lake Fill (Non-M&I)[2]	649	4,017	4,017	4,017	4,017	4,017
MET GW Replenishment (Non-M&I)[2,3]	18,027	51,600	51,600	51,600	51,600	51,600
Total non- M&I Demand	**18,676**	**55,617**	**55,617**	**55,617**	**55,617**	**55,617**
Total Water Demand	**427,701**	**486,747**	**495,958**	**502,014**	**501,487**	**501,394**

NOTES:
[1] Agency usage from various sources including OC Basin (managed by OCWD) and other smaller groundwater basins. OCWD and South Orange County Wastewater Authority (SOCWA) are the wastewater providers of North county and South county agencies, respectively. A few MWDOC member agencies produce their own recycled water.

[2] MWDOC is the wholesale provider of imported water that provides treated and untreated water from MET for M&I (direct) and non-M&I (indirect) uses within its service area.

[3] Includes indirect use which are Cyclic Program, Groundwater replenishment, and seawater barrier water.

MWDOC's wholesale demands for potable and non-potable water in 2020 totaled 161,555 AF (Table 4-2). Sales to agencies (treated and untreated imported water) comprised 88.4% of the total volume. Untreated imported water for groundwater recharge comprised 11.2%, and untreated import water for surface storage comprised 0.4% (Table 4-2). This table only includes water (potable and non-potable) that is purchased from MET and sold by MWDOC to their retail agencies and OCWD.

Table 4-2 Wholesale: Demands for Potable and Non-Potable Water – Actual

DWR Submittal Table 4-1 Wholesale: Demands for Potable and Non-Potable Water - Actual			
Use Type	2020 Actual		
	Additional Description	Level of Treatment When Delivered	Volume (AF)*
Sales to other agencies	MWD Treated and Untreated Imported Water	Drinking Water	142,879
Groundwater recharge	Untreated Import Water for Groundwater Recharge + Sea Water Barrier	Raw Water	18,027
Other Potable	Untreated Import Water for Surface Storage	Raw Water	649
		TOTAL:	161,555
**** Units of measure (AF, CCF, MG)*** *must remain consistent throughout the UWMP as reported in Table 2-3.*			
NOTES:			

4.2.1 Direct (M&I) Use – Municipal/Industrial and Agricultural Demands

Direct water use in Orange County includes municipal, industrial, and agricultural use. It represents, based on a 10-year average, approximately 81 percent of MWDOC's service area total demands. Demands for direct use are met through imported water (treated and untreated), groundwater, local surface water, and recycled water. M&I demands represent the full spectrum of water use within a region, including residential and commercial, industrial, institutional (CII), as well as un-metered uses (e.g., hydrant flushing, fire-fighting). Agricultural demands represent less than 1 percent of the total direct use. It has significantly decreased over the years due to development and urban growth within the service area.

4.2.2 Indirect (non-M&I) Use – Replenishment/Barrier and Surface Water Demands

Indirect water use in Orange County includes water to replenish groundwater basins and to serve as a barrier against seawater intrusion. It represents, based on a 10-year average, 19 percent of MWDOC's total demands. Most, if not all of the indirect water use delivered is for managing and replenishing the OC Basin. This water is purchased by OCWD, a special district created by the state and governed by a ten-member Board of Directors to protect, manage, and replenish the OC Basin with purchased imported water, storm water, and recycled water. OCWD further protects the groundwater basin from seawater intrusion through the injection of imported and recycled water along the coast, known as the Talbert Injection Barrier.

Since demands for replenishment of the groundwater basin storage and seawater barriers are driven by the availability of local supplies to OCWD, the demand forecast for this type of use is based on the projection of the following supplies under normal conditions:

- Santa Ana River Flows (Base flows & Storm flows);
- Incidental Recharge;
- Imported supplies from MET; and
- Recycled supplies for replenishment & seawater barrier use.

In addition to Replenishment and Barrier demands, MWDOC also provides imported water to meet the needs of surface water demands, such as those that occurs with respect to Irvine Lake. The water delivered to Irvine Lake is used for both consumptive purposes and water storage. Imported water delivered into Irvine Lake can be held for short or long periods of time to be later delivered for consumptive use. Based on a 10-year average, surface water supplies total 4,000 acre-feet per year (AFY) in Irvine Lake.

Figure 4-2 shows the historical demand of imported water for indirect consumption in MWDOC's service area. Since 2011, groundwater replenishment comprised much of the indirect water demands.
In FY 2019-20, this trend changed due to lower demands for groundwater, and thereby replenishment, primarily due to contamination of the groundwater basin from PFAS. In FY 2017-18, total demand for indirect imported water was higher than average due to an increase in in-lieu water deliveries because of the significant amount of imported water MET received due to the historical amounts of rainfall/snowfall in Northern California.

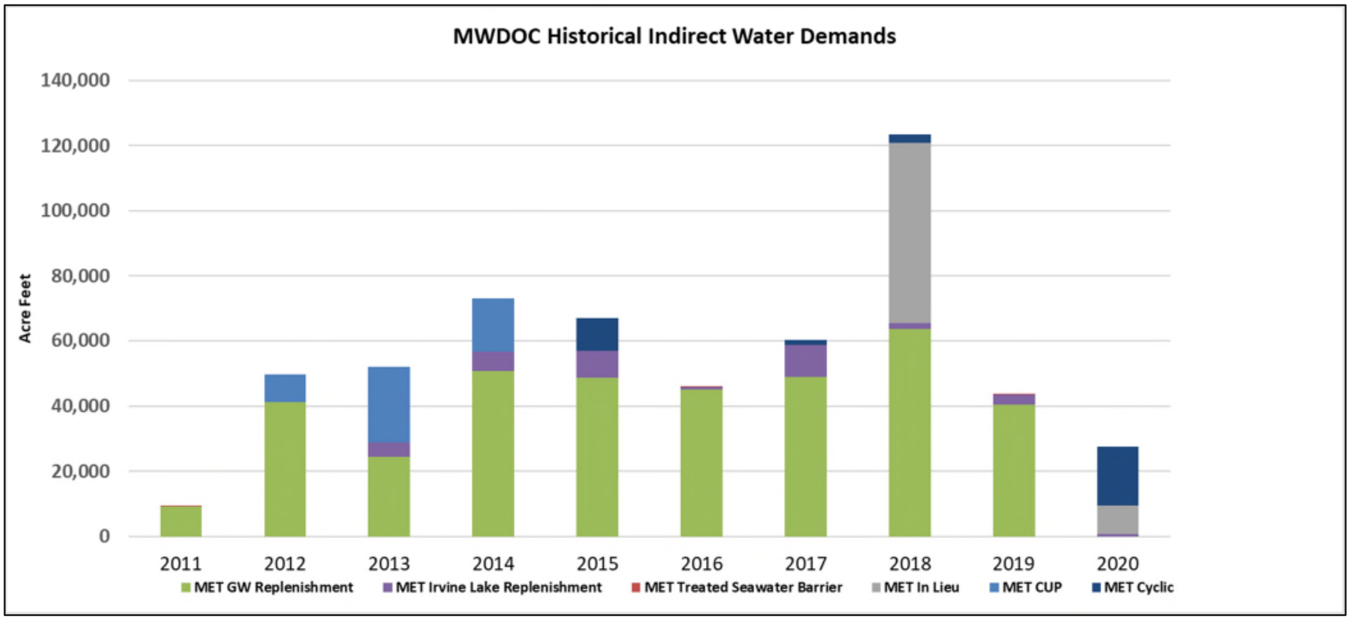


Figure 4-2: MWDOC's Historical Imported Water Use for Indirect Consumption

4.3 Water Use Projections

4.3.1 Water Use Projection Methodology

In 2021, MWDOC and OCWD, in collaboration with their member agencies, led the effort to update water demand projections originally done as part of the 2021 OC Water Demand Forecast for MWDOC and OCWD. The updated demand projections, prepared by CDM Smith, were for the Orange County region as a whole, and provided retail agency specific demands. The projections span the years of 2025-2050 and are based upon information surveyed from each Orange County water agency. Appendix H presents details of the projection methodology.

The forecast methodology began with a retail water agency survey that asked for FY 2017-18, FY 2018-19 and FY 2019-20 water use by major sector, including number of accounts. If a member agency provided recycled water to customers that information was also requested. Given that FY 2017-18 was a slightly above-normal demand year (warmer/drier than average) and FY 2018-19 was a slightly below-normal demand year (cooler/wetter than average), water use from these two years were averaged to represent an average-year base water demand.

For the residential sectors (single-family and multifamily) the base year water demand was divided by households in order to get a total per unit water use (gallons per home per day). In order to split household water use into indoor and outdoor uses, three sources of information were used, along with CDM Smith's expertise. The sources of information included: (1) *the Residential End Uses of Water* (Water Research Foundation, 2016); (2) California's plumbing codes and landscape ordinances; and (3) CA DWR's Model Water Efficient Landscape Ordinance (MWELO) calculator.

Three different periods of residential end uses of water were analyzed as follows:

- **Pre-2010 efficiency levels** – Has an average indoor water use that is considered to be moderately efficient, also does not include the most recent requirements for MWELO.
- **High-efficiency levels** – Includes the most recent plumbing codes that are considered to be highly efficient, and also includes the most recent requirements for MWELO.
- **Current average efficiency levels** – Represents the weighted average between pre-2010 efficiency and high efficiency levels, based on average age of homes for each retail water agency.

For outdoor residential water use, the indoor per capita total was multiplied by each member agency-specific persons per household in order to get an indoor residential household water use (gallons per day per home), and then was subtracted from the base year total household water use for single-family and multifamily for each agency based on actual water use as reported by the agency surveys.

For existing residential homes, the current average indoor and outdoor water use for each member agency were used for the year 2020. It was assumed that indoor water uses would reach the high efficiency level by 2040. Based on current age of homes, replacement/remodeling rates, and water utility rebate programs it is believed this assumption is very achievable. It was also assumed that current outdoor water use would be reduced by 5% by 2050.

For new homes, the indoor high efficiency level was assumed for the years 2025 through 2050. Outdoor uses for new homes were assumed to be 25% and 30% lower than current household water use for single-family and multifamily homes, respectively. This methodology is illustrated in Figure 4-3 below.

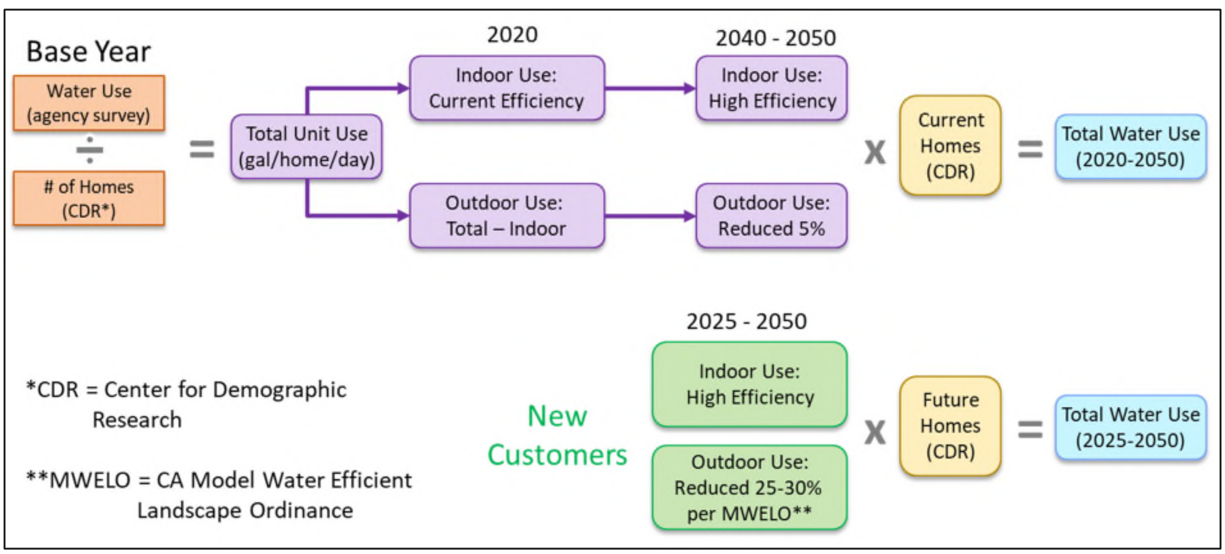


Figure 4-3 Water Use Projection Methodology Diagram

Existing and projected population, single-family and multifamily households for each retail water agency were provided by CDR under contract by MWDOC and OCWD. CDR provides historical and future demographics by census tracts for all of Orange County (Section 3.4). Census tract data is then clipped to retail water agency service boundaries in order to produce historical and projected demographic data by agency.

For the CII water demands, which have been fairly stable from a unit use perspective (gallons/account/day), it was assumed that the unit demand in FY 2019-20 would remain the same from 2020-2025 to represent COVID-19 impacts. Reviewing agency water use data from FY 2017-18 through FY2019-20 revealed that residential water use increased slightly in FY 2019-20 while CII demands decreased slightly as a result of COVID-19. From 2030 to 2050, the average CII unit use from FY 2017-18 and 2018-19 was used. These unit use factors were then multiplied by an assumed growth of CII accounts under three broad scenarios:

- Low Scenario – assuming no growth in CII accounts
- Mid Scenario – assuming 0.5% annual growth in CII accounts
- High Scenario – assuming 1.5% annual growth in CII accounts

For most retail agencies, the Mid Scenario of CII account growth was used, but for those retail agencies that have had faster historical growth the High Scenario was used. For those retail agencies that have had relatively stable CII water demand, the Low Scenario was used.

For those agencies that supply recycled water for non-potable demands, we used agency-specified growth assumptions. Most agencies have already maximized their recycled water and thus are not expecting for this category of demand to grow. However, a few agencies in South Orange County do expect moderate growth in recycled water customers.

For large landscape customers served currently by potable water use, we assumed these demands to be constant through 2050, except for agencies that have growing recycled water demands. For the agencies that have growing recycled water demands, large landscape demands served by potable water were reduced accordingly. For non-revenue water, which represents the difference in total water production less all water billed to customers, this percentage constant through 2050.

A member agency's water use demand projection is the summation of their residential water demand, CII demands, large landscape and recycled water demands, and water losses all projected over the 25-year time horizon. These demands were provided to each of the Orange County water agencies for their review, feedback, and revision before being finalized.

The MWDOC regional water demand projection was collaboratively developed between MWDOC and its member agencies. This collaboration involved the projection model developed by CDM Smith as well as specific assumptions provided by MWDOC's member agencies. There were also some specific retail agency projections that were utilized in the MWDOC regional demand projections. Each MWDOC Member Agency water demand projections, analyses, methodologies, and assumptions can be found in their respective UWMPs.

4.3.1.1 Weather Variability and Long-Term Climate Change Impacts

In any given year water demands can vary substantially due to weather. In addition, long-term climate change can have an impact on water demands into the future. For the 2014 OC Water Reliability Study, CDM Smith developed a statistical model of total water monthly production from 1990 to 2014 from a sample of retail water agencies. This model removed impacts from population growth, the economy and drought restrictions in order to estimate the impact on water use from temperature and precipitation.

The results of this statistical analysis are:

- Hot/dry weather demands will be 5.5% greater than current average weather demands
- Cooler/wet weather demands will be 6% lower than current average weather demands
- Climate change impacts will increase current average weather demands by:
    - 2% in 2030
    - 4% in 2040
    - 6% in 2050

4.3.2 25-Year Water Use Projection

4.3.2.1 Water Use Projections for 2021-2025

Total demands (direct and indirect) are met through imported water (treated and untreated), groundwater, local surface water, and recycled water. MWDOC utilizes total demands to incorporate the best available planning information when projecting the imported water demands of its service area. As shown in Table 4-3 below, MWDOC's total service area water demands are expected to gradually increase in the first three years (2021 to 2023) due to projected growth in the service area's M&I demands; however, the bulk of the increase in demands are projected in the last two years, as a result of indirect imported demands for groundwater replenishment returning in the years 2024 and 2025.

The current regulatory impacts of PFAS in the OC Basin has reduced the need for purchasing any imported groundwater replenishment water, due to reductions in groundwater pumping. This is expected to last over the next three years (2021 to 2023), under normal hydrological conditions. However, with groundwater treatment anticipated to be online for a number of retail agencies in the years 2023 and 2024, groundwater production is expected to increase. Thus, OCWD estimates a gradual need of imported replenishment water in years 2024 and 2025. With the final expansion of OCWD's Groundwater Replenishment System (GWRS) online in 2023, the future need of imported replenishment water is expected to average 51,600 AF per year.

Table 4-3: MWDOC's Service Area Total Potable and Non-Potable Demand Projections for 2021-2025

Total Water Demand					
Fiscal Year Ending	2021	2022	2023	2024	2025
Total Water Demand (AF)	431,539	435,377	439,215	461,948	486,747
NOTES: This assumes no replenishment water in 2021, 2022, and 2023 due impacts from PFAS.					

4.3.2.2 Water Use Projections for 2025-2045

Under normal conditions, total direct and indirect water demands are projected to increase to 501,394 AF by the year 2045, an increase of about 3% between 2025 and 2045 (Table 4-4). This demand projection comes from MWDOC's Demand Forecast TM update done in 2021, that considered such factors as current and future demographics, future conservation measures, and ground & surface water needs. Section 4.3.1 offers a description of the methodology used to calculated MWDOC's demand projections.

Table 4-4: MWDOC's Service Area Total Potable and Non-Potable Demand Projections for 2025-2045

Total Water Demand					
Fiscal Year Ending	2025	2030	2035	2040	2045
Total Water Demand (AF)	486,747	495,958	502,014	501,487	501,394
NOTES:					

Table 4-5 presents 2025-2045 demand projections for water (potable and non-potable) that is purchased from MET and sold by MWDOC to their retail agencies and OCWD. Projections for groundwater recharge and other potable uses (i.e., Irvine Lake fill) are expected to remain constant between 2025 and 2045. Sales to other agencies is expected to rise by about 2.5% (comparing 2025 values to 2045 values).

Table 4-5: Wholesale: Use for Potable and Raw Water – Projected

DWR Submittal Table 4-2 Wholesale: Use for Potable and Raw Water - Projected						
Use Type	Additional Description	Projected Water Use (AF) *				
		2025	2030	2035	2040	2045 (opt)
Sales to other agencies	MWD (Retail M&I)	119,743	120,573	123,502	123,107	122,819
Groundwater recharge	MWD GW Replenishment (Non-M&I)	51,600	51,600	51,600	51,600	51,600
Other Potable	MWD Irvine Lake Fill (Non-M&I)	4,017	4,017	4,017	4,017	4,017
	TOTAL:	175,360	176,190	179,119	178,724	178,436
**** Units of measure (AF, CCF, MG)** must remain consistent throughout the UWMP as reported in Table 2-3.*						
NOTES:						

A comparison of actual (2020) and projected (2025-2045) wholesale total water use is presented in Table 4-6 below.

Table 4-6: Wholesale: Total Water Use (Potable and Non-Potable)

DWR Submittal Table 4-3 Wholesale: Total Water Use (Potable and Non-Potable)						
	2020	2025	2030	2035	2040	2045 (opt)
Potable and Raw Water From Tables 4-1W and 4-2W	161,555	175,360	176,190	179,119	178,724	178,436
Recycled Water Demand* From Table 6-4W	0	0	0	0	0	0
TOTAL WATER DEMAND:	161,555	175,360	176,190	179,119	178,724	178,436
NOTES: Volumes in AF.						

4.4 Water Loss

MWDOC is a recognized industry leader in Water Loss programs and activities. While MWDOC does not own or operate any transmission or distribution system themselves, MWDOC helps member agencies evaluate and reduce their distribution systems' real and apparent losses through comprehensive Water Loss Control Programs. In 2015, the MWDOC Board of Directors authorized staff to begin implementing a Water Loss Control Technical Assistance Program (TAP) to support member agency compliance with Senate Bills 1420 and 555, both of which address distribution system Water Loss. The TAP program established a menu of technical assistance that water retailers can elect to participate in. These programs connect water retailers with industry experts who provide one on one technical assistance through data analysis, agency specific advising, and assessment. The TAP services offered by MWDOC include Water Balance Compilation, Component Analysis of Real and Apparent Losses, Source/Production Meter Accuracy Testing, Billing Data Chain Assessment, and Internal Water Loss Committee Planning. MWDOC's Water Loss Control TAP has a very positive impact on building knowledge of water loss recovery strategies by all retail water agencies in the County and implementation of those strategies. To date MWDOC has hosted 30 Water Loss Work Group Meetings with approximately 35 agency representatives' attending each meeting. A total of 137 Annual Water Balances have been compiled and validated over the last five years, vastly improving water agency understanding of volumes of real and apparent losses, strategies to recovery losses and value of losses.

Due to the success of the TAP program, MWDOC began to consider other services that would assist in controlling water loss. In 2019, the MWDOC Board authorized the implementation of a Water Loss Control Shared Services Business Plan (Business Plan) based on the needs outlined in the survey and the direction of the Water Loss Control Performance Standards currently in development. Services provided under the program available to MWDOC member agencies include Water Balance Validation, Customer Meter Accuracy Testing, Distribution System Pressure Surveys, Distribution System Leak

Detection, Suspected Leak Investigations, and No Discharge Distribution System Flushing (No-DES). Since the start of the shared services program in August 2019, more than 780 miles of distribution system leak detection has been completed, which resulted in discovery of 373 hidden leaks that have been repaired or are in the process of being repaired. These leak repairs result in recovering more than 84.5 million gallons of water valued at more than $300,000 per year. A total of 1,439 water meter accuracy tests have been completed by 6 agencies improving agency knowledge of meter performance and accuracy of water balance results. A total of thirty-two sites have been monitored during pressure surveys for three agencies that were used to calculate average system pressure, calibrate hydraulic models and investigate pressure anomalies. And lastly, 12 miles of distribution system mains have been flushed resulting in improved water quality for consumers and recovery of 176,200 gallons of water that was filtered and returned to the distribution system for beneficial use.

5 CONSERVATION TARGET COMPLIANCE

The Water Conservation Act of 2009, also known as SBx7-7 (Senate Bill 7 as part of the Seventh Extraordinary Session), signed into law on February 3, 2010, requires the State of California to reduce urban water use by 20 percent by the year 2020 (20x2020). To achieve this each retail urban water supplier must determine baseline water use during their baseline period and target water use for the years 2015 and 2020 to meet the state's water reduction goal. Retail water suppliers are required to comply with SBx7-7 individually or as a region in collaboration with other retail water suppliers, or demonstrate they have a plan or have secured funding to be in compliance, in order to be eligible for water related state grants and loans on or after July 16, 2016.

As a wholesale water supplier, MWDOC is not required to establish a baseline or set targets for daily per capita water use. However, it is required to provide an assessment of its present and proposed future measures, programs and policies that will help its retail water suppliers achieve their SBx7-7 water use reduction targets. One of the ways MWDOC is assisting its retail agencies is by leading the coordination of Orange County Regional Alliance for all of the retail agencies in Orange County. MWDOC's role is to assist each retail water supplier in Orange County in analyzing the requirements and establishing their baseline and target water use, as guided by DWR.

The following sections describe the efforts by MWDOC to assist retail agencies in complying with the requirements of SBx7-7, including the formation of a Regional Alliance to provide additional flexibility to all water suppliers in Orange County. This section also includes the documentation of calculations that allow retail water suppliers to use recycled water for groundwater recharge (indirect reuse) to offset a portion of their potable demand when meeting the regional as well as individual water use targets for compliance purposes. A discussion of programs implemented to support retail agencies in achieving their per capita water reduction goals is covered in Section 9 – Demand Management Measures of this UWMP.

5.1 Orange County 20x2020 Regional Alliance

MWDOC in collaboration with all of its retail agencies as well as the Cities of Anaheim, Fullerton, and Santa Ana, has created the Orange County 20x2020 Regional Alliance in an effort to create flexibility in meeting the daily per capita water use targets. This Regional Alliance allows all of Orange County to benefit from regional investments, such as the GWRS, recycled water, and water conservation programs. The members of the Orange County 20x2020 Regional Alliance are shown in Table 5-1.

Table 5-1: Members of Orange County 20x2020 Regional Alliance

Orange County 20x2020 Regional Alliance	
Anaheim	MNWD
Brea	Newport Beach
Buena Park	Orange
EOCWD	San Clemente
ETWD	San Juan Capistrano
Fountain Valley	Santa Ana
Fullerton	Santa Margarita Water District
Garden Grove	Seal Beach
GSWC	Serrano
Huntington Beach	SCWD
IRWD	TCWD
La Habra	Tustin
La Palma	Westminster
LBCWD	YLWD
Mesa Water	

Within a Regional Alliance, each retail water supplier will have an additional opportunity to achieve compliance under either an individual target or a regional water use target.

- If the Regional Alliance meets its water use target on a regional basis, all agencies in the alliance are deemed compliant.
- If the Regional Alliance fails to meet its water use target, each individual supplier will have an opportunity to meet their water use targets individually.

Individual water suppliers in the Orange County 20x2020 Regional Alliance will state their participation in the alliance and include the regional 2015 and 2020 water use targets in their individual UWMPs.

As the reporting agency for the Orange County 20x2020 Regional Alliance, MWDOC has documented the calculations for the regional urban water use reduction targets. MWDOC will also provide annual monitoring and reporting for the region on progress toward the regional per capita water use reduction targets.

5.2 Water Use Target Calculations

To preserve maximum flexibility in the Orange County 20x2020 Regional Alliance, each water supplier in the Regional Alliance first calculates its individual target in its retail UWMP as if it were complying individually. Then, the individual targets are weighted by each supplier's population and averaged over all members in the alliance to determine the regional water use target.

5.2.1 Retail Agency Compliance Targets

As described above, the first step in calculating a regional water use target is to determine each water supplier's individual target. DWR has established four target options for urban retail water suppliers to choose from in calculating their water use reduction targets under SBx7-7. The four options are as follows:

- *Option 1* requires a simple 20 percent reduction from the baseline by 2020 and 10 percent by 2015.
- *Option 2* employs a budget-based approach by requiring an agency to achieve a performance standard based on three metrics
    - Residential indoor water use of 55 gallons per capita per day (GPCD)
    - Landscape water use commensurate with the Model Landscape Ordinance
    - 10 percent reduction in baseline CII water use
- *Option 3* is to achieve 95 percent of the applicable state hydrologic region target as set forth in the State's 20x2020 Water Conservation Plan.
- *Option 4* requires the subtraction of Total Savings from the baseline GPCD:
    - Total savings includes indoor residential savings, meter savings, CII savings, and landscape and water loss savings.

MWDOC has analyzed each of these options and has worked with all retail agencies in Orange County to assist them in selecting the most suitable option in 2010 and 2015. In 2015, retail water agencies may update their 2020 water use target using a different target method than was used in 2010. However, the target method is not permitted to change after the 2015 UWMP is submitted with the exception of having changes to the distribution service area.

5.2.2 Regional Targets Calculation and 2020 Compliance

The regional water use targets for the Orange County 20x2020 Regional Alliance are calculated by weighting the individual retail agency water use targets by population and averaging them over all members of the alliance (Appendix B1). The calculation of the baseline water use and water use targets in the 2010 UWMP was based on the 2000 U.S. Census population numbers obtained from CDR. In 2015, the baseline water use and water use targets for all retail agencies have been revised using population numbers based on the 2010 U.S. Census obtained from CDR in 2012.

The regional alliance target calculation is provided below in Table 5-2. Column (1) and (2) show the 2015 and 2020 population for each individual supplier. The individual targets, including appropriate deductions for recycled water, for each supplier is provided in column (3) for the 2015 interim targets, and column (4) for the 2020 final targets.

To calculate the weighted averages for each retail water supplier, the population is multiplied by the individual targets to get a weighted total for each individual supplier. This is found in column (3) for the 2015 interim targets and in column (5) for the 2020 final targets. The regional targets for the Orange County 20x2020 Regional Alliance are then derived as the sum of the individual weighted averages divided by the total population for a regional alliance.

For example, the 2020 water use target for the City of Brea is 221 GPCD, and the 2020 population is 45,317. By multiplying this 2020 target by the population, the result is a weighted average of 10,003,978. The sum of the weighted averages for all members of the Orange County 20x2020 Regional Alliance is 505,077,088. By dividing this weighted total by the regional population of 3,185,461, the resulting regional 2020 water use target is 159 GPCD.

The source of the information in Table 5-2, including the population figures, is from within the individual 2020 UWMPs for each water supplier in the Orange County 20x2020 Regional Alliance.

Table 5-2: Calculation of Regional Urban Water Use Targets for Orange County 20x2020 Regional Alliance

Calculation of Regional Compliance Daily Per Capita Water Use						
Orange County 20x2020 Regional Alliance	(1) 2015 Population	(2) 2020 Population	(3) Individual Targets 2015	(4) Weighted Total 2015	(5) Individual Targets 2020	(6) Weighted Total 2020
Brea	42,943	45,317	248	10,664,892	221	10,003,978
Buena Park	82,495	82,023	178	14,687,524	158	12,980,878
EOCWD RZ	3,252	3,210	261	850,233	232	746,002
ETWD	48,579	47,911	183	8,905,378	163	7,807,042
Fountain Valley	57,768	56,747	157	9,049,547	142	8,032,538
Garden Grove	176,666	176,635	152	26,922,535	142	25,002,684
GSWC	169,213	168,108	157	26,567,284	142	23,795,687
Huntington Beach	197,787	201,327	151	29,937,195	142	28,497,837
IRWD	378,245	418,163	192	72,503,652	170	71,249,163
La Habra	61,913	61,923	151	9,353,551	150	9,304,086
La Palma	15,921	15,567	149	2,371,281	140	2,179,079

Calculation of Regional Compliance Daily Per Capita Water Use						
Orange County 20x2020 Regional Alliance	(1) 2015 Population	(2) 2020 Population	(3) Individual Targets 2015	(4) Weighted Total 2015	(5) Individual Targets 2020	(6) Weighted Total 2020
LBCWD	20,103	19,468	183	3,684,178	163	3,171,382
Mesa Water	109,542	111,051	163	17,814,705	145	16,053,433
MNWD	168,999	170,236	194	32,829,113	173	29,395,029
Newport Beach	63,229	61,916	228	14,407,217	203	12,540,480
Orange	138,647	138,995	203	28,156,956	181	25,091,226
San Clemente	51,280	51,065	172	8,817,256	153	7,804,701
San Juan Capistrano	37,987	38,301	206	7,832,864	183	7,020,098
Santa Margarita WD	156,469	161,264	190	29,688,827	169	27,198,793
Seal Beach	24,001	24,000	149	3,570,691	142	3,397,200
Serrano WD	6,421	6,263	434	2,785,481	386	2,415,057
South Coast WD	34,993	34,232	169	5,916,823	150	5,145,021
Trabuco Canyon WD	12,747	12,921	233	2,973,383	200	2,581,514
Tustin	67,611	66,421	170	11,500,554	151	10,042,788
Westminster	94,394	94,068	137	12,900,652	130	12,232,790
Yorba Linda WD	74,741	75,608	266	19,899,036	237	17,893,214
Anaheim	361,290	365,987	183	65,977,152	162	59,408,797
Fullerton	140,672	141,648	201	28,253,525	179	25,288,490
Santa Ana	338,336	335,086	123	41,538,549	116	38,731,637
Regional Alliance Total	3,136,244	3,185,461	**173**	550,360,035	**159**	505,010,624

Table 5-3 provides the regional urban water use targets for the Orange County 20x2020 Regional Alliance – the 2015 target is 173 GPCD and the 2020 target is 159 GPCD. The actual 2015 GPCD achieved by the regional alliance is 125 GPCD indicating that not only has the region met its 2015 target but it has already well below its 2020 water use target. This is indicative of the collective efforts of MWDOC and retail agencies in reducing water use in the region. Note, the target and actual GPCD values listed include appropriate deductions for recycled water used for indirect potable reuse (IPR) as detailed below.

Table 5-3: Urban Water Use Target and Actual GPCD for Orange County 20x2020 Regional Alliance

	2020 Target GPCD	2020 Actual GPCD
Orange County 20X2020 Regional Alliance	159	109

5.2.3 Deducting Recycled Water Used for IPR

SBx7-7 allows urban retail water suppliers to calculate a deduction for recycled water entering their distribution system indirectly through a groundwater source. Individual water suppliers within the OC Basin have the option of choosing this deduction to account for the recharge of recycled water into the OC Basin by OCWD, historically through Water Factory 21, and more recently by GWRS. These deductions also benefit all members of the Orange County 20x2020 Regional Alliance.

MWDOC has provided the documentation for the calculations of this deduction to assist retail water suppliers if they choose to include recycled water for IPR in their individual targets. This calculation is applied as a deduction from the water supplier's calculation of Gross Water Use. Table 5-4 provides the calculation to deduct recycled water for IPR for OC Basin Agencies. Because year-to-year variations can occur in the amount of recycled water applied in a groundwater recharge operation, a previous five-year average of recharge is used, as found in column (1). To account for losses during recharge and recovery, a factor of 96.5 percent is applied in column (2). After accounting for these losses, the estimated volume of recycled water entering the distribution system is calculated in column (3).

In column (4), the annual deduction for recycled water for IPR is expressed as a percentage of the total volume of water extracted from the OC Basin in that year. This is the annual percentage of total OCWD basin production that is eligible for a deduction. For individual water suppliers in the OC Basin, the annual deduction is calculated as their basin pumping in a given year multiplied by the value in column (4).

For example, if Agency A pumped 10,000 AF of water from the OC Basin in FY 2004-05, then 1.47 percent of that total production would be deducted from the agency's calculation of Gross Water Use for that year as found in column (4). This equates to a deduction of 147 AF.

The deductible amount of indirect recycled water increased from 66,152 AF in 2015 to approximately 94,235 AF in 2020 as a result of the full production from GWRS. OCWD has additional expansion plans for GWRS, which are expected to further increase the deductible amount of indirect recycled water up to approximately 145,600 AF, or 130 million gallons per day (MGD).

Table 5-4: Calculation of Annual Deductible Volume of Indirect Recycled Water Entering Distribution System

Deduct Recycled Water Used for IPR [1]						
Fiscal Year Ending	Total Groundwater Recharge	(1) 5-Year Average Recharge (AF)	(2) Loss Factor for Recharge & Recovery	(1) x (2) = (3) Volume Entering Distribution System (AF)	Total Basin Production (AF)	(4) Percent of Total Basin Production
1990	6,498	6,498	96.5%	6,271	229,878	2.73%
1991	6,634	6,498	96.5%	6,271	235,532	2.66%
1992	6,843	6,566	96.5%	6,336	244,333	2.59%
1993	8,161	6,658	96.5%	6,425	243,629	2.64%
1994	5,042	7,034	96.5%	6,788	237,837	2.85%
1995	2,738	6,636	96.5%	6,403	276,096	2.32%
1996	4,282	5,884	96.5%	5,678	302,273	1.88%
1997	4,389	5,413	96.5%	5,224	310,217	1.68%
1998	2,496	4,922	96.5%	4,750	297,726	1.60%
1999	3,489	3,789	96.5%	3,657	322,476	1.13%
2000	5,774	3,479	96.5%	3,357	320,250	1.05%
2001	2,067	4,086	96.5%	3,943	323,129	1.22%
2002	4,143	3,643	96.5%	3,515	322,590	1.09%
2003	3,867	3,594	96.5%	3,468	274,927	1.26%
2004	1,784	3,868	96.5%	3,733	272,954	1.37%
2005	4,156	3,527	96.5%	3,404	232,199	1.47%
2006	4,086	3,203	96.5%	3,091	215,172	1.44%
2007	218	3,607	96.5%	3,481	284,706	1.22%
2008	17,792	2,822	96.5%	2,723	351,622	0.77%
2009	54,261	5,607	96.5%	5,411	310,586	1.74%
2010	65,950	16,103	96.5%	15,539	273,889	5.67%

Deduct Recycled Water Used for IPR [1]						
Fiscal Year Ending	Total Groundwater Recharge	(1) 5-Year Average Recharge (AF)	(2) Loss Factor for Recharge & Recovery	(1) x (2) = (3) Volume Entering Distribution System (AF)	Total Basin Production (AF)	(4) Percent of Total Basin Production
2011	66,083	28,461	96.5%	27,465	251,622	10.92%
2012	71,678	40,861	96.5%	39,431	235,222	16.76%
2013	72,877	55,153	96.5%	53,223	298,175	17.85%
2014	66,167	66,170	96.5%	63,854	318,967	20.02%
2015	76,546	68,551	96.5%	66,152	293,903	22.51%
2016	100,347	70,670	96.5%	68,197	262,795	25.95%
2017	94,081	77,523	96.5%	74,810	282,257	26.50%
2018	103,990	82,004	96.5%	79,134	228,146	34.69%
2019	93,399	88,226	96.5%	85,138	290,749	29.28%
2020	94,235	93,673	96.5%	90,394	271,263	33.32%

NOTES:
[1] Indirect is recycled water for groundwater recharge through spreading and injection of GWRS and Water Factory 21. The yearly totals are apportioned among the OCWD Basin agencies on the basis of groundwater production over a five year rolling average.

[2] Loss factor provided by OCWD, includes loss over county lines to LA Basin.

6 WATER SUPPLY CHARACTERIZATION

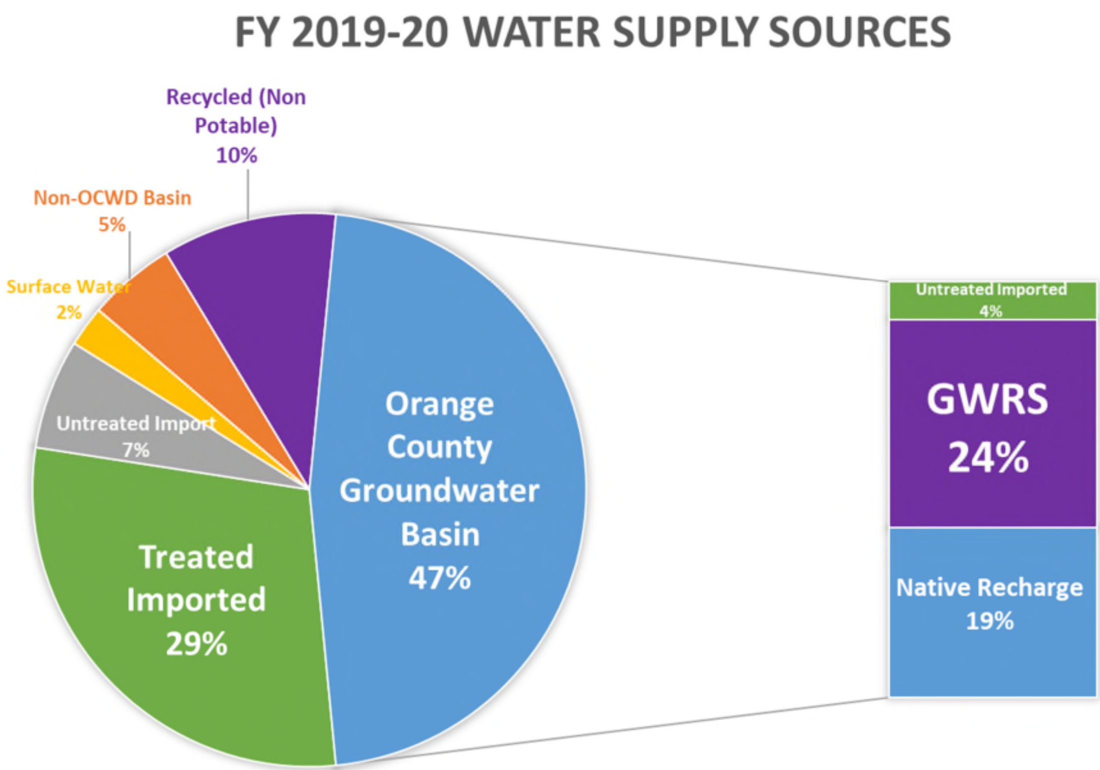
As a counterpart to Section 4's Water Use Characterization, this section characterizes MWDOC's water supply along with a description of the groundwater, wastewater and recycled water provided by other agencies. This section includes identification and quantification of water supply sources through 2045, descriptions of each water supply source and their management, opportunities for exchanges and transfers, and discussion regarding any planned future water supply projects. This section also includes the energy intensity of the water service, a new UWMP requirement.

6.1 Water Supply Overview

Water supplies within MWDOC's service area are from local and imported sources. MWDOC is the regional wholesaler of imported water purchased from MET, which is sourced from the CRA and SWP. Local retail agencies and one local wholesale agency purchase imported water through MWDOC to supplement their local supplies. In FY 2019-20, MWDOC supplied approximately 142,879 AFY of treated and untreated imported water to its retail agencies for M&I purposes and 18,675 AFY for groundwater replenishment (Cyclic Storage) and surface water purposes. In FY 2019-20, imported water represented 36 percent of total water supply in the MWDOC service area. However, imported water volume varies vary year to year; over the last 10 years, it has represented 39 percent of total M&I water supply.

Local supplies developed by other entities and retail agencies include groundwater, recycled water, and surface water. Local sources presently account for 65 percent of the service area's water supplies, whereby groundwater is the major source of local supply. The primary groundwater basin, OC Basin, is located in the northern portion of MWDOC's service area and is managed by OCWD. OCWD also provides advanced treatment to secondary treated wastewater from Orange County Sanitation District (OC San) to produce recycled water for various water agencies in north Orange County. In south Orange County, there are a number of water agencies that provide their own wastewater treatment, to produce recycled water. A relatively minimal amount of MWDOC's water supply portfolio – approximately two percent in FY 2019-20 – is attributed to surface water.

Figure 6-1 shows a breakdown of all sources within MWDOC's service area. Although MWDOC only delivers imported water to its retail agencies, other sources of water are obtained locally and are specific to each retail agency. Note that GWRS supplies are included as part of groundwater pumping numbers.

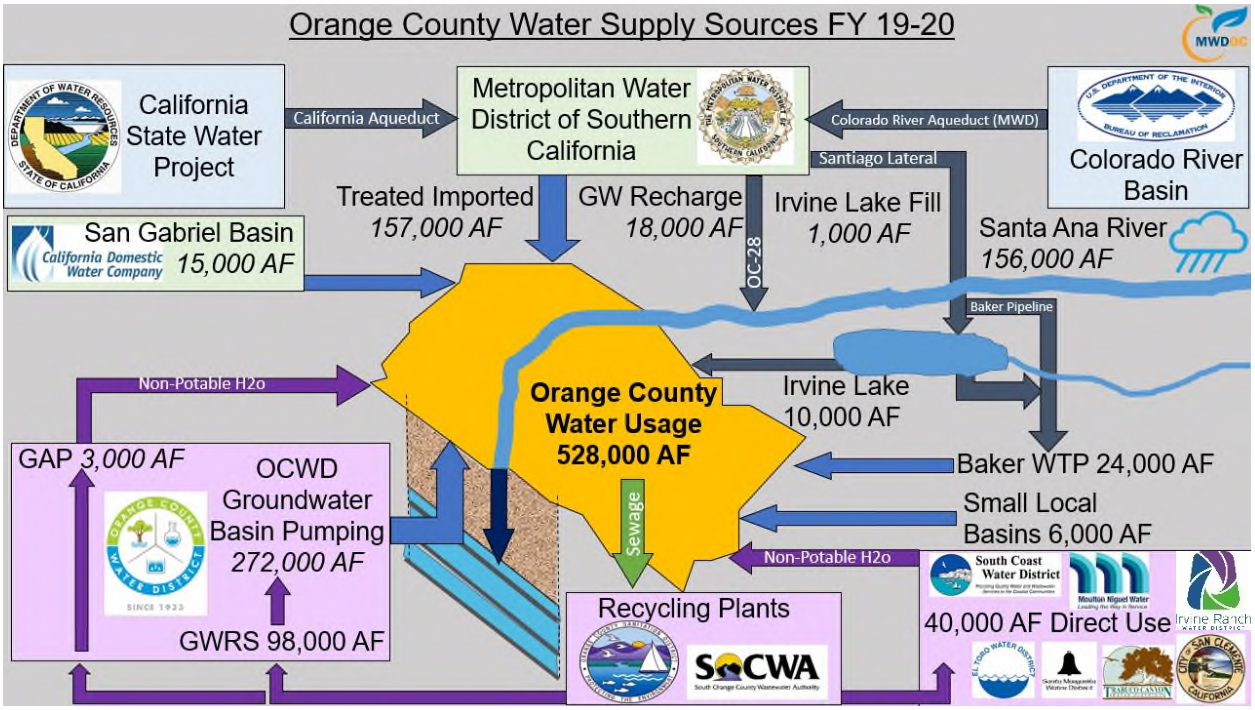


Note: Supplies are specific to the MWDOC Service Area. The Orange County Water Basin water supply can further be broken down by the sources of supply on the right and are intented to add up to the total 47% of water supplies that the Orange County Groundwater Basin represents.

Figure 6-1: FY 2019-20 Water Supply Sources within MWDOC's Service Area

MWDOC and its retail agencies collectively work together to improve the water reliability within the service area by developing additional local supplies, implementing water use efficiency efforts, and expanding local projects. MWDOC also works in collaboration with two primary agencies – MET and OCWD – to ensure a safe and high-quality water supply to Orange County.

Figure 6-2 illustrates the different water sources in MWDOC's service area and for all of Orange County.



Note: Supplies are for Orange County, which include MWDOC member agencies as well as the cities of Anaheim, Fullerton, and Santa Ana.

Figure 6-2: Orange County Water Supply Sources

Although MWDOC supports the various water supply sources for agencies within MWDOC's service area, MWDOC supplies only imported water. In FY 2019-20, MWDOC used its imported water supplies for M&I uses, groundwater recharge, and surface storage (Table 6-1).

MWDOC's projected water supply sources from MET for M&I are expected to increase through 2045, with the imported water for groundwater recharge and surface storage projected to remain the same (Table 6-2). The following subsections will provide a detailed discussion of the water supply sources in MWDOC's service area, as well as evaluate MWDOC's projected supply for the next 25 years.

Table 6-1: Wholesale: Water Supplies – Actual

DWR Submittal Table 6-8 Wholesale: Water Supplies — Actual			
Water Supply	Additional Detail on Water Supply	2020	
		Actual Volume (AF)	Water Quality
Purchased or Imported Water	From MET for Municipal & Industrial	142,879	Drinking Water
Purchased or Imported Water	From MET for Groundwater Recharge	18,027	Other Non-Potable Water
Purchased or Imported Water	From MET for Surface Storage	649	Other Non-Potable Water
	Total:	161,555	
NOTES: Source: MWDOC UWMP Supply Projections, 2021			

Table 6-2: Wholesale: Water Supplies – Projected

DWR Submittal Table 6-9 Wholesale: Water Supplies — Projected						
Water Supply	Additional Detail on Water Supply	**Projected Water Supply (AF)**				
		2025	**2030**	**2035**	**2040**	**2045**
		Reasonably Available Volume	Reasonably Available Volume	Reasonably Available Volume	Reasonably Available Volume	Reasonably Available Volume
Purchased or Imported Water	From MET for Municipal & Industrial	119,743	120,573	123,502	123,107	122,819
Purchased or Imported Water	From MET for Groundwater Recharge	51,600	51,600	51,600	51,600	51,600
Purchased or Imported Water	From MET for Surface Storage	4,017	4,017	4,017	4,017	4,017
	Total:	175,360	176,190	179,119	178,724	178,436
NOTES: Source: MWDOC UWMP Supply Projections and OCWD, 2021						

6.2 Imported Water

In FY 2019-20, 36 percent of MWDOC's water supply portfolio was attributed to treated and untreated imported water. MWDOC purchases water from MET and distributes this water to its 28 member agencies to supplement local supplies. MET's two principal sources of water are the Colorado River and the SWP. MET receives water from the Colorado River through the CRA and from the SWP through the California Aqueduct. For Orange County, the water obtained from these sources is treated at the Robert B. Diemer Filtration Plant located in Yorba Linda. Typically, the Diemer Filtration Plant receives a blend of Colorado River water from Lake Mathews through the MET Lower Feeder and SWP water through the Yorba Linda Feeder.

6.2.1 Metropolitan Water District of Southern California

MET is the largest water wholesaler for domestic and municipal uses in California, serving approximately 19 million customers. MET wholesales imported water supplies to 26 member cities and water districts in six southern California counties. Its service area covers the southern California coastal plain, extending approximately 200 miles along the Pacific Ocean from the City of Oxnard in the north to the international boundary with Mexico in the south. This encompasses 5,200 square miles and includes portions of Los Angeles, Orange, Riverside, San Bernardino, San Diego, and Ventura counties. Approximately 85 percent of the population from these counties reside within MET's boundaries.

MET is governed by a Board of Directors comprised of 38 appointed individuals with a minimum of one representative from each of MET's 26 member agencies. The allocation of directors and voting rights are determined by each agency's assessed valuation. Each member of the Board is entitled to cast one vote for each ten million dollars ($10,000,000) of assessed valuation of property taxable for district purposes, in accordance with Section 55 of the Metropolitan Water District Act. Directors can be appointed through the chief executive officer of the member agency or by a majority vote of the governing board of the agency. Directors are not compensated by MET for their service (The Metropolitan Water District Act, 1969).

MET is responsible for importing water into the region through its operation of the CRA and its contract with the State of California for SWP supplies. Major imported water aqueducts bringing water to southern California are shown in

Figure 6-3. Member agencies receive water from MET through various delivery points and pay for service through a rate structure made up of volumetric rates, capacity charges and readiness to serve charges. Member agencies provide estimates of imported water demand to MET annually in April regarding the amount of water they anticipate they will need to meet their demands for the next five years.

In Orange County, MWDOC and the cities of Anaheim, Fullerton, and Santa Ana are MET member agencies that purchase imported water directly from MET. Furthermore, MWDOC purchases both treated potable and untreated water from MET to supplement its retail agencies' local supplies. Figure 6-4 illustrates the MET feeders and major transmission pipelines that deliver water within Orange County.

Figure 6-3: Major Aqueducts that Supply Water to Southern California

Figure 6-4: MET Feeders and Transmission Mains that Serve Orange County

6.2.1.1 MET's 2020 Urban Water Management Plan

MET's 2020 UWMP reports on its water reliability and identifies projected supplies to meet the long-term demand within its service area. The MET 2020 UWMP discusses the current water supply conditions and long-term plans for supply implementation and continued development of a diversified resource mix. It describes the programs being implemented such as the CRA, SWP, Central Valley storage/transfer programs, water use efficiency programs, local resource projects, and in-region storage that will enable the region to meet its water supply needs. MET's 2020 UWMP also presents MET's supply capacities from 2025 through 2045 for average year, single dry-year, five consecutive dry-year, and more frequent and severe droughts, as specified in the UWMP Act.

Information concerning MET's UWMP, including the background, associated challenges, and long-term development of programs for each of MET's supply sources and capacities have been summarized and included in the following subsections. Additional information on MET can be found directly in MET's 2020 UWMP.

6.2.1.2 Colorado River Aqueduct

Background

The Colorado River was MET's original source of water after MET's establishment in 1928. The CRA, which is owned and operated by MET, transports water from the Colorado River to its terminus Lake Mathews, in Riverside County. The actual amount of water per year that may be conveyed through the CRA to MET's member agencies is subject to the availability of Colorado River water. Approximately 40 million people rely on the Colorado River and its tributaries for water with 5.5 million acres of land using Colorado River water for irrigation. The CRA includes supplies from the implementation of the Quantification Settlement Agreement and its related agreements to transfer water from agricultural agencies to urban uses. The 2003 Quantification Settlement Agreement enabled California to implement major Colorado River water conservation and transfer programs, in order to stabilize water supplies and reduce the state's demand on the river to its 4.4 million acre-feet (MAF) entitlement. Colorado River transactions are potentially available to supply additional water up to the CRA capacity of 1.25 MAF on an as-needed basis. Water from the Colorado River or its tributaries is available to users in California, Arizona, Colorado, Nevada, New Mexico, Utah, Wyoming, and Mexico. California is apportioned the use of 4.4 MAF of water from the Colorado River each year plus one-half of any surplus that may be available for use collectively in Arizona, California, and Nevada. In addition, California has historically been allowed to use Colorado River water apportioned to, but not used by, Arizona or Nevada. MET has a basic entitlement of 550,000 AFY of Colorado River water, plus surplus water up to an additional 662,000 AFY when the following conditions exists (MET, 2021):

- Water is unused by the California holders of priorities 1 through 3
- Water is saved by the Palo Verde land management, crop rotation, and water supply program
- When the U.S. Secretary of the Interior makes available either one or both of the following:
    - Surplus water
    - Colorado River water that is apportioned to but unused by Arizona and/or Nevada.

Current Conditions and Supply

MET has not received surplus water for a number of years. The Colorado River supply faces current and future imbalances between water supply and demand in the Colorado River Basin due to long-term drought conditions. Analysis of historical records suggests a potential change in the relationship between precipitation and runoff in the Colorado River Basin. The past 21 years (1999-2020) have seen an overall drying trend, even though the period included several wet or average years. The river basin has substantial storage capacity, but the significant reduction in system reservoir storage in the last two decades is great enough to consider the period a drought (DWR, 2020a). At the close of 2020, system storage was at or near its lowest since 2000, so there is very little buffer to avoid a shortage from any future period of reduced precipitation and runoff (MET, 2021). Looking ahead, the long-term imbalance in the Colorado River Basin's future supply and demand is projected to be approximately 3.2 MAF by the year 2060 (USBR, 2012).

In light of declining reservoir levels, the Lower Basin Drought Contingency Plan (DCP) was signed in 2019. This agreement incentivizes storage in Lake Mead and requires certain volumes of water be stored in Lake Mead under certain Lake Mead elevation levels through 2026. MET is to store certain volumes of water in Lake Mead as DCP ICS once Lake Mead is below elevation 1,045 feet. This agreement also increases MET's flexibility to take delivery of water stored as ICS at Lake Mead elevations below 1,075 feet. The goal of this agreement is to keep Lake Mead above critical elevations, and overall it increases MET's flexibility to store water in Lake Mead in greater volumes and to take delivery of stored water to fill the CRA as needed.

Over the years, MET has helped fund and implement various programs to improve Colorado River supply reliability and help resolve the imbalance between supply and demand. Implementation of such programs have contributed to achievements like achieving a record low diversion of the Colorado River in 2019, a level not seen since the 1950s. Colorado River water management programs include:

- **Imperial Irrigation District / MET Conservation Program** – Under agreements executed in 1988 and 1989, this program allows MET to fund water efficiency improvements within Imperial Irrigation District's service area in return for the right to divert the water conserved by those investments. An average of 105,000 AFY of water has been conserved since the program's implementation.
- **Palo Verde Land Management, Crop Rotation, and Water Supply Program** – Authorized in 2004, this 35-year program allows MET to pay participating farmers to reduce their water use, and for MET to receive the saved water. Over the life of the program, an average of 84,500 AFY has been saved and made available to MET.
- **Bard Seasonal Fallowing Program** – Authorized in 2019, this program allows MET to pay participating farmers in Bard to reduce their water use between the late spring and summer months of selected years, which provides up to 6,000 AF of water to be available to MET in certain years.
- **Management of MET-Owned Land in Palo Verde** – Since 2001, MET has acquired approximately 21,000 acres of irrigable farmland that are leased to growers, with incentives to grow low water-using crops and experiment with low water-consumption practices. If long-term

water savings are realized, MET may explore ways to formally account them for Colorado River supplies.

- **Southern Nevada Water Authority (SNWA) and MET Storage and Interstate Release Agreement** – Entered in 2004, this agreement allows SNWA to store its unused, conserved water with MET, in exchange for MET to receive additional Colorado River water supply. MET has relied on the additional water during dry years, especially during the 2011-2016 California drought, and SNWA is not expected to call upon MET to return water until after 2026.
- **Lower Colorado Water Supply Projects** – Authorized in 1980s, this project provides up to 10,000 AFY of water to certain entities that do not have or have insufficient rights to use Colorado River water. A contract executed in 2007 allowed MET to receive project water left unused by the project contractors along the River – nearly 10,000 AF was received by MET in 2019 and is estimated for 2020.
- **Exchange Programs** – MET is involved in separate exchange programs with the United States Bureau of Reclamation, which takes place at the Colorado River Intake and with San Diego County Water Authority (SDCWA), which exchanges conserved Colorado River water.
- **Lake Mead Storage Program** – Executed in 2006, this program allows MET to leave excessively conserved water in Lake Mead, for exclusive use by MET in later years.
- **Quagga Mussel Control Program** – Developed in 2007, this program introduced surveillance activities and control measures to combat quagga mussels, an invasive species that impact the Colorado River's water quality.
- **Lower Basin Drought Contingency Plan** – Signed in 2019, this agreement incentivizes storage in Lake Mead through 2026 and overall, it increases MET's flexibility to fill the CRA as needed (MET, 2021).

Future Programs / Plans

The Colorado River faces long-term challenges of water demands exceeding available supply with additional uncertainties due to climate change. Climate change impacts expected in the Colorado River Basin include the following:

- More frequent, more intense, and longer lasting droughts, which will result in water deficits
- Continued dryness in the Colorado River Basin, which will increase the likelihood of triggering a first-ever shortage in the Lower Basin
- Increased temperatures, which will affect the percentage of precipitation that falls as rain or snow, as well as the amount and timing of mountain snowpack (DWR, 2020b)

Acknowledging the various uncertainties regarding reliability, MET plans to continue ongoing programs, such as those listed earlier in this section. Additionally, MET supports increasing water recycling in the Colorado River Basin and is in the process of developing additional transfer programs for the future (MET, 2021).

6.2.1.3 State Water Project

Background

The SWP consists of a series of pump stations, reservoirs, aqueducts, tunnels, and power plants operated by DWR and is an integral part of the effort to ensure that business and industry, urban and suburban residents, and farmers throughout much of California have sufficient water. Water from the SWP originates at Lake Oroville, which is located on the Feather River in Northern California. Much of the SWP water supply passes through the Delta. The SWP is the largest state-built, multipurpose, user-financed water project in the United States. Nearly two-thirds of residents in California receive at least part of their water from the SWP, with approximately 70 percent of SWP's contracted water supply going to urban users and 30 percent to agricultural users. The primary purpose of the SWP is to divert and store water during wet periods in Northern and Central California and distribute it to areas of need in Northern California, the San Francisco Bay area, the San Joaquin Valley, the Central Coast, and Southern California (MET, 2021).

The Delta is key to the SWP's ability to deliver water to its agricultural and urban contractors. All but five of the 29 SWP contractors receive water deliveries below the Delta (pumped via the Harvey O. Banks or Barker Slough pumping plants). However, the Delta faces many challenges concerning its long-term sustainability such as climate change posing a threat of increased variability in floods and droughts. Sea level rise complicates efforts in managing salinity levels and preserving water quality in the Delta to ensure a suitable water supply for urban and agricultural use. Furthermore, other challenges include continued subsidence of Delta islands, many of which are below sea level, and the related threat of a catastrophic levee failure as the water pressure increases, or as a result of a major seismic event.

Current Conditions and Supply

"Table A" water is the maximum entitlement of SWP water for each water contracting agency. Currently, the combined maximum Table A amount is 4.17 million acre-feet per year (MAFY). Of this amount, 4.13 MAFY is the maximum Table A water available for delivery from the Delta. On average, deliveries are approximately 60% of the maximum Table A amount (DWR, 2020b).

SWP contractors may receive Article 21 water on a short-term basis in addition to Table A water if requested. Article 21 of SWP contracts allows contractors to receive additional water deliveries only under specific conditions, generally during wet months of the year (December through March). Because a SWP contractor must have an immediate use for Article 21 supply or a place to store it outside of the SWP, there are few contractors like MET that can access such supplies.

Carryover water is SWP water allocated to an SWP contractor and approved for delivery to the contractor in a given year, but not used by the end of the year. The unused water is stored in the SWP's share of San Luis Reservoir, when space is available, for the contractor to use in the following year.

Turnback pool water is Table A water that has been allocated to SWP contractors who have exceeded their demands. This water can then be purchased by another contractor depending on its availability.

SWP Delta exports are the water supplies that are transferred directly to SWP contractors or to San Luis Reservoir storage south of the Delta via the Harvey O. Banks pumping plant. Estimated average annual Delta exports and SWP Table A water deliveries have generally decreased since 2005, when Delta export regulations affecting SWP pumping operations became more restrictive due to federal biological opinions (Biops). The Biops protect species listed as threatened or endangered under the federal and state Endangered Species Acts (ESAs) and affect the SWP's water delivery capability because they restrict SWP exports in the Delta and include Delta outflow requirements during certain times of the year, thus reducing the available supply for export or storage.

Before being updated by the 2019 Long-Term Operations Plan, the prior 2008 and 2009 Biops resulted in an estimated reduction in SWP deliveries of 0.3 MAF during critically dry years to 1.3 MAF in above normal water years as compared to the previous baseline. However, the 2019 Long-Term Operations Plan and Biops are expected to increase SWP deliveries by an annual average of 20,000 acre-feet as compared to the previous Biops (MET, 2021). Average Table A deliveries decreased in the 2019 SWP Final Delivery Capability Report compared to 2017, mainly due to the 2018 Coordinated Operation Agreement (COA) Addendum and the increase in the end of September storage target for Lake Oroville. Other factors that also affected deliveries included changes in regulations associated with the Incidental Take Permit (ITP) and the Reinitiation of Consultation for Long-Term Operations (RoC on LTO), a shift in Table A to Article 21 deliveries which occurred due to higher storage in SWP San Luis, and other operational updates to the SWP and federal Central Valley Project (CVP) (DWR, 2020b). Since 2005, there are similar decreasing trends for both the average annual Delta exports and the average annual Table A deliveries (Table 6-3).

Table 6-3: MET SWP Program Capabilities

Year	Average Annual Delta Exports (MAF)	Average Annual Table A Deliveries (MAF)
2005	2.96	2.82
2013	2.61	2.55
2019	2.52	2.41
Percent Change*	-14.8%	-14.3%

*Percent change is between the years 2019 and 2005.

Ongoing regulatory restrictions, such as those imposed by the Biops on the effects of SWP and the CVP operations on certain marine life, also contribute to the challenge of determining the SWP's water delivery reliability. In dry, below-normal conditions, MET has increased the supplies delivered through the California Aqueduct by developing flexible CVP/SWP storage and transfer programs. The goal of the storage/transfer programs are to access additional supplies to maximize deliveries during dry hydrologic conditions and regulatory restrictions. In addition, the California State Water Resources Control Board (SWRCB) has set water quality objectives that must be met by the SWP including minimum Delta outflows, limits on SWP and CVP Delta exports, and maximum allowable salinity level. The following factors affect the ability to estimate existing and future water delivery reliability:

- **Water availability at the source:** Availability can be highly variable and depends on the amount and timing of rain and snow that fall in any given year. Generally, during a single-dry year or two, surface and groundwater storage can supply most water deliveries, but multiple-dry years can result in critically low water reserves. Fisheries issues can also restrict the operations of the export pumps even when water supplies are available.

- **Water rights with priority over the SWP:** Water users with prior water rights are assigned higher priority in DWR's modeling of the SWP's water delivery reliability, even ahead of SWP Table A water.
- **Climate change:** Mean temperatures are predicted to vary more significantly than previously expected. This change in climate is anticipated to bring warmer winter storms that result in less snowfall at lower elevations, reducing total snowpack. From historical data, DWR projects that by 2050, the Sierra snowpack will be reduced from its historical average by 25 to 40 percent. Increased precipitation as rain could result in a larger number of "rain-on-snow" events, causing snow to melt earlier in the year and over fewer days than historically, affecting the availability of water for pumping by the SWP during summer. Furthermore, water quality may be adversely affected due to the anticipated increase in wildfires. Rising sea levels may result in potential pumping cutbacks on the SWP and CVP.
- **Regulatory restrictions on SWP Delta exports:** The Biops protect special-status species such as delta smelt and spring- and winter-run Chinook salmon and imposed substantial constraints on Delta water supply operations through requirements for Delta inflow and outflow and export pumping restrictions. Restrictions on SWP operations imposed by state and federal agencies contribute substantially to the challenge of accurately determining the SWP's water delivery reliability in any given year (DWR, 2020b).
- **Ongoing environmental and policy planning efforts:** Governor Gavin Newsom ended California WaterFix in May 2019 and announced a new approach to modernize Delta Conveyance through a single tunnel alternative. The EcoRestore Program aims to restore at least 30,000 acres of Delta habitat, with the near-term goal of making significant strides toward that objective by 2020 (DWR, 2020b).
- **Delta levee failure:** The levees are vulnerable to failure because most original levees were simply built with soils dredged from nearby channels and were not engineered. A breach of one or more levees and island flooding could affect Delta water quality and SWP operations for several months. When islands are flooded, DWR may need to drastically decrease or even cease SWP Delta exports to evaluate damage caused by salinity in the Delta.

Operational constraints will likely continue until a long-term solution to the problems in the Delta is identified and implemented. New Biops for listed species under the Federal ESA or by the California Department of Fish and Game's issuance of incidental take authorizations under the Federal ESA and California ESA might further adversely affect SWP and CVP operations. Additionally, new litigation, listings of additional species or new regulatory requirements could further adversely affect SWP operations in the future by requiring additional export reductions, releases of additional water from storage or other operational changes impacting water supply operations.

Future Programs / Plans

MET's Board approved a Delta Action Plan in June 2007 that provides a framework for staff to pursue actions with other agencies and stakeholders to build a sustainable Delta and reduce conflicts between water supply conveyance and the environment. The Delta Action Plan aims to prioritize immediate short-term actions to stabilize the Delta while an ultimate solution is selected, and mid-term steps to maintain the Delta while a long-term solution is implemented. Currently, MET is working towards addressing four elements: Delta ecosystem restoration, water supply conveyance, flood control protection, and storage development.

In May 2019, Governor Newsom ended California WaterFix, announced a new approach to modernize Delta Conveyance through a single tunnel alternative, and released Executive Order 10-19 that directed state agencies to inventory and assess new planning for the project. DWR then withdrew all project approvals and permit applications for California WaterFix, effectively ending the project. The purpose of the Delta Conveyance Project (DCP) gives rise to several project objectives (MET, 2021). In proposing to make physical improvements to the SWP Delta conveyance system, the project objectives are:

- To address anticipated rising sea levels and other reasonably foreseeable consequences of climate change and extreme weather events.
- To minimize the potential for public health and safety impacts from reduced quantity and quality of SWP water deliveries, and potentially CVP water deliveries, south of the Delta resulting from a major earthquake that causes breaching of Delta levees and the inundation of brackish water into the areas in which existing pumping plants operate.
- To protect the ability of the SWP, and potentially the CVP, to deliver water when hydrologic conditions result in the availability of sufficient amounts, consistent with the requirements of state and federal law.
- To provide operational flexibility to improve aquatic conditions in the Delta and better manage risks of further regulatory constraints on project operations.

6.2.1.4 Central Valley / State Water Project Storage and Transfer Programs

Storage is a major component of MET's dry year resource management strategy. MET's likelihood of having adequate supply capability to meet projected demands, without implementing its Water Supply Allocation Plan (WSAP), is dependent on its storage resources. Due to the pattern of generally drier hydrology, the groundwater basins and local reservoirs have dropped to low operating levels and remain below healthy storage levels. For example, the Colorado River Basin's system storage at the close of 2020, was at or near its lowest since 2000, so there is very little buffer to avoid a shortage from any future period of reduced precipitation and runoff (MET, 2021).

MET stores water in both DWR and MET surface water reservoirs. MET's surface water reservoirs are Lake Mathews, Lake Skinner, and Diamond Valley Lake, which have a combined storage capacity of over 1 MAF. Approximately 650,000 AF are stored for seasonal, regulatory, and drought use, while approximately 370,000 AF are stored for emergency use.

MET also has contractual rights to DWR surface Reservoirs, such as 65 TAF of flexible storage at Lake Perris (East Branch terminal reservoir) and 154 TAF of flexible storage at Castaic Lake (West Branch terminal reservoir) that provides MET with additional options for managing SWP deliveries to maximize the yield from the project. This storage can provide MET with up to 44 TAF of additional supply over multiple dry years, or up to 219 TAF to Southern California in a single dry year (MET, 2021).

MET endeavors to increase the reliability of water supplies through the development of flexible storage and transfer programs including groundwater storage (MET, 2021). These include:

- **Lake Mead Storage Program:** Executed in 2006, this program allows MET to leave excessively conserved water in Lake Mead, for exclusive use by MET in later years. MET created "Intentionally Created Surplus" (ICS) water in 2006-2007, 2009-2012, and 2016-2019, and withdrew ICS water in 2008 and 2013-2015. As of January 1, 2021, MET had a total of 1.3 MAF of Extraordinary Conservation ICS water.
- **Semitropic Storage Program:** The maximum storage capacity of the program is 350 TAF, and the minimum and maximum annual yields available to MET are 34.7 TAF and 236.2 TAF, respectively. The specific amount of water MET can expect to store in and subsequently receive from the program depends on hydrologic conditions, any regulatory requirements restricting MET's ability to export water for storage and demands placed by other program participants. During wet years, MET has the discretion to use the program to store portions of its SWP supplies which are in excess, and during dry years, the Semitropic Water Storage District returns MET's previously stored water to MET by direct groundwater pump-in or by exchange of surface water supplies.
- **Arvin-Edison Storage Program:** The storage program is estimated to deliver 75 TAF, and the specific amount of water MET can expect to store in and subsequently receive from the program depends on hydrologic conditions and any regulatory requirements restricting MET's ability to export water for storage. During wet years, MET has the discretion to use to program to store portions of its SWP supplies which are in excess, and during dry years, the Arvin-Edison Water Storage District returns MET's previously stored water to MET by direct groundwater pump-in or by exchange of surface water supplies.
- **Antelope Valley-East Kern (AVEK) Water Agency Exchange and Storage Program:** Under the exchange program, for every two AF MET receives, MET returns 1 AF back to AVEK, and MET will also be able to store up to 30 TAF in the AVEK's groundwater basin, with a dry-year return capability of 10 TAF.
- **High Desert Water Bank Program:** Under this program, MET will have the ability to store up to 280 TAF of its SWP Table A or other supplies in the Antelope Valley groundwater basin, and in exchange will provide funding for the construction of monitoring and production wells, turnouts from the California Aqueduct, pipelines, recharge basins, water storage, and booster pump facilities. The project is anticipated to be in operation by 2025.
- **Kern-Delta Water District Storage Program:** This groundwater storage program has 250 TAF of storage capacity, and water for storage can either be directly recharged into the groundwater basin or delivered to Kern-Delta Water District farmers in lieu of pumping groundwater. During dry years, the Kern-Delta Water District returns MET's previously stored water to MET by direct groundwater pump-in return or by exchange of surface water supplies.
- **Mojave Storage Program:** MET entered into a groundwater banking and exchange transfer agreement with Mojave Water Agency that allows for the cumulative storage of up to 390 TAF. The agreement allows for MET to store water in an exchange account for later return.

6.2.1.5 Untreated Imported Water - Baker Treatment Plant

The Baker Treatment Plant is a 28.1 MGD drinking water treatment plant at the site of the former Baker Filtration Plant in Lake Forest. The plant was a joint regional project by five South Orange County water districts: ETWD, IRWD, MNWD, SMWD, and TCWD, which have capacity rights of 3.2 MGD, 6.8 MGD, 8.4 MGD, 8.4 MGD, and 1.3 MGD, respectively. The project went online in early 2017 and is managed and run by IRWD.

The plant has multiple water supply sources that increase water supply reliability, including imported untreated water from MET through the Santiago Lateral and local surface water from Irvine Lake. It provides a reliable local drinking water supply during emergencies or extended facility shutdowns on the MET delivery system and increases operational flexibility by creating redundancy within the water conveyance system.

6.2.2 Supply Reliability Within MET

6.2.2.1 MET's Water Service Reliability Assessment Results

In MET's 2020 UWMP, MET evaluated supply reliability by projecting supply and demand under a normal year, single-dry year, and five-year consecutive dry years, based on conditions affecting the SWP (MET's largest and most variable supply). For this supply source, the average of historic years 1922-2017 most closely represents water supply conditions in a normal water year, the single driest year was 1977 and the five-year dry period was 1988-1992. The analyses also include Colorado River supplies under the same hydrological variations.

MET also incorporated the SWP and Colorado River's reliability factors, such as water quality objectives set by the SWRCB, Biops, and amendments to the COA for the SWP and Quantification Settlement Agreements for the Colorado River into their assessment.

MET has concluded that the region can provide reliable water supplies under normal, single-dry, and five-year consecutive dry conditions (Table 6-4, Table 6-5, Table 6-6, respectively). MWDOC is a MET member agency, and MET's projections take into account the imported demands from Orange County. As so, MET's water reliability assessments are used to determine that demands within MWDOC can be met for all three hydrological conditions.

Table 6-4: MET's Projected Supply Capability and Demands through 2045 for a Normal Year

Normal Water Year
Supply Capability[1] and Projected Demands
Average of 1922-2017 Hydrologies
(Acre-feet per year)

Forecast Year	2025	2030	2035	2040	2045
Current Programs					
In-Region Supplies and Programs	875,000	876,000	875,000	875,000	872,000
California Aqueduct[2]	1,774,000	1,766,000	1,763,000	1,762,000	1,761,000
Colorado River Aqueduct					
Total Supply Available[3]	1,214,000	1,290,000	1,283,000	1,230,000	1,250,000
Aqueduct Capacity Limit[4]	*1,250,000*	*1,250,000*	*1,250,000*	*1,250,000*	*1,250,000*
Colorado River Aqueduct Capability	1,214,000	1,250,000	1,250,000	1,230,000	1,250,000
Capability of Current Programs	**3,863,000**	**3,892,000**	**3,888,000**	**3,867,000**	**3,883,000**
Demands					
Total Demands on Metropolitan	1,191,000	1,142,000	1,101,000	1,116,000	1,140,000
Exchange with SDCWA	278,000	278,000	278,000	278,000	278,000
Total Metropolitan Deliveries[5]	**1,469,000**	**1,420,000**	**1,379,000**	**1,394,000**	**1,418,000**
Surplus	**2,394,000**	**2,472,000**	**2,509,000**	**2,473,000**	**2,465,000**
Programs Under Development					
In-Region Supplies and Programs	0	0	0	0	0
California Aqueduct	13,000	13,000	13,000	13,000	13,000
Colorado River Aqueduct					
Total Supply Available[3]	0	0	0	0	0
Aqueduct Capacity Limit[4]	*36,000*	*0*	*0*	*20,000*	0
Colorado River Aqueduct Capability	0	0	0	0	0
Capability of Proposed Programs	**13,000**	**13,000**	**13,000**	**13,000**	**13,000**
Potential Surplus	**2,407,000**	**2,485,000**	**2,522,000**	**2,486,000**	**2,478,000**

[1] Represents Supply Capability for resource programs under listed year type.

[2] California Aqueduct includes Central Valley transfers and storage program supplies conveyed by the aqueduct.

[3] Colorado River Aqueduct includes programs and Exchange with SDCWA conveyed by the aqueduct.

[4] Maximum CRA deliveries limited to 1.25 MAF including Exchange with SDCWA.

[5] Total demands are adjusted to include Exchange with SDCWA.

Table 6-5: MET's Projected Supply Capability and Demands through 2045 for a Single Dry Year

Single Dry-Year
Supply Capability[1] and Projected Demands
Repeat of 1977 Hydrology
(Acre-feet per year)

Forecast Year	2025	2030	2035	2040	2045
Current Programs					
In-Region Supplies and Programs	875,000	876,000	875,000	875,000	872,000
California Aqueduct[2]	647,000	634,000	633,000	634,000	633,000
Colorado River Aqueduct					
Total Supply Available[3]	1,174,000	1,403,500	927,500	1,327,500	974,500
Aqueduct Capacity Limit[4]	*1,250,000*	*1,250,000*	*1,250,000*	*1,250,000*	*1,250,000*
Colorado River Aqueduct Capability	1,174,000	1,250,000	927,500	1,250,000	974,500
Capability of Current Programs	**2,696,000**	**2,760,000**	**2,435,500**	**2,759,000**	**2,479,500**
Demands					
Total Demands on Metropolitan	1,319,000	1,270,000	1,227,000	1,246,000	1,273,000
Exchange with SDCWA	278,000	278,000	278,000	278,000	278,000
Total Metropolitan Deliveries[5]	**1,597,000**	**1,548,000**	**1,505,000**	**1,524,000**	**1,551,000**
Surplus	**1,099,000**	**1,212,000**	**930,500**	**1,235,000**	**928,500**
Programs Under Development					
In-Region Supplies and Programs	0	0	0	0	0
California Aqueduct	0	0	0	0	0
Colorado River Aqueduct					
Total Supply Available[3]	0	0	0	0	0
Aqueduct Capacity Limit[4]	*76,000*	*0*	*322,500*	*0*	*275,500*
Colorado River Aqueduct Capability	0	0	0	0	0
Capability of Proposed Programs	**0**	**0**	**0**	**0**	**0**
Potential Surplus	**1,099,000**	**1,212,000**	**930,500**	**1,235,000**	**928,500**

[1] Represents Supply Capability for resource programs under listed year type.
[2] California Aqueduct includes Central Valley transfers and storage program supplies conveyed by the aqueduct.
[3] Colorado River Aqueduct includes programs and Exchange with SDCWA conveyed by the aqueduct.
[4] Maximum CRA deliveries limited to 1.25 MAF including Exchange with SDCWA.
[5] Total demands are adjusted to include Exchange with SDCWA.

Table 6-6: MET's Projected Supply Capability and Demands through 2045 for a Normal Water Year

Drought Lasting Five Consecutive Water Years
Supply Capability[1] and Projected Demands
Repeat of 1988-1992 Hydrology
(Acre-feet per year)

Forecast Year	2025	2030	2035	2040	2045
Current Programs					
In-Region Supplies and Programs	191,000	196,000	197,000	197,000	197,000
California Aqueduct[2]	730,800	768,000	789,000	812,000	792,000
Colorado River Aqueduct					
Total Supply Available[3]	1,240,000	1,466,000	1,466,000	1,415,000	1,437,000
Aqueduct Capacity Limit[4]	*1,250,000*	*1,250,000*	*1,250,000*	*1,250,000*	*1,250,000*
Colorado River Aqueduct Capability	1,240,000	1,250,000	1,250,000	1,250,000	1,250,000
Capability of Current Programs	**2,161,800**	**2,214,000**	**2,236,000**	**2,259,000**	**2,239,000**
Demands					
Total Demands on Metropolitan	1,351,000	1,332,000	1,297,000	1,290,000	1,313,000
Exchange with SDCWA	278,000	278,000	278,000	278,000	278,000
Total Metropolitan Deliveries[5]	**1,629,000**	**1,610,000**	**1,575,000**	**1,568,000**	**1,591,000**
Surplus	**532,800**	**604,000**	**661,000**	**691,000**	**648,000**
Programs Under Development					
In-Region Supplies and Programs	0	0	0	0	0
California Aqueduct	0	0	0	0	0
Colorado River Aqueduct					
Total Supply Available[3]	0	0	0	0	0
Aqueduct Capacity Limit[4]	*10,000*	*0*	*0*	*0*	*0*
Colorado River Aqueduct Capability	*0*	*0*	*0*	*0*	*0*
Capability of Proposed Programs	**0**	**0**	**0**	**0**	**0**
Potential Surplus	**532,800**	**604,000**	**661,000**	**691,000**	**648,000**

[1] Represents Supply Capability for resource programs under listed year type.
[2] California Aqueduct includes Central Valley transfers and storage program supplies conveyed by the aqueduct.
[3] Colorado River Aqueduct includes programs and Exchange with SDCWA conveyed by the aqueduct.
[4] Maximum CRA deliveries limited to 1.25 MAF including Exchange with SDCWA.
[5] Total demands are adjusted to include Exchange with SDCWA.

6.2.2.2 MET's Drought Risk Assessment Results

For its DRA, MET assessed the reliability of each individual water supply source over the five consecutive year drought through a modeling method using the same historical hydrologic conditions as the water service reliability assessment: 1922 to 2017. MET used the five-consecutive years of 1988 to 1992 to complete its DRA, because this represents the driest five-consecutive year historic sequence for MET's supply. Even without activating WSCP actions, according to MET's UWMP Table 2-7, MET's water supply from the SWP and CRA can reliably meet the demands of a five-year drought from FY 2020-21 through FY 2024-25 (Table 6-7).

Table 6-7: MET's Projected Supply Capability and Demands during a Five-Year Drought

Metropolitan's Drought Risk Assessment
Water Use, Supply, and Risk Assessment for 2021 – 2025
(also included as Appendix 12 DWR Submittal Table 7-5)

Based on DWR DRA Optional Planning Tool (Annual totals in AF)

Water Use Worksheet	
Historic and Actual	
2016	1,663,599
2017	1,449,015
2018	1,560,487
2019	1,327,928
Customer Water Use Subtotal	1,394,261
Losses[1]	48,520
2020 Total Gross Water Use	**1,442,781**
Five Consecutive Water Years	
Change from 2020	186,219
2021 Gross Water Use	**1,629,000**
Change from 2021	68,000
2022 Gross Water Use	**1,697,000**
Change from 2022	23,000
2023 Gross Water Use	**1,720,000**
Change from 2023	(192,000)
2024 Gross Water Use	**1,528,000**
Change from 2024	101,000
2025 Gross Water Use	**1,629,000**

[1] Losses include treated system losses and surface reservoir evaporation.

Supply Worksheet[1]	
2021 (1st year)	**1,499,000**
2022 (2nd year)	**2,297,000**
2023 (3rd year)	**1,563,000**
2024 (4th year)	**1,731,000**
2025 (5th year)	**1,636,000**
Supply 1 - Colorado River Aqueduct supplies[2]	
2021 (1st year)	1,250,000
2022 (2nd year)	1,250,000
2023 (3rd year)	1,250,000
2024 (4th year)	1,250,000
2025 (5th year)	1,250,000
Supply 2 - State Water Project supplies	
2021 (1st year)	249,000
2022 (2nd year)	1,047,000
2023 (3rd year)	313,000
2024 (4th year)	481,000
2025 (5th year)	386,000
Supply 3 - In-Region supplies	
2021 (1st year)	0
2022 (2nd year)	0
2023 (3rd year)	0
2024 (4th year)	0
2025 (5th year)	0

DRAFT Submittal Table 7-5: Five-Year Drought Risk Assessment Tables to address Water Code Section 10635(b)

2021	Total
Gross Water Use	**1,629,000**
Total Supplies	**1,499,000**
Surplus/Shortfall w/o WSCP Action	**(130,000)**
Planned WSCP Actions (use reduction and supply augmentation)	
WSCP - supply augmentation benefit	130,000
WSCP - use reduction savings benefit	0
Revised Surplus/(shortfall)	0
Resulting % Use Reduction from WSCP action	**0%**

2022	Total
Gross Water Use [Use Worksheet]	**1,697,000**
Total Supplies [Supply Worksheet]	**2,297,000**
Surplus/Shortfall w/o WSCP Action	**600,000**
Planned WSCP Actions (use reduction and supply augmentation)	
WSCP - supply augmentation benefit	0
WSCP - use reduction savings benefit	0
Revised Surplus/(shortfall)	600,000
Resulting % Use Reduction from WSCP action	**0%**

2023	Total
Gross Water Use [Use Worksheet]	**1,720,000**
Total Supplies [Supply Worksheet]	**1,563,000**
Surplus/Shortfall w/o WSCP Action	**(157,000)**
Planned WSCP Actions (use reduction and supply augmentation)	
WSCP - supply augmentation benefit	157,000
WSCP - use reduction savings benefit	0
Revised Surplus/(shortfall)	0
Resulting % Use Reduction from WSCP action	**0%**

2024	Total
Gross Water Use [Use Worksheet]	**1,528,000**
Total Supplies [Supply Worksheet]	**1,731,000**
Surplus/Shortfall w/o WSCP Action	**203,000**
Planned WSCP Actions (use reduction and supply augmentation)	
WSCP - supply augmentation benefit	0
WSCP - use reduction savings benefit	0
Revised Surplus/(shortfall)	203,000
Resulting % Use Reduction from WSCP action	**0%**

2025	Total
Gross Water Use [Use Worksheet]	**1,629,000**
Total Supplies [Supply Worksheet]	**1,636,000**
Surplus/Shortfall w/o WSCP Action	**7,000**
Planned WSCP Actions (use reduction and supply augmentation)	
WSCP - supply augmentation benefit	0
WSCP - use reduction savings benefit	0
Revised Surplus/(shortfall)	7,000
Resulting % Use Reduction from WSCP action	**0%**

1. Includes Metropolitan's core supplies as defined in WSCP in Appendix 4. Detailed Supply Worksheets are included in Appendix 3 Table A.3-8.
2. Maximum CRA deliveries limited to 1.25 MAF, including Exchange with SDCWA and IID.

6.2.3 Planned Future Sources

Beyond the programs highlighted in Sections 6.2.1, MET continues to invest in efforts to meet its goal of long-term regional water supply reliability, focusing on the following:

- Continuing water conservation
- Developing water supply management programs outside of the region
- Developing storage programs related to the Colorado River and the SWP
- Developing storage and groundwater management programs within the Southern California region
- Increasing water recycling, groundwater recovery, stormwater and seawater desalination
- Pursuing long-term solutions for the ecosystem, regulatory and water supply issues in the California Bay-Delta (MET, 2021)

6.3 Groundwater

Among all local supplies available to MWDOC's service area, groundwater supplies make up the majority. The water supply resources within MWDOC's service area are enhanced by the existence of groundwater basins, which provide a reliable local source and, additionally, are used as reservoirs to store water during wet years and draw from storage during dry years.

MWDOC does not provide nor sell any groundwater to its retail agencies. However, its retail agencies do extract groundwater locally to diversify their portfolio. Table 6-8 shows a breakdown of historical groundwater production by the retail agencies from all groundwater basins within MWDOC's service area.

This section describes the five groundwater basins used by MWDOC's retail agencies and provides a 25-year projection of the service area's groundwater supply.

Table 6-8: Groundwater pumped in the Past 5 Years within MWDOC's Service Area (AF)

Groundwater Basin	Fiscal Year Ending				
	2016	2017	2018	2019	2020
OC Basin[1]	195,319	205,262	155,658	204,989	192,652
San Juan Basin	1,640	1,661	2,817	2,395	3,010
La Habra Basin	3,540	3,296	2,921	2,183	2,751
Main San Gabriel Basin	11,753	12,434	14,059	14,790	14,870
San Mateo Basin	433	462	620	411	390
Total Groundwater[2]:	**212,595**	**223,116**	**176,076**	**224,769**	**213,674**

NOTES:
[1] Includes only the MWDOC member agencies' groundwater production. Does not include the groundwater production of Anaheim, Fullerton, and Santa Ana.
[2] Total volumes are +/- 1 AF due to rounding

6.3.1 Orange County Groundwater Basin

This section describes the medium-priority OC Basin and the management measures taken by OCWD, the basin manager to optimize local supply and minimize overdraft.

The OCWD was formed in 1933 by a special legislative act of the California State Legislature to protect and manage the County's vast, natural, groundwater supply using the best available technology and defend its water rights to the OC Basin. This legislation is found in the State of California Statutes, Water – Uncodified Acts, Act 5683, as amended. The OC Basin is managed by OCWD under the Act, which functions as a statutorily-imposed physical solution. The OCWD Management Area includes approximately 89 percent of the land area of the OC Basin, and 98 percent of all groundwater production occurs within the area. Approximately 2.5 million residents live within OCWD's boundaries and rely upon the basin for their primary water supply. OCWD manages water resource monitoring programs, land use elements related to basin management, groundwater elevation, groundwater quality, and coastal area monitoring through a number of monitoring programs. OCWD monitors the basin by collecting groundwater elevation and quality data from approximately 400 District-owned wells and manages an electronic database that stores water elevation, water quality, production, recharge, and other data on over 2,000 wells and facilities within and outside OCWD boundaries (City of La Habra et al., 2017). For detailed monitoring programs and management information, refer to the 2017 Basin 8-1 Alternative (Appendix D).

Groundwater levels are managed within a safe basin operating range to protect the long-term sustainability of the OC Basin and to protect against land subsidence. OCWD regulates groundwater levels in the OC Basin by regulating the annual amount of pumping and setting the Basin Production Percentage (BPP) for the water year. As defined in the District Act, the BPP is the ratio of water produced from groundwater supplies within the OCWD service area to all water produced within the area from both supplemental sources and groundwater within the OCWD (OCWD, 2020a).

6.3.1.1 Basin Characteristics

The OC Basin underlies the northern half of Orange County beneath broad lowlands. The OC Basin, managed by OCWD, covers an area of approximately 350 square miles, bordered by the Coyote and Chino Hills to the north, the Santa Ana Mountains to the northeast, and the Pacific Ocean to the southwest. The OC Basin boundary extends to the Orange County-Los Angeles Line to the northwest, where groundwater flows across the county line into the Central Groundwater Basin of Los Angeles County. A map of the OC Basin is shown on Figure 6-5. The total thickness of sedimentary rocks in the OC Basin is over 20,000 feet, with only the upper 2,000 to 4,000 feet containing fresh water. The OC Basin's full volume is approximately 66 MAF.

There are three major aquifer systems that have been subdivided by OCWD, the Shallow Aquifer System, the Principal Aquifer System, and the Deep Aquifer System. These three aquifer systems are hydraulically connected as groundwater is able to flow between each other through intervening aquitards or discontinuities in the aquitards. The Shallow Aquifer system occurs from the surface to approximately 250 feet below ground surface. Most of the groundwater from this aquifer system is pumped by small water systems for industrial and agricultural use. The Principal Aquifer system occurs at depths between 200 and 1,300 feet below ground surface. Over 90 percent of groundwater production is from wells that are screened within the Principal Aquifer system. Only a minor amount of groundwater is pumped from the Deep Aquifer system, which underlies the Principal Aquifer system and is up to 2,000 feet deep in the center of the OC Basin.

Per- and polyfluoroalkyl substances (PFAS) are a group of thousands of manmade chemicals that includes perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS). PFAS compounds were once commonly used in many products including, among many others, stain- and water-repellent fabrics, nonstick products (e.g., Teflon), polishes, waxes, paints, cleaning products, and fire-fighting foams. Beginning in the summer of 2019, the California State Division of Drinking Water (DDW) began requiring testing for PFAS compounds in some groundwater production wells in the OCWD area.

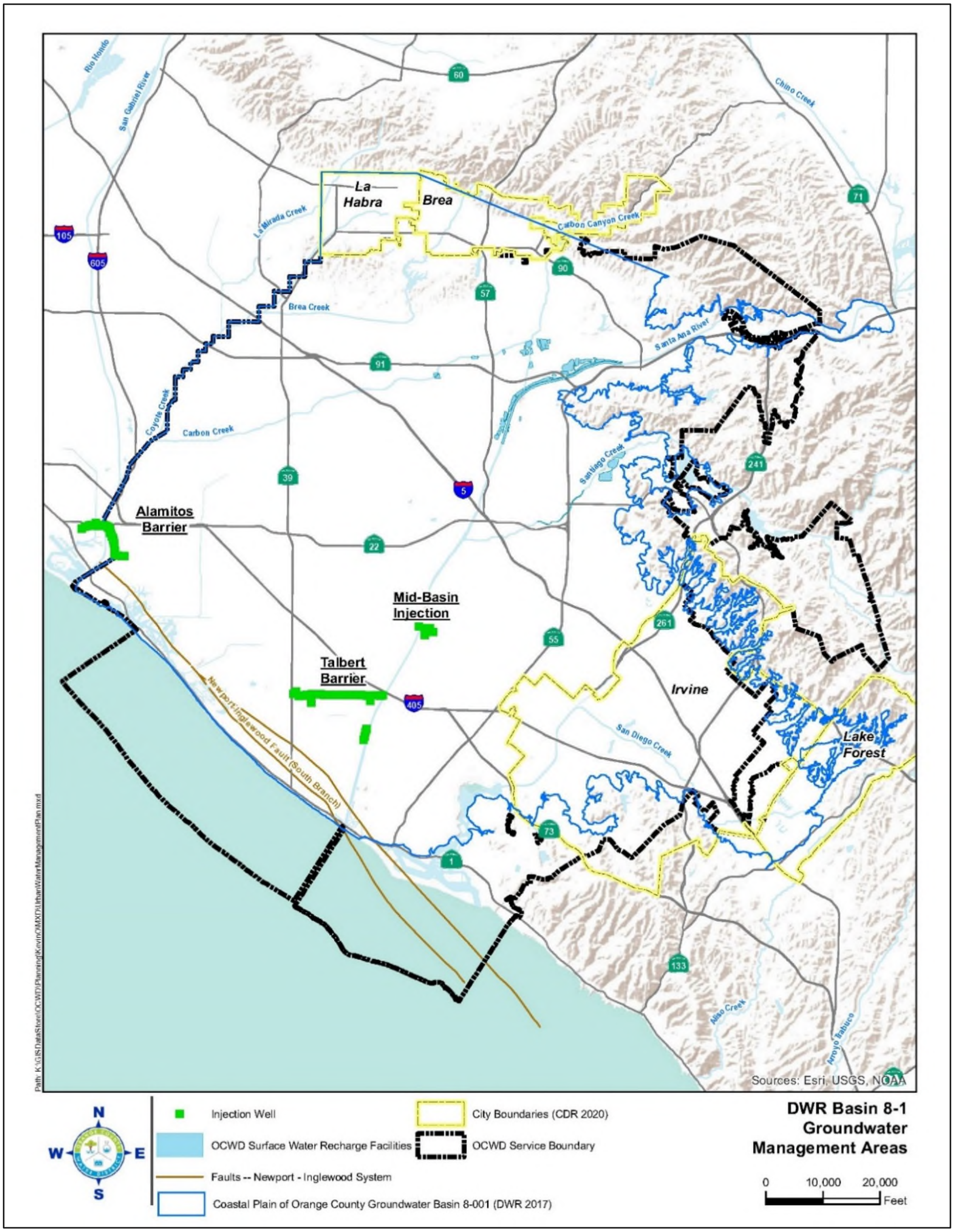


Figure 6-5: Map of the OC Basin

Groundwater production in FY 2019-20 was expected to be approximately 325,000 acre-feet but declined to 286,550 acre-feet primarily due to PFAS impacted wells being turned off around February 2020. OCWD expects groundwater production to be in the area of 245,000 acre-feet in FY 2020-21 due to the currently idled wells and additional wells being impacted by PFAS and turned off. As PFAS treatment systems are constructed, OCWD expects total annual groundwater production to slowly increase back to normal levels (310,000 to 330,000 acre-feet) (OCWD, 2020a).

6.3.1.2 Sustainable Groundwater Management Act

In 2014, the State of California adopted the Sustainable Groundwater Management Act (SGMA) to help manage its groundwater sustainably, and limit adverse effects such as significant groundwater-level declines, land subsidence, and water quality degradation. SGMA requires all high- and medium-priority basins, as designated by DWR, be sustainably managed. DWR designated the Coastal Plain of OC Basin as a medium-priority basin, primarily due to heavy reliance on the OC Basin's groundwater as a source of water supply. Compliance with SGMA can be achieved in one of two ways (City of La Habra et al., 2017):

1. A Groundwater Sustainability Agency (GSA) is formed and a GSP is adopted, or
2. Special Act Districts created by statute, such as OCWD, and other agencies may prepare and submit an Alternative to a GSP

Led by OCWD, the agencies within Basin 8-1, including La Habra, collaborated to submit an Alternative to a GSP in 2017, titled the "Basin 8-1 Alternative" to meet SGMA compliance. This document will be updated every five years. The current (2017) version is included in Appendix D.

6.3.1.3 Basin Production Percentage

Background

The OC Basin is not adjudicated and as such, pumping from the OC Basin is managed through a process that uses financial incentives to encourage groundwater producers to pump a sustainable amount of water. The framework for the financial incentives is based on establishing the BPP, the percentage of each Producer's total water supply that comes from groundwater pumped from the OC Basin. Groundwater production at or below the BPP is assessed the Replenishment Assessment (RA). While there is no legal limit as to how much an agency pumps from the OC Basin, there is a financial disincentive to pump above the BPP. The BPP is set uniformly for all Producers by OCWD on an annual basis. Agencies that pump above the BPP are charged the RA plus the Basin Equity Assessment (BEA). The BEA is presently calculated so that the cost of groundwater production is equivalent to the cost of importing potable water supplies. This approach serves to discourage, but not eliminate, production above the BPP, and the BEA can be increased to discourage production above the BPP if necessary.

The BPP is set based on groundwater conditions, availability of imported water supplies, and Basin management objectives. The supplies available for recharge must be estimated for a given year. The supplies of recharge water that are estimated are: 1) Santa Ana River stormflow, 2) Natural incidental recharge, 3) Santa Ana River baseflow, 4) GWRS supplies, and 5) other supplies such as imported water and recycled water purchased for the Alamitos Barrier. The BPP is a major factor in determining the cost of groundwater production from the OC Basin for that year. The BPP set for Water Year 2021-22 is 77%.

BPP Adjustments for Basin Management

OCWD has established management guidelines that are used to establish future BPPs, as seen in Table 6-9. Raising or lowering the BPP allows OCWD to manage the amount of pumping from the basin. OCWD has a policy to manage the groundwater basin within a sustainable range to avoid adverse impacts to the basin. OCWD seeks to maintain some available storage space in the basin to maximize surface water recharge when such supplies are available, especially in relatively wet years. By keeping the basin relatively full during wet years, and for as long as possible in years with near-normal recharge, the maximum amount of groundwater could be maintained in storage to support pumping in future drought conditions. During dry hydrologic years when less water would be available for recharge, the BPP could be lowered to maintain groundwater storage levels. A component of OCWD's BPP policy is to manage the groundwater basin so that the BPP will not fluctuate more that 5 percent from year to year.

Based on most recent modeling of water supplies available for groundwater recharge and water demand forecasts, OCWD anticipates being able to sustain the BPP at 85% starting in 2025. The primary reasons for the higher BPP are the expected completion of the GWRS Final Expansion (GWRSFE) in 2023 and the relatively low water demands of approximately 400,000 afy.

Modeling and forecasts generate estimates based on historical averages. Consequently, forecasts use average hydrologic conditions which smooth the dynamic and unpredictable local hydrology. Variations in local hydrology are the most significant impact to supplies of water available to recharge the groundwater basin. The BPP projection of 85% is provided based upon average annual rainfall weather patterns.
If OCWD were to experience a relatively dry period, the BPP could be reduced to maintain water storage levels, by as much as five percent.

Table 6-9: Management Actions Based on Changes in Groundwater Storage

Available Storage Space (amount below full basin condition, AF)	Basin Management Action to Consider
Less than 100,000	Raise BPP
100,000 to 300,000	Maintain and / or raise BPP towards 75% goal
300,000 to 350,000	Seek additional supplies to refill basin and / or lower the BPP
Greater than 350,000	Seek additional supplies to refill basin and lower the BPP

BPP Exemptions

In some cases, OCWD encourages treating and pumping groundwater that does not meet drinking water standards in order to protect water quality. This is achieved by using a financial incentive called the BEA Exemption. A BEA Exemption is used to promote beneficial uses of poor-quality groundwater and reduce or prevent the spread of poor-quality groundwater into non-degraded aquifer zones. OCWD uses a partial or total exemption of the BEA to compensate a qualified participating agency or Producer for the costs of treating poor quality groundwater, which typically include capital, interest and operations and maintenance costs for treatment facilities. (City of La Habra et al., 2017). Similarly, for proactive water quality management, OCWD exempts a portion of the BEA for their Coastal Pumping Transfer Program

(CPTP). The CPTP encourages inland groundwater producers to increase pumping and coastal producers to decrease pumping in order to reduce the groundwater basin drawdown at the coast and protect against seawater intrusion. Inland pumpers can pump above the BPP without having to pay the full BEA for the amount pumped above the BPP (OCWD, 2015). Coastal pumpers receive BEA revenue from OCWD to assist in offsetting their additional water supply cost from taking less groundwater.

6.3.1.3.1 OCWD Groundwater Reliability Plan

In order to adapt to the substantial growth in water demands in OCWD's management area, it is paramount to anticipate and understand future water demands and develop projects to increase future water supplies proactively to match demands. The GRP is a continuation of these planning efforts that estimates the OC Basin's sustainable average annual production and extrapolates water needs of the OC Basin by combining recently completed water demand projections and modeling of Santa Ana River flows available for recharge. These data will be used to evaluate future water supply projects and guide management of the OC Basin. OCWD is currently developing the GRP, and the first public draft is expected to be available May 2021.

Current water demand projections show a relatively slow increase over the 25-year planning horizon, which is generally of similar magnitude as the additional production from the GWRSFE in early 2023. Once complete, the GWRSFE will increase capacity from 100,000 to 134,000 AFY of high-quality recycled water. This locally controlled, drought proof supply of water reduces the region's dependance on imported water.

Historically, the Santa Ana River has served as the primary source of water to recharge the OC Basin. To determine the availability of future Santa Ana River flows, OCWD utilized surface water flow modeling of the upper watershed. Modeling was developed to predict the impacts future stormwater capture and wastewater recycling projects in the upper watershed would have on future Santa Ana River flow rates at Prado Dam. Santa Ana River base flows are expected to decrease as more water recycling projects are built in the upper watershed. OCWD continues to work closely with the US Army Corps of Engineers to temporarily impound and slowly release up to approximately 20,000 AF of stormwater in the Prado Dam Conservation Pool. To some extent, the losses in baseflow are partially offset through the capture of additional stormwater held in the Prado Dam Conservation Pool. When available, OCWD will continue to augment groundwater recharge through the purchase of imported water through MET. OCWD will diligently monitor and evaluate future water supply projects to sustainably manage and protect the OC Basin for future generations.

6.3.1.3.2 OCWD Engineer's Report

The OCWD Engineer's Report reports on the groundwater conditions and investigates information related to water supply and groundwater basin usage within OCWD's service area.

The overall BPP achieved in the 2019 to 2020 water year within OCWD for non-irrigation use was 75.9 percent. The achieved pumping was less than the BPP established for the 2019 to 2020 water year primarily due to the water quality impacts of PFAS. A BPP of 77 percent will be used for water year 2021-22. Analysis of the OC Basin's projected accumulated overdraft, the available supplies to the OC Basin (assuming average hydrology) and the projected pumping demands indicate that this level of pumping can be sustained for 2021-22 without detriment to the OC Basin (OCWD, 2021).

In FY 2021-22 additional production of approximately 22,000 AF above the BPP will be undertaken by the City of Tustin, City of Garden Grove, City of Huntington Beach, Mesa Water, and IRWD. These agencies use the additional pumping allowance in order to accommodate groundwater quality improvement projects. As in prior years, production above the BPP from these projects would be partially or fully exempt from the BEA as a result of the benefit provided to the OC Basin by removing poor-quality groundwater and treating it for beneficial use (OCWD, 2021).

6.3.1.4 Recharge Management

Recharging water into the OC Basin through natural and artificial means is essential to support pumping from the OC Basin. Active recharge of groundwater began in 1949, in response to increasing drawdown of the OC Basin and, consequently, the threat of seawater intrusion. The OC Basin's primary source of recharge is flow from the Santa Ana River, which is diverted into recharge basins and its main Orange County tributary, Santiago Creek. Other sources of recharge water include natural infiltration, recycled water, and imported water. Natural recharge consists of subsurface inflow from local hills and mountains, infiltration of precipitation and irrigation water, recharge in small flood control channels, and groundwater underflow to and from Los Angeles County and the ocean.

Recycled water for the OC Basin recharge is from two sources. The main source of recycled water is from the GWRS, which is injected into the Talbert Seawater Barrier and recharged in the Kraemer, Miller, Miraloma and La Palma Basins (City of La Habra et al., 2017). The second source of recycled water is water purified at the Water Replenishment District's Leo J. Vander Lans Treatment Facility, which supplies water to the Alamitos Seawater Barrier (owned and operated by the Los Angeles County Department of Public Works). OCWD's share of the Alamitos Barrier injection total for water year 2018-19 was less than half of the total injection, based on barrier wells located within Orange County. The Water Replenishment District of Southern California (WRD) also works closely with OCWD to ensure that the water demands at the Alamitos Barrier are fulfilled through the use of recycled water as opposed to imported water, however the recycled portion was less than 33 percent for the last six years due to operational issues and wastewater supply interruptions (OCWD, 2020a). Injection of recycled water into these barriers is an effort by OCWD to control seawater intrusion into the OC Basin. Operation of the injection wells forms a hydraulic barrier to seawater intrusion.

OCWD purchases imported water for recharge from MWDOC. Untreated imported water can be used to recharge the OC Basin through the surface water recharge system in multiple locations, such as Anaheim Lake, Santa Ana River, Irvine Lake, and San Antonio Creek. Treated imported water can be used for in-lieu recharge, as was performed extensively from 1977 to 2007 (City of La Habra et al., 2017). For detailed recharge management efforts from OCWD, refer to OCWD's 2017 Basin 8-1 Alternative (Appendix D).

6.3.1.5 MET Imported Water for Groundwater Replenishment

In the past OCWD, MWDOC, and MET have coordinated water management to increase storage in the OC Basin when imported supplies are available for this purpose. MET's groundwater replenishment program was discontinued on January 1, 2013, and currently MET via MWDOC sells replenishment water to OCWD at the full-service untreated MET rate. Figure 6-6 shows MWDOC's imported water sales to OCWD since FY 1990-91, which averages approximately 31,200 AF per year. Recently, due to low Santa

Ana River flows as a result of low precipitation and increased use along the river, OCWD has needed to purchase more imported replenishment water per year than the average of 31,200 AFY over the last 25 years (this does not include water amounts from MET's Conjunctive Use Program (CUP) or its Cyclic Storage Account). However, with the emergence of PFAS affecting groundwater production, the need of purchasing imported water has been temporary suspended. Until PFAS treatment is in place for most groundwater producers, imported replenishment water will be significantly reduced.

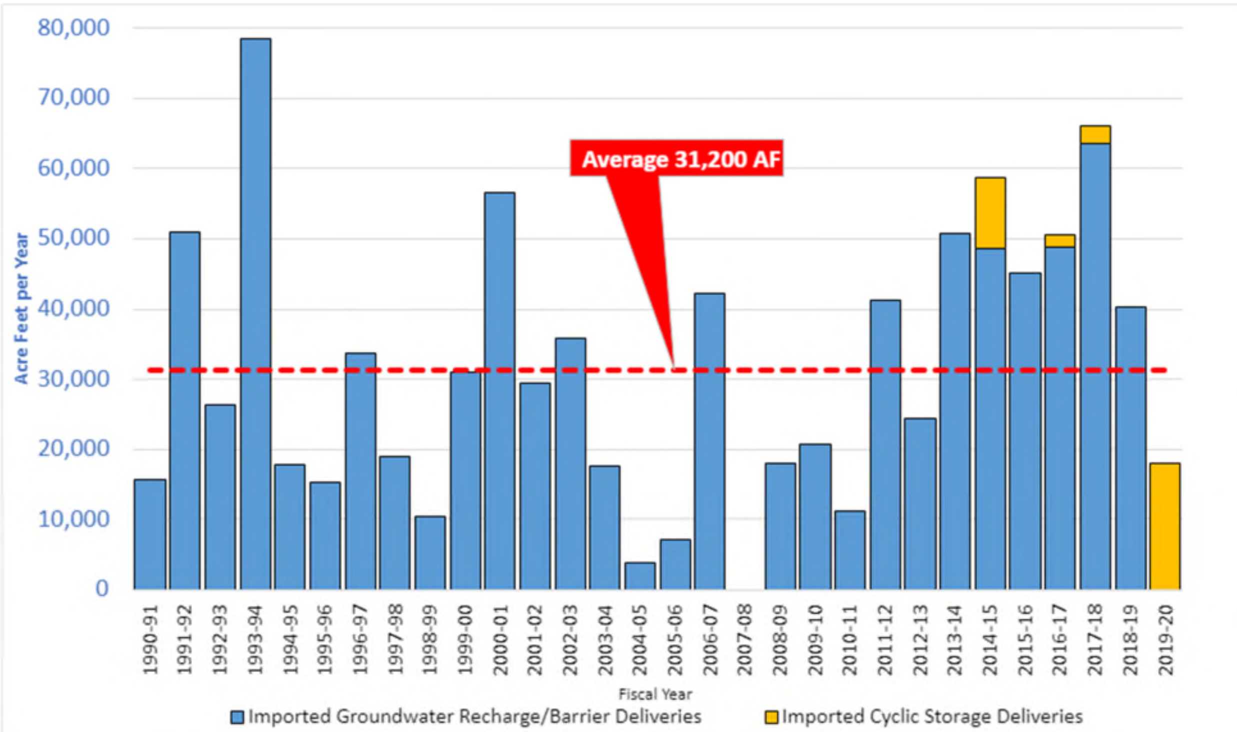


Figure 6-6: MWDOC Imported Water Sales for Groundwater Replenishment

6.3.1.6 MET Conjunctive Use/Cyclic Storage Program with OCWD

Since 2004, OCWD, MWDOC, and certain groundwater producers have participated in MET's CUP. This program allows for the storage of MET water in the OC Basin. The existing MET program provides storage of up to 66,000 AF of water in the OC Basin to be pumped by participating producers in place of receiving imported supplies during dry years or water shortage events. In exchange, MET contributed to improvements in basin management facilities and to an annual administrative fee. These improvements included eight new groundwater production wells, improvements to the seawater intrusion barrier, and construction of the Diemer Bypass Pipeline. The water is accounted for via the CUP program administered by the wholesale agencies and is controlled by MET such that it can be withdrawn over a three-year time period (OCWD, 2020a).

The CUP account was filled in the wet years of 2007 & 2013 and withdrawn to near-zero during the dry-years of 2010 & 2016. MET has not stored water in the CUP account since 2014, and the CUP account has been withdrawn to zero and is projected to remain at 0 AF by the end of 2021. The CUP contract with MET ends in 2028.

As so, the values in Figure 6-7 from 2015 onwards, represent only volumes from the MET Cyclic Storage Agreement. The Cyclic Storage account is an alternative storage account with MET. However, unlike the CUP program, OCWD controls when the water is used. The Cyclic Water Storage Program allows MET to store water in a local groundwater basin during surplus conditions, where MET has limited space in its regional storage locations. Once the water is stored via direct delivery or In-lieu the groundwater agency has the ability to purchase this water at a future date or over a 5-year period.

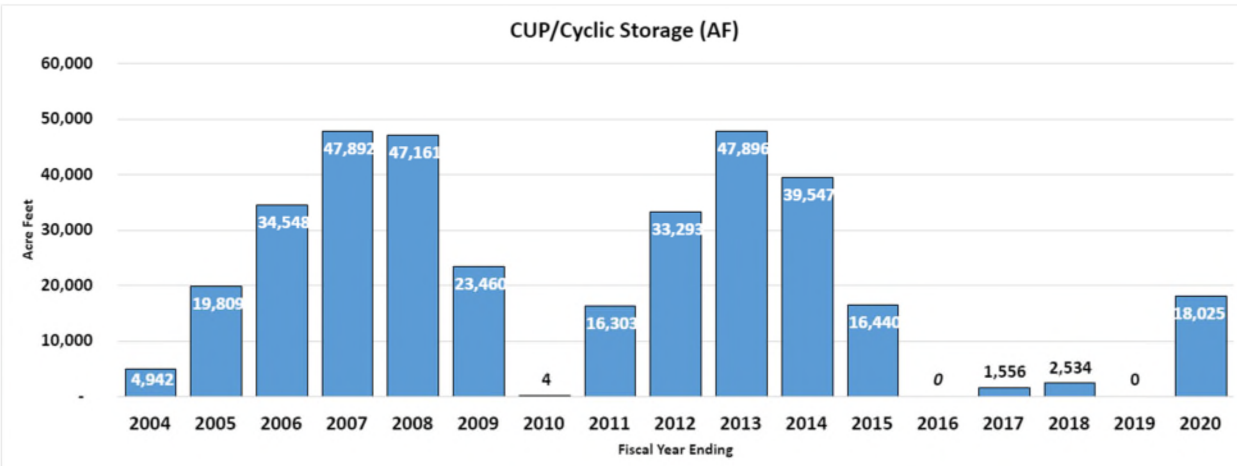


Figure 6-7: MWDOC Conjunctive Use Program Historical Storage Balance

6.3.2 Other Groundwater Basins

6.3.2.1 San Juan Groundwater Basin

Basin Characteristics

Per DWR's designation, the San Juan Basin is a non-adjudicated, very low-priority basin (DWR, 2019). The San Juan Basin is located in the San Juan Creek Watershed and is comprised of four principal groundwater basins: 1) Lower Basin, 2) Middle Basin, 3) Upper Basin, and 4) Arroyo Trabuco. A map of the four principal groundwater basins is shown in Figure 6-8. The Middle Basin, Lower Basin, and Lower Trabuco consists of approximately 5.9 square miles of water bearing alluvium. Groundwater occurs in the relatively thin alluvial deposits along the valley floors and within the major stream channels. The younger alluvial deposits within the San Juan Basin consists of a heterogeneous mixture of sand, silts, and gravel.

Water quality in the San Juan Basin ranges from good to poor, as the deep lower basins contain brackish water that requires treatment, while the shallower upper subbasin has lower total dissolved solids (TDS) concentration. Groundwater production occurs primarily within the Lower Arroyo Trabuco, the Middle Basin, and the Lower Basin due to lack of storage and production capacity in the Upper Basin. Groundwater production within the San Juan Basin faces additional challenges including shallow bedrock conditions, elevated dissolved solids content of the water, riparian habitat constraints on groundwater level drawdown, permit limits, and climate changes or drought conditions.

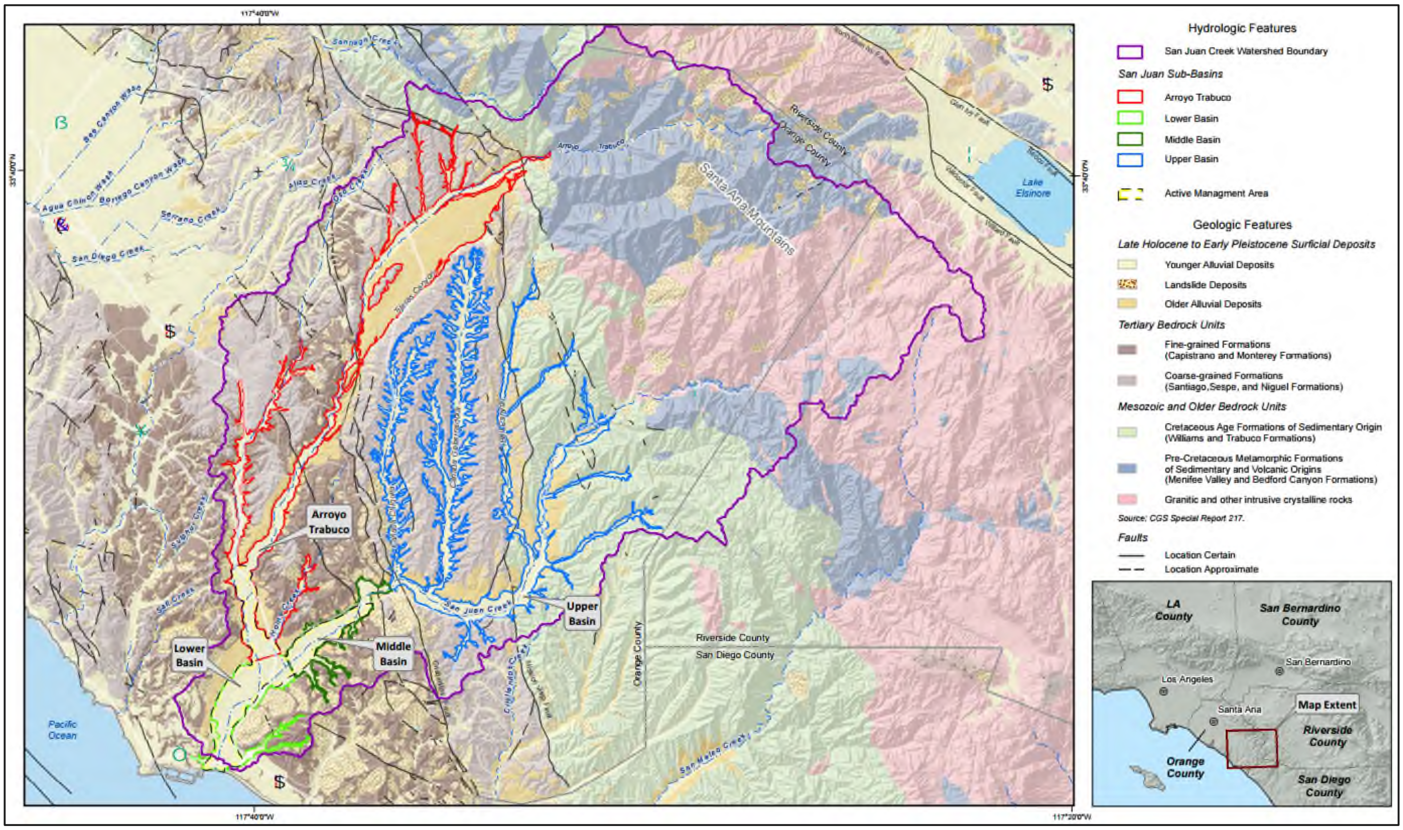


Figure 6-8: Principal Groundwater Basins for the San Juan Groundwater Basin

The physical boundaries of the San Juan Basin include the Santa Ana Mountain to the north, sedimentary rock formations to the sides of the Upper Basin and Arroyo Trabuco, and the Pacific Ocean to the south.

The San Juan Basin is recharged through a variety of sources such as:

- Streambed infiltration in San Juan Creek, Horno Creek, Oso Creek, and Arroyo Trabuco.
- Subsurface inflows along boundaries at the head of the tributaries upstream and other minor subsurface inflows from other boundaries.
- Precipitation and applied water.
- Flow from fractures and springs.

Discharge of groundwater from the San Juan Basin occurs from a variety of sources such as:

- Groundwater production
- Rising groundwater
- Evapotranspiration
- Outflow to Pacific Ocean

Currently, three agencies, have groundwater rights to the San Juan Basin and use this water for either municipal purposes or for irrigation. The agencies with groundwater rights to the Basin and their 2020 pumping allocations are listed below (Wildermuth Environmental, Inc., 2020):

- South Coast Water District: 1,300 AFY
- San Juan Basin Authority (SJBA): 12,500 AFY
- City of San Juan Capistrano: 6,150 AFY of SJBA's water rights, including 5,800 AFY at the Alipaz well field and Tirador well and up to 350 AFY for the San Juan Hills Golf Club

Basin Management

The SWRCB has determined that the San Juan Creek watershed is not a groundwater basin but is rather a surface and underground flowing stream. Therefore, it is subject to SWRCB jurisdiction and its processes with respect to the appropriation and use of waters within the watershed. The SJBA is a joint powers agency comprised of representatives from four local jurisdictions formed in 1971 to manage the watershed. Member agencies include SCWD, City of San Juan Capistrano, MNWD, and SMWD. Both the SJBA and SCWD have their own SWRCB Permit for Diversion and Use of Water: Permit No. 21074 and Permit No. 21138, respectively (Wildermuth Environmental, Inc., 2020).

The San Juan Basin differs from many adjudicated groundwater basins as it does not strictly follow the term "safe yield" in preventing undesirable results occurring as a result of over-production of groundwater. The SJBA adopted the concept of "adaptive management" of the Basin to vary pumping from year to year based on actual basin conditions derived from monitoring efforts, with the groundwater management implication that during dry periods groundwater pumping will be lower than in wet periods. SJBA serves as the "Basin Manager" responsible for annually determining the amounts of adapted "available safe yield" so that SJBA and SCWD can pump pursuant to their water rights, so that 80% of water available for pumping goes to SJBA (up to a maximum of 12,500 AFY), and 20% goes to SCWD (up to a maximum of 1,300 AFY) (Wildermuth Environmental, Inc., 2020).

Following the recommendations of the San Juan Basin Groundwater and Facilities Management Plan (Appendix E), SJBA began developing adaptive pumping management (APM) plans to annually determine the water available for pumping. The first APM plan was the 2016 plan and the most current at the time of this writing is the 2020 plan. The plans are updated each April, after most of the rainy season has passed, to define and initial pumping allocation for the subsequent 12-month period (May to April) based on current Basin conditions. Adjustments to the initial allocation are made as appropriate. Based on climate conditions and groundwater levels in the Inland and Stonehill management zones, the Basin is near full, indicating that the initial 2020 pumping allocations may be set at the maximum limits (Wildermuth Environmental, Inc., 2020).

The APM plan also discusses the various efforts SJBA leads in order to support the continued sustainable production from the Basin. Examples of such efforts include aquifer testing to better understand Basin characteristics and monthly water quality and water level monitoring programs (Wildermuth Environmental, Inc., 2020). For the full text of the 2020 APM plan, refer to Appendix F.

The storage in the groundwater basin is small, at an estimated 41,400 AF, relative to recharge and production. The range of natural yield of the San Juan Basin is 7,000 AFY to 11,000 AFY. Instream recharge along both San Juan Creek and Arroyo Trabuco Creek is the only viable largescale recharge method for the San Juan Basin due to the lack of suitable off-stream sites for stormwater storage and recharge, and the inability of the basin to accept large amounts of recharge at a specific site (SJBA, 2016).

6.3.2.2 La Habra Groundwater Basin

Basin Characteristics

The unadjudicated La Habra Groundwater Basin covers parts of Los Angeles County and Orange County and is part of both the Central Basin, and the OC Basin, which are both medium-priority basins. The Basin lies entirely within the Coyote Creek Watershed and the La Habra Basin area is shown on Figure 6-9. A portion of the La Habra Basin is located within Central Basin as well as the northern tip of the OC Basin.

The City of La Habra has been deemed the exclusive GSA under SGMA for the La Habra-Brea Management Area. This management area is part of Basin 8-1 but is hydrogeologically distinct from the OCWD Management Area and is not under the jurisdiction of OCWD. La Habra adopted a resolution to establish the La Habra Basin as a separate basin from Basin 8-1. OCWD adopted a resolution to support the City's request to DWR for an internal jurisdictional boundary modification in the OC Basin that follows the city limits of La Habra and Brea as it is outside of the OCWD's jurisdictional boundary.

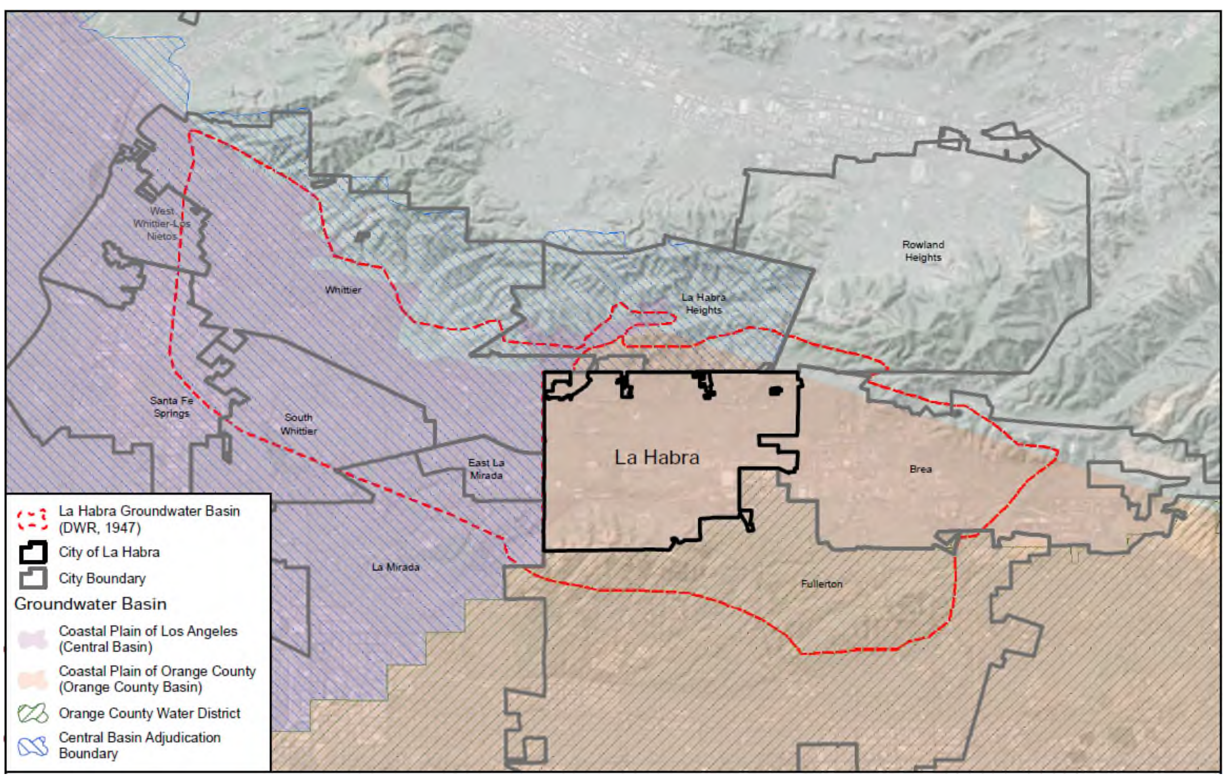


Figure 6-9: La Habra Groundwater Basin

From a structural geological standpoint, the La Habra Basin area is dominated by the northwest trending La Habra Syncline (a U–shaped down–fold) which is bounded on the north by the Puente Hills and on the south by the Coyote Hills. The fold is a naturally occurring trough, or valley, where significant quantities of groundwater have accumulated over the past 150,000 years. The La Habra Basin consists of three water-bearing zones: 1) the Alluvium, 2) the La Habra Formation (including the Coyote Hills Formation), and 3) the San Pedro Formation.

The Alluvium is comprised of young and old alluvium. The deposits are found along the surface stream courses and is composed of unconsolidated silt, clay, sand, and gravel. Alluvium thickness ranges from a few feet to over 100 feet. Generally, the La Habra Formation lies below the Alluvium, consisting of the La Habra and Coyote Hills Formations. However, in the Coyote Hill and Puente Hills, the Alluvium is uplifted and exposed. The La Habra Formation consists of non-marine mudstone, siltstone, sandstone, and conglomerate. It ranges in thickness from 300 to nearly 1,200 feet. Water levels of wells in the La Habra Formation have been measured between 100 and 200 feet below ground surface across the Basin.

Underneath the La Habra Formation lies the San Pedro Formation. As the deepest water bearing unit, the San Pedro Formation is comprised of sand, gravel, sandstone, conglomerate, and shale. The San Pedro Formation ranges between 200 and 400 feet in thickness and produces the best quality groundwater of all the water bearing zones. Pressure levels of confined groundwater in wells of the San Pedro aquifer zone range from about 100 to 200 feet below ground surface (La Habra, Groundwater Study, August 2014).

Basin Management and Safe Yield

As stated in Section 6.3.1.1, the agencies within Basin 8-1, such as the City of La Habra, collaborated to submit an Alternative to a GSP in 2017, titled the "Basin 8-1 Alternative" to meet SGMA compliance. This document supersedes the Groundwater Management Plan from 2014 and will be updated every five years. The current (2017) version of the SGMA-compliant document is included in Appendix D.

The La Habra Basin is not adjudicated. Instead, the City of La Habra follows a "safe yield" which is used for the management and future planning of the La Habra Basin for sustained beneficial use. The safe yield is the volume of groundwater that can be pumped without depleting the aquifer to a point where it cannot recover through natural recharge over a reasonable period of time.

The safe yield for the La Habra Basin was estimated to be approximately 4,500 AFY. This safe yield was determined through an average from two separate studies that took into account natural groundwater recharge and natural groundwater discharge. The La Habra Basin continues to be managed sustainably by maintaining and coordinating groundwater production within the estimated safe yield. The City of La Habra is also evaluating its existing monitoring program with the intent to develop a more robust groundwater elevation and water quality monitoring program (La Habra, 2020).

Historical and Current Groundwater Extraction

From 1922 to the early 1940's water levels in the La Habra Basin declined markedly because of increased water extraction and deficient rainfall. Water levels rose in the mid 1940's and then declined again in the late 1940's reaching the lowest recorded levels in the middle to late 1950's. From 1960 to 1977, water levels increased in elevation because of a significant decrease in water extraction. Based upon recorded stream runoff yields, it is estimated that approximately 2,100 AF of water would percolate during the average year. For direct percolation of rainfall and resulting runoff within the valley itself, it is estimated that an average of 1,600 AFY would percolate. Thus, the groundwater recharge is estimated at approximately 3,700 AFY. Subsurface flow estimates are about 5,500 AFY. Therefore, it is estimated that the average long–term supply that can be extracted without severe or sustained changes in the amount of groundwater in storage, is approximately 4,500 AFY (an average of the two values).

The City of La Habra pumps local groundwater from the La Habra Basin from three production wells for drinking water purposes and one non-potable groundwater well used for irrigation. Groundwater production in the La Habra Basin has ranged from 3,295 AF in FY 2016-17 to 2,245 AF in FY 2018-19 (La Habra, 2020).

6.3.2.3 Main San Gabriel Groundwater Basin

California Domestic Water Company (CDWC) has water rights, production, treatment and conveyance facilities in the adjudicated Main San Gabriel Groundwater Basin that serve customers overlying the basin within Suburban Water Systems as well as serving the cities of Brea and La Habra in Orange County. Based on the ten-year average from FY 2010-11 through 2019-20, Brea and La Habra purchase approximately 13,261 AFY of Main San Gabriel Groundwater Basin groundwater from CDWC, but this volume varies from year to year.

There is not a limit or cap on the amount of water CDWC can produce from the basin. CDWC owns approximately 12,363 AF of prescriptive pumping rights in the Main San Gabriel Basin. Prescriptive pumping rights are adjusted based on the determination of the Operating Safe Yield (OSY) annually. Based on the FY 2020-21 OSY set at 150,000 AF, CDWC's prescriptive pumping rights total 9,383.24 AF. Currently, this is the amount of groundwater CDWC can produce from the basin before incurring replacement water assessments, further described in Section 6.3.2.3.1.

The Main San Gabriel Basin and its operations are described below.

Basin Characteristics

The Main San Gabriel Basin lies in eastern Los Angeles County and occupies most of San Gabriel Valley. The hydrologic basin or watershed coincides with a portion of the upper San Gabriel River watershed, and the aquifer or groundwater basin underlies most of the San Gabriel Valley. It is bounded on the north by the San Gabriel Mountains, on the northwest by Raymond Basin, on the southeast by Puente Basin, and on the south by Central Basin. The Main San Gabriel Basin encompasses approximately 107,000 acres and has a storage of 8.9 MAF when the groundwater elevation at the Baldwin Park Key Well is 316 feet. Generally speaking, one foot of groundwater elevation is equivalent to approximately 8,000 AF of storage.

The hydrogeological San Gabriel Basin is divided between three sub-basins, Main Basin, Puente Basin, and portions of Six Basins area. A portion of Six Basins area is tributary to the Main Basin. Each of the sub-basins are adjudicated and managed separately.

Major sources of recharge to the Main San Gabriel Basin are infiltration of rainfall on the valley floor and runoff from the nearby mountains. The Main San Gabriel Basin is the first of a series of basins to receive the water from mountain runoff. The Main San Gabriel Basin interacts hydrogeologically and institutionally with adjoining basins, including Puente Basin, Central Basin, and West Coast Basin (Main San Gabriel Basin Watermaster, 2020a).

Figure 6-10 depicts the boundaries of the Main San Gabriel Basin.

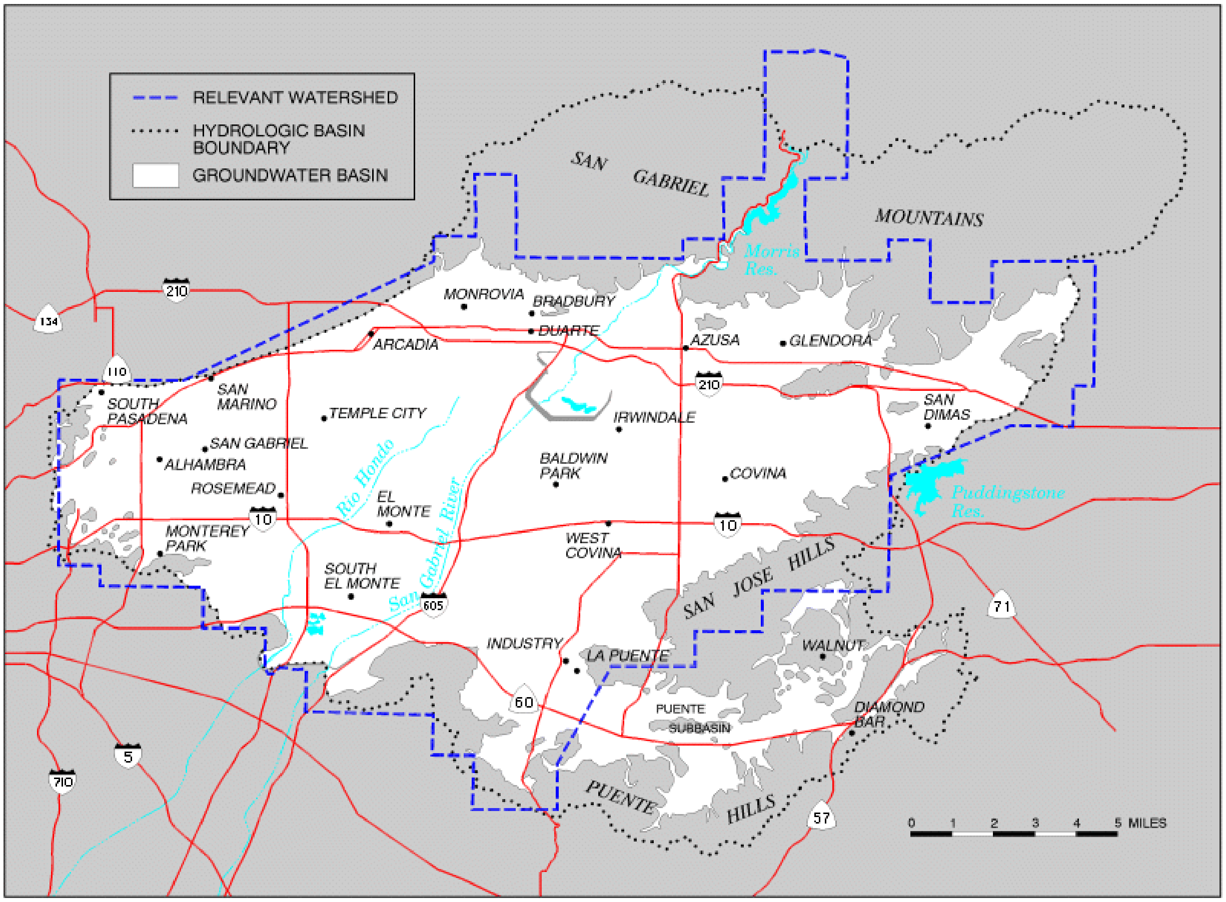


Figure 6-10: Main San Gabriel Groundwater Basin

6.3.2.3.1 Basin Judgment

Rapid urbanization in the San Gabriel Valley in the 1940s resulted in an increased demand for groundwater drawn from the Upper Area users in Main San Gabriel Basin. Consequently, the Main San Gabriel Basin was in a state of overdraft and the available water supply for the Lower Area and downstream users decreased. In 1968, at the request of producers, the Upper San Gabriel Municipal Water District filed a complaint that would adjudicate water rights in the Basin and would bring all Basin producers under control of one governing body. The final result was the entry of the Main San Gabriel Basin Judgment in 1973.

The Judgment defined the water rights of 190 original parties to the legal action. It created a new governing body, the Main San Gabriel Basin Watermaster, and described a program for management of water in the Basin. Under the terms of the Main San Gabriel Basin Judgment all rights to the diversion of surface water and production of groundwater within the Main Basin and its relevant watershed were adjudicated. The Main Basin Judgment does not restrict the quantity of water agencies may extract from the Main Basin. Rather, it provides a means for replacing with Supplemental Water all annual extractions in excess of an agency's annual right to extract water. The Main Basin Watermaster annually establishes an OSY for the Main Basin that is then used to allocate to each agency its portion of the OSY that can be produced free of a Replacement Water Assessment. If a producer extracts water in excess of his right under the annual OSY, it must pay an assessment for Replacement Water that is sufficient to purchase one AF of Supplemental Water to be spread in the basin for each AF of excess production. All water production is metered and is reported quarterly to the Main Basin Watermaster. The OSY is set at 150,000 AF for FY 2020-21.

In addition to Replacement Water Assessments, the Main Basin Watermaster levies an Administration Assessment to fund the administration of the Main Basin management program under the Main Basin Judgment and a Make-up Obligation Assessment in order to fulfill the requirements for any Make-Up Obligation under the Long Beach Judgment and to supply fifty percent of the administration costs of the River Watermaster service. The Main Basin Watermaster levies an In-lieu Assessment and may levy special Administration Assessments.

Water rights under the Main Basin Judgment are transferable by lease or purchase so long as such transfers meet the requirements of the Main Basin Judgment. There is also provision for Cyclic Storage Agreements that allow parties and non-parties to store imported supplemental water in the Main San Gabriel Basin under such agreements with the Main Basin Watermaster pursuant to uniform rules and conditions and Court approval (Main San Gabriel Basin Watermaster, 2020a).

The Main Basin Watermaster has entered into a Cyclic Storage Agreement with three municipal water districts, MET, Three Valleys Municipal Water District (TVMWD), and Upper San Gabriel Valley Municipal Water District (USGVMWD). The first agreement with MET and USGVMWD permits MET to deliver and store imported water in the Main Basin in an amount not to exceed 100,000 AF for future Replacement Water use. The second Cyclic Storage Agreement is with TVMWD and permits MET to deliver and store 40,000 AF for future Replacement Water use. The third is with San Gabriel Valley Municipal Water District. The Amended Main San Gabriel Basin Judgment contains more detailed information on the agreements and management of water rights to the basin (Appendix G).

The Main San Gabriel Basin is currently in an extended period of drought-like conditions, with 18 out of the most recent 25 years having below-average rainfall, as well as minimal runoff and limited recharge. As a result, Basin recovery is dependent on the Main Basin Watermaster’s management actions. Long-term water demand has fallen steadily over the last decade, and in FY 2019-20, the demand was approximately 30% below the peak in 2006. The Key Well also rose 6.3 feet in FY 2019-20 due to increases in Cyclic Storage and local and Resource Development Assessment (RDA) water.

6.3.2.4 San Mateo Valley Groundwater Basin

Basin Characteristics

Per DWR’s designation, the San Mateo Valley Basin is a non-adjudicated, very low-priority basin located to the south of the Orange County boundary, within the boundary of the Marine Corps Base (Base), Camp Pendleton, in San Diego County. The basin covers an area of 4.7 square miles (DWR, 2019a). Historically, the Base utilized groundwater from the basin for Base use and for irrigation of agricultural lease lands on Base property. Recent data have not been obtained on use of water from the basin by the Base.

Marine terrace deposits characterized as predominantly fine to coarse sand and gravel in the southern part of San Clemente are underlain by the San Mateo and Capistrano Formations. These deposits are in direct hydraulic contact with the ocean and are subject to seawater intrusion. The San Mateo Formation consists of marine sands and conglomerates, while the Capistrano Formation that underlies it consists of interbedded sandstone and shale zones, with nested turbidite-filled channels that are conducive to groundwater production (Dudek, 2015).

Confined groundwater in the San Mateo Valley Basin is produced from a deep-lying series of semi-consolidated sandstone beds with numerous coarse gravel lenses. The majority of the soils have slow or very slow infiltration rates. The usable surface area of the Basin was identified to be 107 acres with a hypothetical usable depth ranging from 10 to 110 feet (Boyle Engineering Corporation, 1987).

San Clemente operates two water supply wells, Well 6 and Well 8, to augment it's water supply.

Basin Management

Due to the unadjudicated, very low-priority designation of the San Mateo Valley Basin, a formal management plan does not exist.

The Basin has recharge areas along San Mateo Creek, downgradient from drinking water supply wells (DWR, 2019b).

6.3.2.5 Impaired Groundwater

The combined yield from the seven projects described below, was 25,443 AF in FY 2019-20. This supply is expected to increase substantially to over 30,000 AF at ultimate development of these projects. Since these projects use groundwater, a similar amount must either be replenished on an average annual basis to maintain water balance or be salvaged from water that otherwise would flow into the ocean as subsurface outflow. The benefit of these projects is to provide a firm base supply, restore use of groundwater storage impaired by natural causes and/or agricultural drainage, improve conjunctive use storage operations, and provide a drought supply by the additional capacity to tap groundwater in storage.

Huntington Beach Well 9: This project would restore the 3,000 gpm well capacity by removing nuisance odor from dissolved Hydrogen Sulfide. The City is pursuing assistance from OCWD to help fund both capital and operational costs for this project. Upon completion of the treatment system, Well 9 will be able to produce high quality water at full design capacity (Psomas, 2016).

Tustin Main Street Desalter - The City of Tustin currently operates two desalter plants. The Main Street Treatment plant began operating in 1989 with a capacity of 2 MGD. The Main Street Desalter reduces nitrate levels from the groundwater produced by Tustin's Main Street wells. The untreated groundwater undergoes either Reverse Osmosis (RO) or Ion Exchange treatment.

Tustin 17th Street Desalter - The Tustin 17th Street Desalter began operating in 1996 with a capacity of 3 MGD. The Tustin 17th Street Desalter reduces high nitrate and TDS concentrations from the groundwater pumped by Tustin's 17th Street wells. The 17th Street Desalter plant uses two RO membrane trains to treat the groundwater.

Mesa Water Reliability Facility (MWRF) – Mesa currently owns and operates MWRF with a capacity of 5.8 MGD that removes color from the water using microfiltration (MF).

IRWD Deep Aquifer Treatment System – IRWD's Deep Aquifer Treatment System (DATS) purifies drinking water from the lower aquifer of the OC Basin. The water in this aquifer is very high quality, but has a brownish tint imparted from the remains of ancient vegetation. The DATS facility went on-line in 2002 and can treat up to 7.4 MGD from two wells that pump water from 2000 feet below ground level.

IRWD Wells 21 & 22 Desalter Treatment plant - The Wells 21 and 22 Rehabilitation, Pipelines and Water Treatment Plant project recovers and treats local groundwater to remove nitrates using reverse osmosis. The treated water is used in the potable water system. Adding this new source of drinking water helps to satisfy increasing demand for water and provides a sustainable infrastructure with long-term benefits. The Wells 21 and 22 project will produce approximately 6,300 acre-feet per year of drinking water for the IRWD service area.

IRWD Irvine Desalter Project - The Irvine Desalter Project was completed in 2006 and purifies water found in the Irvine sub-basin of the larger OC Basin. It is a two-part endeavor, with recycled water and drinking water components. The Irvine Desalter Potable Treatment Facility uses two reverse osmosis trains to produce 2.7 MGD by removing salts that are caused by natural geology and past agricultural use.

San Juan Basin Desalter - The GWRP came on-line in 2004, also known as the San Juan Basin Desalter, is a 5 MGD plant that is owned and operated by the City of San Juan Capistrano. The GWRP takes groundwater high in iron, manganese, and TDS using RO and makes it suitable for potable water uses. The plant has never operated continuously at the 5 MGD rate, but prior to the drought restrictions in the basin, had been producing water at the rate of about 3 MGD.

SCWD Groundwater Desalter - SCWD currently owns and operates a 1 MGD GRF that came on-line in 2007, also known as the Capistrano Beach Desalter. The plant extracts brackish groundwater from an aquifer in the San Juan Basin and goes through iron and manganese removal due to high mineral content.

6.3.3 Planned Future Sources

The agencies that manage the OC, Main San Gabriel, La Habra, and San Juan basins regularly evaluate potential projects and conduct studies to review the feasibility of new projects or sources. A few groundwater basin-related projects that are planned or in progress are described below.

OC Basin

GWRSFE **–** The final expansion of the GWRS is currently underway and is the third and final phase of the project. When the Final Expansion is completed in early 2023, the plant's treatment capacity will increase from 100 to 130 MGD. To produce 130 MGD, additional treated wastewater from OC San's Treatment Plant 2 is required. This recycled water represents a high quality, drought-proof source of water to protect and enhance the OC Basin. The Final Expansion project will include expanding the existing GWRS treatment facilities, constructing new conveyance facilities at OC San Plant 2, and rehabilitating an existing pipeline between OC San Plant 2 and the GWRS. Once completed, the GWRS plant will recycle 100% of OC San's reclaimable sources and produce enough water to meet the needs of over one million people.

Forecast Informed Reservoir Operations (FIRO) at Prado Dam – Stormwater represents a significant source of water used by OCWD to recharge the OC Basin. Much of this recharge is made possible by the capture of Santa Ana River stormflows behind Prado Dam in the Conservation Pool. FIRO represents the next generation of operating water reservoirs using the best available technology. Advances in weather and stormwater runoff forecasting hold promise to allow USACE to safety impound more stormwater while maintaining equivalent flood risk management capability behind Prado Dam. Preliminary modeling show that by expanding the Conservation Pool from elevation 505 to 512 ft msl, annual recharge to the groundwater basin could increase by as much as 4,500 to 7,000 AFY.

Main San Gabriel Groundwater Basin

Involvement in MET's Regional Recycled Water Project **–** The Main San Gabriel Basin is listed in Phase I of this project, which is expected to deliver approximately 40,000 AF of recharge water to the basin for spreading and groundwater replenishment. The Main San Gabriel Basin Watermaster Board of Directors authorized a letter of intent that was provided to MET expressing the basin's intent to continue cooperating and working with MET on the project.

San Juan Basin

San Juan Watershed Project – The San Juan Watershed Project is a multi-phase project proposed by SMWD and project partners. If implemented, this project would enhance water reliability by capturing local stormwater runoff as well as directing recycled water into temporary storage and using it to recharge the San Juan Creek Watershed. A final Environmental Impact Report (EIR) was submitted by SMWD in 2019 (SMWD, 2021a)

6.4 Surface Water

In FY 2019-20, two percent of MWDOC's water supply portfolio was attributed to surface water captured in local reservoirs. The largest surface water reservoir in Orange County is Santiago Reservoir (Irvine Lake), which is further discussed in Section 6.4.1. In other areas, surface water runoff percolates into alluvial materials or groundwater basins. IRWD, SMWD, and SCWD capture and manage surface water supplies at certain locations. Surface water is managed by MWDOC's member agencies (Orange County Local Agency Formation Commission, 2020).

6.4.1 Irvine Lake

Santiago Reservoir, or Irvine Lake, is the largest surface water reservoir in Orange County. Irvine Lake was built in 1931 and captures runoff from the upper Santiago Creek Watershed, as well as stores imported water (Orange County Local Agency Formation Commission, 2020). The 700-acre Irvine Lake is co-owned by IRWD and Serrano Water. The lake holds more than 9 billion gallons of water and is contained by the 810-foot-tall Santiago Dam. IRWD uses water from Irvine Lake as a source of water for non-drinking purposes such as irrigation and as a source of water for the Baker Treatment Plant (Section 6.2.1.5). Serrano Water District (Serrano) also uses Irvine Lake to provide treated drinking water to its customers in the City of Villa Park and parts of the City of Orange. Both agencies balance the benefits of storing water in Irvine Lake with minimizing evaporation and preserving the ability to capture rainwater from the surrounding hills. During years with less rainfall, IRWD and Serrano also add imported water from MET to the lake (IRWD, 2021a).

6.5 Stormwater

MWDOC does not own or operate stormwater facilities. This section describes existing and planned stormwater sources in the region that benefit Orange County.

6.5.1 Existing Sources

Costly and limited imported water availability from the CRA and SWP has heightened the need to enhance water supply by increasing local stormwater capture. The Prado Dam in Riverside, California captures approximately 52 TAF of stormwater annually, on average, for recharge in Orange County. During times of minimal flood threat, the dam can be regulated to control runoff in order to supply water to OCWD. The current agreement between the US Army Corps of Engineers and OCWD allows for the capture of stormwater up to an elevation of 498 feet above sea level during flood season and up to 505 feet above sea level during non-flood season behind Prado Dam (OCWD, 2016).

6.5.2 Planned Future Sources

The Prado Basin Feasibility Study evaluates the alternatives to restore environmental resources within the Prado Basin and Santa Ana River and increase the existing volume of water conservation potential. Increasing stormwater capture by an additional 7 feet during the flood season, to 505 ft above sea level, can provide up to an additional 30 TAFY of water (OCWD, 2016). The proposed Water Conservation Plan includes re-operation of the Prado Dam for controlled release of water for reduced discharge rates from the Prado Dam and reducing sediment deposition in the Basin to increase the effective yield of water from the Santa Ana River for diversion and infiltration at OCWD's facilities downstream of the dam. The final EIR was published in 2021 and OCWD anticipates that the Prado Dam Water Control Manual will be updated by the US Army Corps of Engineers in 2021 to include stormwater capture to elevation 505 feet year-round (OCWD, 2021).

6.6 Wastewater and Recycled Water

MWDOC is not directly involved in wastewater services and does not own or operate the wastewater collection system in its service area. Additionally, MWDOC does not own or operate wastewater treatment facilities. Some local agencies provide wastewater collection and treatment as well as potable water services, while other agencies send their wastewater to large regional facilities. Wastewater is not collected by MWDOC and MWDOC does not treat or discharge wastewater.

MWDOC is indirectly involved in recycled water production, through its supply to systems whose wastewater is sent for IPR. MWDOC does not produce or manage recycled water, but supports, encourages, and partners in recycled water efforts within its service area. Recycled water planning within MWDOC's service area requires close coordination with multiple agencies that often have overlapping jurisdictional boundaries. As imported water supplies have become increasingly challenged, the local agencies, including OCWD have continued working to identify opportunities for the use of recycled water for irrigation purposes, groundwater recharge and some non-irrigation applications. The following sections expand on the existing agency collaboration involved in these efforts as well as MWDOC's member agencies projected recycled water use over the next 25 years.

6.6.1 Agency Coordination

MWDOC does not own or operate wastewater treatment facilities and the individual agencies that MWDOC supplies often send collected wastewater to either OC San in North County or SOCWA in South County for treatment and disposal. OCWD is the manager of the OC Basin and strives to maintain and increase the reliability of the OC Basin through replenishment with imported water, stormwater, and advanced treated wastewater.

6.6.1.1 Orange County Sanitation District

OC San collects wastewater from residential, commercial, and industrial customers in 21 cities, three special districts, and portions of unincorporated Orange County, totaling 479 square miles that serves more than 2.5 million residents. These flows include dry weather urban runoff collected from 15 diversion points and discharged into the sewer system for treatment and Santa Ana River Interceptor flows from the upper Santa Ana watershed.

OC San operates and maintains two treatment plants: Reclamation Plant No. 1, located in Fountain Valley with a capacity of 320 MGD, and Treatment Plant No. 2 located in Huntington Beach with a capacity of 312 MGD. OC San also operates 572 miles of collection system pipelines along with 15 offsite pump stations. Treated wastewater is discharged to the Pacific Ocean via an ocean outfall in compliance with state and federal requirements as set forth in OC San's National Pollutant Discharge Elimination System (NPDES) permit. Approximately 100 MGD of secondary effluent undergoes advanced treatment at the GWRS facility operated by the OCWD and 7 MGD undergoes tertiary treatment at OCWD's Green Acres Project (GAP) facility. OC San's ocean outfall is 120-inch diameter and extends four miles off the coast of Huntington Beach. A 78-inch diameter emergency outfall also exists that extends 1.3 miles off the coast.

OC San Reclamation Plant No. 1 - Reclamation Plant No. 1 treats raw wastewater and has a maximum treatment capacity of 320 MGD. The plant provides primary and secondary treatment and supplies secondary effluent to OCWD for further tertiary treatment at their GAP facility and advanced treatment at their GWRS. Reclamation Plant No. 1 is the only plant that provides water to OCWD for additional treatment and recycling. An interplant pipeline allows flows to be conveyed to Treatment Plant No. 2.

OC San Treatment Plant No. 2 - Treatment Plant No. 2 provides primary and secondary treatment to raw wastewater and has a maximum treatment capacity of 312 MGD. All secondary effluent from their plant is discharged to the ocean through the ocean outfall.

6.6.1.2 Orange County Water District

OCWD is the manager of the OC Basin and provides water to 19 municipal water agencies and special districts. A full description of the OC Basin is available in Section 6.3.1. OCWD and OC San have jointly constructed and expanded two water recycling projects that include: 1) OCWD GAP and 2) OCWD GWRS.

OCWD GAP

OCWD owns and operates the GAP, a water recycling system that provides up to 8,400 AFY of recycled water for irrigation and industrial uses. GAP provides an alternate source of water that is mainly delivered to parks, golf courses, greenbelts, cemeteries, and nurseries in the cities of Costa Mesa, Fountain Valley, Newport Beach, and Santa Ana. Approximately 100 sites use GAP water, current recycled water users include Mile Square Park and Golf Courses in Fountain Valley, Costa Mesa Country Club, Chroma Systems carpet dyeing, Kaiser Permanente, and Caltrans.

OCWD GWRS

OCWD's GWRS allows southern California to decrease its dependency on imported water and creates a local and reliable source of water. OCWD's GWRS purifies secondary treated wastewater from OC San to levels that meet and exceed all state and federal drinking water standards. The GWRS Phase 1 plant has been operational since January 2008 and uses a three-step advanced treatment process consisting of MF, RO (RO), and ultraviolet (UV) light with hydrogen peroxide. A portion of the treated water is injected into the seawater barrier to prevent seawater intrusion into the groundwater basin. The other portion of the water is pumped to ponds where the water percolates into deep aquifers and becomes part of Orange County's water supply. The treatment process is described on OCWD's website. (OCWD, GWRS, 2020).

The GWRS first began operating in 2008 producing 70 million gallons of water per day (MGD) and in 2015, it underwent a 30 MGD expansion. Approximately 39,200 AFY of the highly purified water is pumped into the injection wells and 72,900 AFY is pumped to the percolation ponds in the City of Anaheim where the water is naturally filtered through sand and gravel to deep aquifers of the groundwater basin. The OC Basin provides approximately 77 percent of the potable water supply for north and central Orange County. The design and construction of the first phase (78,500 AFY) of the GWRS project was jointly funded by OCWD and OC San; Phase 2 expansion (33,600 AFY) was funded solely by OCWD.

The Final Expansion of the GWRS is currently underway and is the third and final phase of the project. When the Final Expansion is completed in 2023, the plant will produce 130 MGD. To produce 130 MGD, additional treated wastewater from OC San is required. This additional water will come from OC San's Treatment Plant 2, which is in the City of Huntington Beach approximately 3.5 miles south of the GWRS. The Final Expansion project will include expanding the existing GWRS treatment facilities, constructing new conveyance facilities at OC San Plant 2 and rehabilitating an existing pipeline between OC San Plant 2 and the GWRS. Once completed, the GWRS plant will recycle 100 percent of OC San's reclaimable sources and produce enough water to meet the needs of over one million people.

6.6.1.3 South Orange County Wastewater Authority

SOCWA is a Joint Powers Authority created on July 1, 2001 to facilitate and manage the collection, transmission, treatment, and discharge of wastewater for more than 500,000 homes and businesses across South Orange County. It was formed as the legal successor to the Aliso Water Management Agency, South East Regional Reclamation Authority, and South Orange County Reclamation Authority. SOCWA has ten member agencies that include: City of Laguna Beach, City of San Clemente, City of San Juan Capistrano, ETWD, EBSD, IRWD, MNWD, SMWD, SCWD, and TCWD. All these service areas receive wholesale water through MWDOC. The service area encompasses approximately 220 square miles including the Aliso Creek, Salt Creek, Laguna Canyon Creek, and San Juan Creek Watersheds.

Within its service area, SOCWA operates four wastewater treatment plants, with an additional eight wastewater treatment plants operated by SOCWA member agencies. Wastewater in the service area is collected at the local and regional level through a series of interceptors that convey influent to the wastewater treatment plants. Treated effluent throughout the service area is conveyed to two gravity flow ocean outfalls operated by SOCWA the Aliso Creek Outfall and the San Juan Creek Outfall. The Aliso Creek outfall has a capacity of 33.2 MGD and extends 1.5 miles offshore near Aliso Beach in the City of Laguna Beach. The San Juan Creek outfall has a nominal capacity of 36.8 MGD which can be increased by pumping and extends 2.2 miles offshore near Doheny Beach in the City of Dana Point. Full secondary treatment is provided at SOCWA wastewater treatment plants, with most plants exceeding this level of treatment when the water is beneficially reused.

SOCWA Coastal Treatment Plant - SOCWA's Coastal Treatment Plant (CTP) in Aliso Canyon, Laguna Niguel has a 6.7 MGD capacity and treats wastewater received from the City of Laguna Beach, EBSD, MNWD, and SCWD to secondary effluent standards. Effluent from the CTP is treated to secondary or tertiary levels depending on the discharge method, ocean outfall or beneficial reuse. Recycled water is treated to Title 22 standards at the Advanced Water Treatment Plant (AWTP) owned by SCWD, but operated by SOCWA, located adjacent to the CTP. During the summer months, over 2 MGD of recycled water can be produced by the AWTP. Treated effluent that is not recycled is discharged through the Aliso Creek Ocean Outfall. Waste sludge is sent to the Regional Treatment Plant (RTP) in Laguna Niguel.

SOCWA Regional Treatment Plant – SOCWA's RTP in Laguna Niguel has a 12 MGD liquid capacity and 24.6 MGD solids handling capacity. The RTP treats wastewater from MNWD's service area to secondary or tertiary levels depending on discharge method, ocean outfall or reuse such as landscape irrigation. Recycled water is treated to applicable Title 22 standards. Secondary effluent is conveyed to the Aliso Creek Ocean Outfall via the SOCWA Effluent Transmission Main.

SOCWA Plant 3A – SOCWA's Plant 3A located in the City of Mission Viejo has a maximum capacity of 6 MGD and treats wastewater received from MNWD and SMWD. Effluent is treated to secondary or tertiary levels depending on the discharge method, ocean outfall or beneficial reuse. Recycled water is treated to applicable Title 22 standards and used to irrigate parks and greenbelts. Secondary effluent is conveyed to the San Juan Creek Outfall via the 3A Effluent Transmission Main.

SOCWA J. B. Latham Treatment Plant - SOCWA's J. B. Latham Treatment Plant located in the City of Dana Point has a 13 MGD capacity and treats wastewater from MNWD, City of San Juan Capistrano, SMWD, and SCWD to secondary effluent standards. The secondary effluent is conveyed directly to the San Juan Creek Outfall as the plant does not have tertiary treatment.

6.6.2 Current Recycled Water Uses

MWDOC does not produce or manage recycled water, but supports, encourages, and partners in recycled water efforts within its service area. Recycled water planning within MWDOC's service area requires close coordination with multiple agencies that many times have overlapping jurisdictional boundaries. As imported water supplies have become more challenged, the local agencies, including OCWD have continued working to identify opportunities for the use of recycled water for irrigation purposes, groundwater recharge and some non-irrigation applications. A list of agencies that provide wholesale or retail recycled water within MWDOC's service area are below.

Recycled water is widely accepted as a water supply source throughout MWDOC’s service area. In the past, recycled water was mainly used for landscape irrigation, but large recycled water projects including OCWD's GAP and GWRS, and IRWD’s recycled water projects have significantly expanded and increased uses. GWRS uses include injection for sea water barriers and percolation for groundwater recharge. IRWD is at the forefront of using recycled water not only for irrigation, but for other uses such as toilet flushing and commercial applications. Other agencies in south Orange County, such as MNWD and SMWD use a significant amount of recycled water. Recycled water in Orange County is treated to various levels depending on the end use and in accordance with Title 22 regulations as described below. For information on OCWD's GAP and GWRS, refer to Section 6.6.1.2.

ETWD Water Recycling Plant – ETWD's Water Recycling Plant (WRP) located in the City of Lake Forest has a maximum influent capacity of 6 MGD. Wastewater is treated to secondary or tertiary levels depending on the discharge method, ocean outfall or beneficial reuse. Recycled water is treated to Title 22 standards with the expansion completed in 2014. Treated effluent that is not recycled is discharged of through the Aliso Creek Ocean Outfall.

SMWD Chiquita Water Reclamation Plant – SMWD's Chiquita Water Reclamation Plant (CWRP) located in Chiquita Canyon treats wastewater to a tertiary level for recycled water use meeting Title 22 standards. CWRP has a maximum design capacity of 8 MGD with plans to increase its size to 10 MGD by 2025. Effluent that is not beneficially reused is discharged via the Chiquita Land Outfall that connects to the San Juan Creek Ocean Outfall.

SMWD Oso Creek Water Reclamation Plant – SMWD's Oso Creek Water Reclamation Plant (OCWRP) located along Oso Creek. Wastewater is treated to a secondary or tertiary depending on the method of discharge, ocean outfall or beneficial reuse. Recycled water is treated to Title 22 standards. A bypass facility allows excess wastewater to be sent to SOCWA's J.B. Latham Treatment Plant as OCWRP does not have an outfall. Without the ability to discharge treated effluent, excess flows beyond recycled water demands are sent to J.B. Latham Treatment Plant. OCWRP has a maximum design capacity of 3 MGD and is considered a scalping plant as it intercepts flows from a large trunkline.

SMWD Nichols Institute Water Reclamation Plant – the Nichols Institute Water Reclamation Plant is operated by SMWD but owned by a private company that owns property within SMWD’s service area. This small facility treats approximately 34 AFY and does not have an outfall. All wastewater is treated to Title 22 standards for recycling purposes. Since this facility is remote from existing water and wastewater facilities, SMWD is not obligated to provide an alternate source of water in the event the facility becomes inoperable.

San Clemente Water Reclamation Plant - The City of San Clemente owns and operates the San Clemente Water Reclamation Plant located within San Clemente. The plant has a design capacity of 7 MGD and treats wastewater to secondary or tertiary levels depending on the discharge method, ocean outfall or beneficial reuse. Any secondary effluent in excess of the plant’s recycling limit is conveyed to the San Juan Creek Ocean Outfall via the San Clemente Land Outfall. Recycling capacity is currently 4.4 MGD after the expansion was completed in 2014 and included 9 miles of pipelines, conversion of a domestic water reservoir to recycled water storage, and a pressure reducing station as well as an interconnection with SMWD.

IRWD Los Alisos Water Recycling Plant – Los Alisos Water Recycling Plant (LAWRP) is operated by IRWD and is located in the City of Lake Forest. LAWRP has a capacity of 7.5 MGD and wastewater is treated to a secondary or tertiary level depending on the use, ocean outfall or beneficial reuse such as landscape irrigation and other non-potable uses. When excess secondary effluent beyond the plant's tertiary treatment capacity is received, it is conveyed to the SOCWA Effluent Transmission Main for discharge via the Aliso Creek Ocean Outfall.

IRWD Michelson Water Recycling Plant – Michelson Water Recycling Plant is located in the City of Irvine and is operated by IRWD. MWRP has a maximum influent capacity of 28 MGD. Wastewater is treated to a tertiary level with advanced treatment in the form of UV disinfection meeting Title 22 standards. All effluent is conveyed to the recycled water distribution system for landscape irrigation, toilet flushing, and industrial uses.

IRWD UCI's Cooling Towers - IRWD partnered with the University of California, Irvine (UCI) by constructing approximately 3,000 feet of pipeline to bring recycled water to the campus's central plant where recycled water is used as make-up water in the cooling towers. This project conserves more than 250 acre-feet of potable water each year and helps UCI achieve its sustainability goals.

IRWD Great Park Ice and Five Point Arena - In 2017, the Irvine Ice Foundation constructed the Great Park Ice and Five Point Arena. This 280,000 square foot facility located at the Great Park in Irvine is considered the largest ice facility in California and one of the largest in the United States. This facility also serves as the official practice facility of the National Hockey League's Anaheim Ducks. IRWD provides the facility's recycled water which is used to make and maintain the ice at the four indoor ice rinks.

IRWD Dual Plumbed Buildings Initiative - IRWD was the first agency to work with a customer to construct a dual plumbed commercial building to use recycled water for flushing toilets and urinals in 1991. Today IRWD serves 127 dual plumbed commercial buildings ranging from a restroom at a park to 20-story high-rise office buildings. From 2015 to 2020, IRWD added 65 commercial buildings to its customer roles and more are on the way.

IRWD Dual Plumbed Hyatt House - This seven-story hotel is fully dual plumbed, using recycled water in all the restrooms including the 149 guest rooms. It is the first fully dual plumbed hotel in the United States.

IRWD Irvine Lake Pipeline (ILP) Conversion Project - The Irvine Lake Pipeline (ILP) Conversion Project was designed to convert the northern section of the ILP from an untreated water system to a recycled water system. This conversion was designed to provide recycled water to approximately 80 landscape and agricultural irrigation customers, offsetting imported water demands and reducing evaporation losses at Irvine Lake. Prior to the recycled water conversion, the ILP delivered imported untreated water that IRWD purchased from MET and stored in Irvine Lake, with subsequent conveyance to irrigation sites. By constructing the ILP Conversion Project, existing irrigation demands that once relied on imported water were converted to recycled water, reducing imported water needs, eliminating evaporation losses, and enhancing water supply reliability. The ILP North Conversion Project includes capacity for both existing and future planned recycled water demands.

TCWD Robinson Ranch Water Reclamation Plant - TCWD owns and operates the Robinson Ranch Wastewater Treatment Plant (RRWTP) located in the Robinson Ranch development in Trabuco Canyon, an unincorporated area of Orange County. RRWTP has a treatment capacity of 0.85 MGD, and the wastewater is treated to a tertiary level meeting Title 22 standards. All of the wastewater is recycled as the plant is not permitted to have stream discharges and is infeasible to connect to the existing outfalls in the SOCWA service area.

MNWD RTP Advanced Wastewater Treatment Plant – MNWD's RTP AWTP is operated by SOCWA and is located in the City of Laguna Niguel. The AWTP has a total capacity of 11.4 MGD and the secondary effluent from RTP is treated to a disinfected tertiary level that meets Title 22 requirements for landscape irrigation use.

MNWD Plant 3A Advanced Wastewater Treatment Plant - MNWD's Plant 3A AWTP is operated by SOCWA and is located within the City of Laguna Niguel. The Plant 3A AWTP has a capacity of 2.4 MGD and the secondary effluent from 3A is treated to a disinfected tertiary level that meets Title 22 requirements for landscape irrigation use.

SCWD CTP Advanced Wastewater Treatment Plant - SCWD's CTP AWTP is operated by SOCWA and is located in the City of Laguna Niguel. The CTP AWTP has a capacity of 2.6 MGD and the secondary effluent from CTP is treated to a disinfected tertiary level that meets Title 22 requirements for landscape irrigation use.

SCWD Aliso Creek Water Reclamation Facility - SCWD completed construction on the Aliso Creek Water Reclamation Facility (ACWRF) in 2014 that intercepts and treats a portion of the urban runoff in lower Aliso Creek to supplement the advanced water treatment facility at CTP. The ACWRF has a capacity of 800 gallons per day (GPD) and the creek water is treated using ultrafiltration and RO to improve the quality of the recycled water supply to make it more attractive for irrigation users.
The ACWRF has not been able to be used as the Aliso Creek water level is below what regulation allows. MWDOC does not directly treat or distribute recycled water within their service area.

6.6.3 Projected Recycled Water Uses

As of April 2019, the State of California amended its recycled water policy to expand its numeric goal 2.5 million AFY by 2030 and added annual required reporting requirements for wastewater and recycled water. Specific to the MWDOC's service area, most agencies within the service area have already maximized their recycled water use. Most are projecting a consistent use through to 2045 and are not expecting for recycled water use to grow. However, a few agencies in South Orange County do expect moderate growth in recycled water production and customers. Collectively, the MWDOC's service area is projected to see an increase in recycled water uses grow from 42,330 AF in 2020 to 57,094 in 2045 (see Section 4).

6.6.4 Potential Recycled Water Uses

Potential recycled water use within MWDOC's service area hinges upon many variables including, but not limited to, economics of treatment and distribution system extension (as well as site retrofits and conversions), water quality, public acceptance, infrastructure requirements, and reliability.

Even though demands exist, it is not necessarily economically feasible to provide recycled water to all potential users. Expansion of recycled water systems eventually reach a point where returns diminish and higher investments for expansion are not cost effective. Water recycling projects involve collecting and treating wastewater to applicable standards depending on the end use, providing seasonal storage, pipeline construction, pump station installation, and conversions for existing potable water users or dual plumbing systems for new users. Creative solutions to secure funding, and overcome regulatory requirements, institutional arrangements, and public acceptance are required to offset existing potable demands with potential recycled water demands.

SMWD Chiquita Water Reclamation Plant Expansion - CWRP currently has a capacity of 5 MGD. SMWD plans to expand the plant to 10 MGD by 2015. The expansion will increase total production and reduce dependency on imported water. SMWD is planning to expand the CWRP tertiary capacity from 5 MGD to 10 MGD by 2015, increasing its recycled water supply to 11,200 AFY. The expansion would reduce SMWD's dependency on imported water and provide additional recycled water for irrigation purposes. Because RMV holds riparian water rights for its ranching, agriculture and tenants' uses; RMV and SMWD are looking into an agreement for RMV to potentially provide water in areas of the Ranch Plan to supplement recycled water in the event recycled water is unavailable.

MNWD Plant 3A Expansion - The 3A Treatment Plant Tertiary Expansion Project will provide an additional 3,000 AFY of capacity for recycled water use. The expansion includes the following components: increase the reliability of the aeration system, expand and/or replacing the existing filters with more effective tertiary filters, expand the disinfection system, expand the tertiary effluent pumps, possible upsizing of the discharge pipeline where it connects to SMWD's recycled water distribution system, modification to various in-plant piping and electrical systems, and addition of a standby generator to maintain operation during a power outage. The expansion will increase the local water supply reliability by producing an additional 3,000 AFY of recycled water, reducing dependence on imported water. The expansion will conserve approximately 5,653,000 kWh of energy per year and 3,448,330 pounds of carbon dioxide by producing and distributing recycled water in lieu of imported water. The expansion also benefits MNWD, the project partner.

6.6.5 Optimization Plan

MET and MWDOC support research efforts to encourage development and use of recycled water. These include conducting studies and research to address public concerns, developing new technologies, and assessing health effects. Addressing public concerns is required to gain the support of stakeholders early in the planning process. Education is required to inform the public of the treatment processes. Developing new technologies is a prerequisite to help reduce the cost of producing recycled water. Health effects assessments have a two-fold purpose of alleviating public concerns and ensuring the protection of public health and the environment. Further research supported by MET and others (such as the National Water Research Institute) will have the benefit of reducing risks for MWDOC's member agencies.

To assist in meeting projections, MWDOC plans to take numerous actions to facilitate the use and production of recycled water within its service area. However, MWDOC is a wholesaler and does not impose development requirements or enact ordinances that mandate the use of recycled water. In many cases, additional recycled water production and use is economically infeasible given the current cost of potable water supplies in comparison to recycled water costs. MWDOC has taken the following actions to facilitate further production and use of recycled water:

- Sponsoring and supporting its member agencies in obtaining Local Resources Program (LRP) incentives from MET;

- Assisting and supporting member agencies in applications made for bond funds such as Proposition 84;
- Encouraging MET to participate in studies that will benefit recycled water production in the service area;
- Supporting MET in deriving solutions to regulatory issues;
- Participating in regional plan such as the South Orange County IRWMP;
- Working cooperatively with retail agencies, MET and its member agencies, and other Orange County water and wastewater agencies to encourage recycled water use and develop creative solutions to increase recycled water use;
- Assisting and supporting its member agencies to participate in MET's Future Supply Program, which provides funding for research and studies needed to set the state standards for Direct Potable Reuse (DPR) on American Water Works Association's (AWWA) research Foundation Project.

The MWDOC public education and Choice School Programs have reached millions of residents, businesses, and students with valuable, trusted water-centric information and education. One of the topics covered includes an introduction to water quality and water recycling as a critical component to the health and reliability of a more extensive Orange County water supply portfolio. MWDOC's multi-agency approach to public information includes collaboration with education, environmental, and utility agencies throughout the county. MWDOC reaches the public with essential information regarding present and future water supplies, the importance of sufficient quantity and quality of water – including recycled water – and the significance of implementing water use efficiency practices in daily life. Through MWDOC, water education programs have reached millions of residents, businesses, and students with information and education on recycled water.

Dealing with needed additional funding and other implementation barriers for recycled water at the state and regional level would assist in increasing recycled water production within MWDOC's service area. State funding assistance could reduce the overall cost per AF of recycled water so that it is comparable to the cost of potable water and would allow the development of more expensive recycled water projects in an earlier timeframe. There are numerous barriers to increasing water recycling that could be addressed at the State level. These barriers include establishment of uniform Regional Water Quality Control Board (RWQCB) requirements for recycled water, especially in areas where water and wastewater agency jurisdictions cross RWQCB jurisdictions resulting in varying requirements; partnering in health studies to illustrate the safety of recycled water; increasing public education; and establishing uniform requirements for retrofitting facilities to accept recycled water.

6.7 Desalination Opportunities

In 2001, MET developed a Seawater Desalination Program (SDP) to provide incentives for developing new seawater desalination projects in MET's service area. In 2014, MET modified the provisions of their LRP to include incentives for locally produced seawater desalination projects that reduce the need for imported supplies. To qualify for the incentive, proposed projects must replace an existing demand or prevent new demand on MET's imported water supplies. In return, MET offers three incentive formulas under the program:

- Sliding scale incentive up to $340 per AF for a 25-year agreement term, depending on the unit cost of seawater produced compared to the cost of MET supplies.
- Sliding scale incentive up to $475 per AF for a 15-year agreement term, depending on the unit cost of seawater produced compared to the cost of MET supplies.
- Fixed incentive up to $305 per AF for a 25-year agreement term.

Developing local supplies within MET's service area is part of their IRP goal of improving water supply reliability in the region. Creating new local supplies reduce pressure on imported supplies from the SWP and Colorado River.

On May 6th, 2015, the SWRCB approved an amendment to the state’s Water Quality Control Plan for the Ocean Waters of California (California Ocean Plan) to address effects associated with the construction and operation of seawater desalination facilities (Desalination Amendment). The amendment supports the use of ocean water as a reliable supplement to traditional water supplies while protecting marine life and water quality. The California Ocean Plan now formally acknowledges seawater desalination as a beneficial use of the Pacific Ocean and the Desalination Amendment provides a uniform, consistent process for permitting seawater desalination facilities statewide.

If the following projects are developed, MET's imported water deliveries to Orange County could be reduced. These projects include the Huntington Beach Seawater Desalination Project and the Doheny Desalination Project.

6.7.1 Ocean Water Desalination

6.7.1.1 Huntington Beach Seawater Desalination Plant

Poseidon Resources LLC (Poseidon), a private company, is developing the Huntington Beach Seawater Desalination Project to be co-located at the AES Power Plant in the City of Huntington Beach along Pacific Coast Highway and Newland Street. The proposed project would produce up to 50 MGD (56,000 AFY) of drinking water to provide approximately 10 percent of Orange County’s water supply needs.

Over the past several years, Poseidon has been working with OCWD on the general terms and conditions for selling the water to OCWD. Three general distribution options have been discussed with the agencies in Orange County. The northern option proposes the water be distributed to the northern agencies closer to the plant within OCWD’s service area with the possibility of recharging/injecting a portion of the product water into the OC Basin. The southern option builds on the northern option by delivering a portion of the product water through the existing OC-44 pipeline for conveyance to the south Orange County water agencies. A third option is also being explored that includes all of the product water to be recharged into the OC Basin. Currently, a combination of these options could be pursued.

The Huntington Beach Seawater Desalination project plant capacity of 56,000 AFY would be the single largest source of new, local drinking water available to the region. In addition to offsetting imported demand, water from this project could provide OCWD with management flexibility in the OC Basin by augmenting supplies into the Talbert Seawater Barrier to prevent seawater intrusion.

In May 2015, OCWD and Poseidon entered into a non-binding Term Sheet that provided the overall partner structure in order to advance the project. Based on the initial Term Sheet, which was updated in 2018, Poseidon would be responsible for permitting, financing, design, construction, and operations of the treatment plant while OCWD would purchase the production volume, assuming the product water quality and quantity meet specific contract parameters and criteria. Furthermore, OCWD would then distribute the water in Orange County using one of the proposed distribution options described above.

Currently, the project is in the regulatory permit approval process with the Regional Water Quality Control Board and the California Coastal Commission. Once all of the required permits are approved, Poseidon will then work with OCWD and interested member agencies in developing a plan to distribute the water. Subsequent to the regulatory permit approval process, and agreement with interested parties, Poseidon estimates that the project could be online as early as 2027.

Under guidance provided by DWR, the Huntington Beach Seawater Desalination Plant's projected water supplies are not considered in either Table 4-1 or Table 6-2 due to its current status within the criteria established by State guidelines (DWR, 2020c).

6.7.1.2 Doheny Desalination Plant

SCWD is proposing to develop an ocean water desalination facility in Dana Point. SCWD intends to construct a facility with an initial capacity of up to 5 million gallons per day (MGD). The initial up to 5 MGD capacity would be available for SCWD and potential partnering water agencies to provide a high quality, locally-controlled, drought-proof water supply. The desalination facility would also provide emergency backup water supplies, should an earthquake, system shutdown, or other event disrupt the delivery of imported water to the area. The Project would consist of a subsurface slant well intake system (constructed within Doheny Beach State Park), raw (sea) water conveyance to the desalination facility site (located on SCWD owned property), a seawater reverse osmosis (SWRO) desalination facility, brine disposal through an existing wastewater ocean outfall, solids handling facilities, storage, and potable water conveyance interties to adjacent local and regional distribution infrastructure.

The Doheny Ocean Desalination Project has been determined as the best water supply option to meet reliability needs of SCWD and south Orange County. SCWD is pursuing the Project to ensure it meets the water use needs of its customers and the region by providing a drought-proof potable water supply, which diversifies SCWD's supply portfolio and protects against long-term imported water emergency outages and supply shortfalls that could have significant impact to our coastal communities, public health, and local economy. Phase I of the Project (aka, the "Local" Project) will provide SCWD and the region with up to 5 MGD of critical potable water supply that, together with recycled water, groundwater, and conservation, will provide the majority of SCWD's water supply through local reliable sources. An up to 15 MGD capacity project has been identified as a potential future "regional" project that could be phased incrementally, depending on regional needs.

On June 27, 2019, SCWD certified the final EIR and approved the Project. The Final EIR included considerable additional information provided at the request of the Coastal Commission and the Regional Board, including an updated coastal hazard analysis, updated brine discharge modeling, and updated groundwater modeling, updated hydrology analysis. The approval of the Project also included a commitment to 100 percent carbon neutrality through a 100 percent offset of emissions through the expansion of Project mitigation and use of renewable energy sources. SCWD is currently in the permitting process and finalizing additional due diligence studies. If implemented, SCWD anticipates an online date of 2025.

Under guidance provided by DWR, the Doheny Seawater Desalination Project's projected water supplies are not considered in either Table 4-1 or Table 6-2 due to its current status within the criteria established by State guidelines (DWR, 2020c).

6.7.2 Groundwater Desalination

In an effort to improve groundwater production, MET provides financial incentives to local agencies to treat brackish groundwater which has been impaired from either natural causes or from agricultural drainage. Through MET's LRP, the goal is to increase usage of groundwater storage within the region for firm local production, conjunctive use storage, and drought supply. In MWDOC's service area, five groundwater recovery brackish water projects have LRP contracts with MET.

MWRF Expansion - The MWRF, owned and operated by Mesa Water, pumps colored water from a deep colored water aquifer and removes the color MF. Due to increased color and bromide in the source water, Mesa Water upgraded the facility to include Nano filtration membrane treatment. In 2012, the MWRF's capacity was increased from 5.8 MGD to 8.6 MGD.

SCWD Capistrano Beach GRF Expansion - SCWD constructed a 1 MGD GRF that came online in FY 2007-08 in Dana Point. SCWD plans to expand the GRF with the addition of new wells. Treating in excess of 1,300 AFY will require expansion of the GRF and agreement with SJBA or confirmation of water rights from the SWRCB.

Garden Grove Nitrate Blending Project - The Garden Grove Nitrate Blending Project was active during the years of 1990 to 2005. The project is located at the Lampson Reservoir site, where groundwater pumped from two wells is blended in order to meet the maximum contaminant level (MCL) for nitrate. The blending project was shut down in 2005, but the City retrofitted Well 28 with a variable frequency drive and reinstated the blending operation.

San Juan Desalter GWRP Expansion – The City of San Juan Capistrano has operated the GWRP since about 2005. A number of issues have impacted the reliability of production from the facility including iron bacteria in the wells, the discovery of a plume of Methyl Tert-Butyl Ether (MTBE) that required a reduction in production in half to about 2 MGD or less since the spring of 2008 until the responsible party contributed to provide Granular Activated Carbon (GAC) Filter for removal of the MTBE to allow increased production. The drought then struck, reducing the amount of water that could be pumped from the San Juan groundwater basin, requiring a large reduction in production from the groundwater basin in 2014, 2015, and initially in 2016.

Tustin Nitrate Removal Project - The Tustin Nitrate Removal Project consists of two groundwater treatment facilities that are allowed above the BPP and the charges are BEA-exempt. The first facility is the Main Street Treatment Plant, operating since 1989 to reduce nitrate levels from the groundwater produced by Wells No. 3 and 4 by blending untreated groundwater with treatment plant product water which undergoes RO and ion exchange treatment processes. The second facility is the Tustin Seventeenth Street Desalter, operating since 1996 to reduce high nitrate and TDS concentration from groundwater produced by Wells No. 2 and 4 and the Newport well using RO (OCWD, 2015 Groundwater Management Plan, June 2015).

6.8 Water Exchanges and Transfers

6.8.1 Existing Exchanges and Transfers

A few MWDOC member agencies have expressed interests in pursuing exchanges and/or transfers of water from outside of the region. MWDOC will continue to help its member agencies in developing these opportunities to enhance their reliability. In fulfilling this role, MWDOC will help its member agencies navigate the operational and administrative issues of wheeling or exchanging water through the MET water distribution system or by examining other delivery options.

Santa Margarita Water District - SMWD has actively pursued additional water supply reliability through water transfers, and successfully completed water transfers in the late 1990's through the MET system. At present, the future of such transfers as a reliable and cost-effective means of providing the basic supply remain uncertain. However, transfer with specific purposes, such as supplementing dry year supplies can be effective. SMWD continues to explore opportunities for water transfers and exchanges as an alternative water supply and has worked with MWDOC and other agencies to investigate possible transfers. SMWD has a transfer agreement with Cucamonga Valley Water District of 4,250 AFY, both short term and long term. SMWD also has a short-term transfer agreement with GSWC of 2,000 AFY.

IRWD Water Banking Program - IRWD developed their Water Banking Program in Kern County and initiated the first delivery of water under the program to their service territory of 1,000 AF in June 2015 as a demonstration effort. The delivered water was determined by MET to meet the definition of an "extraordinary supply"; meaning that IRWD received full credit for the water and that it counts essentially 1:1 during a drought/water shortage condition under MET's WSAP. The banking program has been implemented via agreements with MET to wheel the water through their system, when requested. IRWD has also entered into a 30-year water banking partnership with the Rosedale-Rio Bravo Water Storage District in Kern County in which IRWD can store up to 126,000 AF in the water bank and recover up to approximately 29,000 AF in any single year. IRWD has purchased high quality groundwater recharge land and constructed more than 700 acres of groundwater recharge ponds to allow available surface water to percolate into the basin for later use, in which IRWD has priority rights when Rosedale is not recharging Kern River floodwaters (IRWD, 2021b). There is an approved coordinated operating and exchange agreement between IRWD, MET and MWDOC that will facilitate the recovery and delivery of State Water Project water from the water bank in Kern County into IRWD's service area in Orange County (IRWD, 2021b).

6.8.2 Planned and Potential Exchanges and Transfers

Interconnections with other agencies result in the ability to share water supplies during short term emergency situations or planned shutdowns of major imported water systems. Transfers of water can help with short-term outages but can also be involved with longer term water exchanges to deal with droughts or long-term emergency situations. MWDOC helps its retail agencies develop both local and regional transfer and exchange opportunities that promote reliability within their systems. Examples of these types of projects that might occur in the future are discussed below.

IRWD Water Banking Program – As noted in Section 6.9.1, IRWD has developed its Water Banking Program and it has about 50,000 AF stored for IRWD's benefit.

IRWD and Rosedale were conditionally awarded funds by the California Water Commission (CWC) to develop a regional water bank, the Kern Fan Groundwater Storage Project, to store and capture unallocated Article 21 water from the SWP during periods when surface water is abundant, and they are now completing additional requirements outlined in the program regulations to receive funds.

IRWD is also pursuing various additional sources of water supply for the water bank, including long term agreements with Antelope Valley-East Kern Water Agency and Buena Vista Water Storage District that can provide water supplies for banking and the acquisition of the Jackson Ranch in the Dudley Ridge Water District in Kings County.

During wet years, water surplus to the Jackson Ranch farming operations will be banked in the Strand Ranch Project for future use in IRWD (IRWD, 2021b).

In addition, IRWD and MWDOC have entered into discussions to provide a portion of this banked water to other MWDOC member agencies during shortages. A proposed pilot program between IRWD and MWDOC would allow for up to 5,000 AFY of water in Strand Ranch to be delivered to MWDOC as extraordinary supply with varying reservation costs. MWDOC is currently studying the terms and conditions to determine if this pilot program meets the needs of its agencies (CDM Smith, 2019).

Santa Margarita Water District – SMWD has actively pursued additional water supply reliability through water transfers. They are currently involved in the analysis and evaluation of the Cadiz water storage project. The Cadiz Project includes an average yield of 50,000 AF per year for 50 years that could be produced from the Fenner Valley Groundwater Basin. Cadiz is authorized to pump as much as 75,000 AF per year as long as the average yield over 50 years is 50,000 AF and assuming they are meeting all of the monitoring requirements imposed on the project. If not produced, the water would evaporate from the nearby dry lakes and be lost to productive use. The water would require treatment for Chromium VI and would be conveyed via a pump station and pipeline about 40 miles to MET's CRA. SMWD has an option for 5,000 AF per year, expandable to 15,000 AF per year; OCWD is considering the water supply. Work is underway to develop the terms and conditions for conveying the water via the CRA into southern California. The water would have to be wheeled through the MET system.

Santa Ana River Conservation and Conjunctive Use Project (SARCCUP) – The Santa Ana River Conservation and Conjunctive Use Project (SARCCUP) is a joint project established by five regional water agencies within the Santa Ana River Watershed (Eastern Municipal Water District, Inland Empire Utilities Agency, Western Municipal Water District, OCWD, and San Bernardino Valley Municipal Water District.

In 2016, SARCCUP was successful in receiving $55 million in grant funds from Proposition 84 through DWR. The overall SARCCUP program awarded by Proposition 84, consists of three main program elements:

- Watershed-Scale Cooperative Water Banking Program
- Water Use Efficiency: Landscape Design and Irrigation Improvements and Water Budget Assistance for Agencies
- Habitat Creation and *Arundo Donax* Removal from the Santa Ana River

The Watershed-Scale Cooperative Water Banking Program is the largest component of SARCCUP and since 2016, Valley, MET, and the four SARCCUP-MWD Member Agencies, with MWDOC representing

OCWD, have been discussing terms and conditions for the ability to purchase surplus water from Valley to be stored in the Santa Ana River watershed. With the Valley and MET surplus water purchase agreement due for renewal, it was the desire of Valley to establish a new agreement with MET that allows a portion of its surplus water to be stored within the Santa Ana River watershed.

An agreement between MET and four SARCCUP-MWD Member Agencies was approved earlier this year that gives the SARCCUP agencies the ability to purchase a portion (up to 50%) of the surplus water that San Bernardino Valley Municipal Water District (Valley), a SWP Contractor, sells to MET. Such water will be stored in local groundwater basins throughout the Santa Ana River watershed and extract during dry years to reduce the impacts from multiyear droughts. In Orange County, 36,000 AF can be stored in the OC Basin for use during dry years. More importantly, this stored SARCCUP water can be categorized as “extraordinary supplies”, if used during a MET allocation, and can enhance a participating agencies’ reliability during a drought. Moreover, if excess water is available MWDOC can purchase additional water for its service area.

Further details remain to be developed between OCWD, retail agencies, and MWDOC in how the water will be distributed in Orange County and who participates.

6.9 Future Water Projects

MWDOC has identified the following future regional projects (CDM Smith, 2019):

Poseidon Huntington Beach Ocean Desalination Project – Poseidon proposes to construct and operate the Huntington Beach Ocean Desalination Plant on a 12-acre parcel adjacent to the AES Huntington Beach Generating Station. The facility would have a capacity of 50 MGD and 56,000 AFY, with its main components consisting of a water intake system, a desalination facility, a concentrate disposal system, and a product water storage tank. This project would provide both system and supply reliability benefits to the SOC, the OC Basin, and Huntington Beach. The capital cost in the initial year for the plant is $1.22 billion.

Doheny Ocean Desalination Project – SCWD is proposing to construct an ocean water desalination facility in Dana Point at Doheny State Beach. The facility would have an initial up to 5 MGD capacity, with the potential for future expansions up to 15 MGD. The project’s main components are a subsurface water intake system, a raw ocean water conveyance pipeline, a desalination facility, a seawater reverse osmosis (SWRO) desalination facility, a brine disposal system, and a product water storage tank.

San Juan Watershed Project – SMWD and other project partners have proposed a multi-phased project within the San Juan Creek Watershed to capture local stormwater and develop, convey, and recharge recycled water into the San Juan Groundwater Basin and treat the water upon pumping it out of the basin. The first phase includes the installation of three rubber dams within San Juan Creek to promote in-stream recharge of the basin, with an anticipated production of 700 AFY on average. The second phase would develop additional surface water and groundwater management practices by using stormwater and introducing recycled water for infiltration into the basin and has an anticipated production of 2,660 to 4,920 AFY. The third phase will introduce recycled water directly into San Juan Creek through live stream recharge, with an anticipated production of up to 2,660 AFY (SMWD, 2021b).

Cadiz Water Bank – SMWD and Cadiz, Inc. are developing this project to create a new water supply by conserving groundwater that is currently being lost to evaporation and recovering the conserved water by pumping it out of the Fenner Valley Groundwater Basin to convey to MET's CRA. The project consists of a groundwater pumping component that includes an average of 50 TAFY of groundwater that can be pumped from the basin over a 50-year period, and a water storage component that allows participants to send surplus water supplies to be recharged in spreading basins and held in storage.

South Orange County Emergency Interconnection Expansion – MWDOC has been working with the South Orange County (SOC) agencies on improvements for system reliability primarily due to the risk of earthquakes causing outages of the MET imported water system as well as extended grid outages. Existing regional interconnection agreements between IRWD and SOC agencies provides for the delivery of water through the IRWD system to participating SOC agencies in times of emergency. MWDOC and IRWD are currently studying an expansion of the program, including the potential East Orange County Feeder No. 2 pipeline and an expanded and scalable emergency groundwater program, with a capital cost of $867,451.

SARCCUP Water Storage Program – SARCCUP is a joint project established between MET, MWDOC, Eastern MWD, Western MWD, Inland Empire Utilities Agency, and OCWD that can provide significant benefits in the form of additional supplies during dry years for Orange County. Surplus SWP water from San Bernardino Valley Water District (SBVMWD) can be purchased and stored for use during dry years. This water can even be considered an extraordinary supply under MET allocation Plan, if qualified under MET's extraordinary supply guidelines. OCWD has the ability to store 36,000 AF of SARCCUP water and if excess water is available MWDOC has the ability to purchase additional water. Further details remain to be developed between OCWD, retail agencies, and MWDOC in how the water will be distributed in Orange County and who participates.

MNWD/OCWD Pilot Storage Program - OCWD entered into an agreement with MNWD to develop a pilot program to explore the opportunity to store water in the OC Basin. The purpose of such a storage account would provide MNWD water during emergencies and/or provide additional water during dry periods. As part of the agreement, OCWD hired consultants to evaluate where and how to extract groundwater from the OC Basin with several options to pump the water to MNWD via the East Orange County Feeder No. 2; as well as a review of existing banking/exchange programs in California to determine what compensation methodologies could OCWD assess for a storage/banking program.

6.10 Energy Intensity

As discussed throughout this report, MWDOC is a wholesale agency that provides imported water to coastal and inland areas of Orange County. MWDOC does not own or operate any water, wastewater, or recycled water facilities. As such, it does not have operational control over the upstream portion of the water system. After water has been delivered to member agencies, these agencies are responsible for final treatment, delivery, and any pumping needed to extract groundwater in their service area.

Although MWDOC does not have operational control over the downstream portions of the water system, the energy efficiency of these systems is important to MWDOC's focus on sound planning and appropriate investments in water supply, water use efficiency, regional delivery infrastructure and emergency preparedness. To this end, awareness of the energy intensity of retail agencies helps with planning for future system needs. By setting a baseline, agencies can better understand and manage their operational expenditures. Several factors will affect the energy intensity of water delivery over time and agencies should be aware of these factors. A decrease in water demand in a service area may create a situation where the energy intensity of each AF delivered actually increases as agencies operate the same pumps and water treatment facilities as before. When tracking energy intensity over time, agencies should keep factors such as these in mind and focus on the efficiency of each facility they operate.

Each agency has a unique geography and customer set that they serve so energy intensities of different agencies can be compared for informational purposes, but operational needs and constraints should be considered. For example, agencies with hills in their service area will inherently have higher pumping energy demands than agencies without hills. Additionally, some agencies have water treatment within their operational control while others deliver already treated water – leading to wide ranges in the energy demand among different agencies. Therefore, each agency should come up with their own energy management plan based on their unique needs and challenges. By tracking energy use as a whole, MWDOC can help member agencies prepare for the future and maintain reliability. Overall, from a subset of 19 MWDOC member agencies together with the cities of Fullerton and Santa Ana, the energy intensity for water operations range between 5.5 and 1681 kilowatt hour per AF (kWH/AF). For North OC agencies within the OC Basin, the energy intensity for water operations range from 5.5 to 1681 kWh/AF. For South OC agencies which rely predominantly on imported water for potable use, the energy intensity for water operations range from 177 to 1336 kWh/AF.

7 WATER SERVICE RELIABILITY AND DROUGHT RISK ASSESSMENT

Building upon the water supply identified and projected in Section 6, this key section of the UWMP examines MWDOC's water supplies, water uses, and the resulting water supply reliability. Water service reliability reflects MWDOC's ability to meet the water needs of its customers under varying conditions. For the UWMP, water supply reliability is evaluated in two assessments: 1) the Water Service Reliability Assessment and 2) the DRA. The Water Service reliability assessment compares projected supply to projected demand for three long-term hydrological conditions: a normal year, a single dry year, and a drought period lasting five consecutive years. The DRA, a new UWMP requirement, assesses water supply reliability under a severe drought period lasting for the next five consecutive years, from 2021 to 2025. Factors affecting reliability, such as climate change and regulatory impacts, are considered to prepare more realistic assessments.

7.1 Water Service Reliability Overview

Every urban water supplier is required to assess the reliability of their water service to its customers under a normal year, a single dry year, and multiple dry water years. MWDOC's service area depends on a combination of imported and local supplies to meet its service area water demands and MWDOC has taken numerous steps to ensure its member agencies have adequate supplies. Development of numerous local sources augment the reliability of the imported water system. There are various factors that may impact reliability of supplies such as legal, environmental, water quality and climatic, which are discussed below. The water supplies available to the MWDOC service area are projected to meet full-service demands based on the findings by MET in its 2020 UWMP starting 2025 through 2045 during normal years, single dry year, and five consecutively dry years.

MWDOC is a MET member agency, and MET's projections take into account the imported demands from Orange County. As so, MET's water reliability assessments are used to determine that demands within MWDOC can be met for all three hydrological conditions. As summarized in Section 6.2.2, MET's 2020 UWMP concludes that MET's water supply is able to meet projected demands under normal, single-dry, and five-year consecutive dry conditions.

MET's 2020 IRP update describes the core water resources that will be used to meet full-service demands at the retail level under all foreseeable hydrologic conditions from 2025 through 2045. The foundation of MET's resource strategy for achieving regional water supply reliability has been to develop and implement water resources programs and activities through its IRP preferred resource mix. This preferred resource mix includes conservation, local resources such as water recycling and groundwater recovery, Colorado River supplies and transfers, SWP supplies and transfers, in-region surface reservoir storage, in-region groundwater storage, out-of-region banking, treatment, conveyance and infrastructure improvements.

Table 7-1 shows the basis of water year data used to predict drought supply availability. The average (normal) hydrologic condition for the MWDOC service area is represented by FY 2017-18 and FY 2018-19 and the single-dry year hydrologic condition by FY 2013-14. The five consecutive years of

FY 2011-12 to FY 2015-16 represent the driest five-consecutive year historic sequence for MWDOC's service area. Locally, Orange County rainfall for the five-year period totaled 36 inches, the driest on record.

Table 7-1: Wholesale: Basis of Water Year Data (Reliability Assessment)

DWR Submittal Table 7-1 Wholesale: Basis of Water Year Data (Reliability Assessment)			
Year Type	Base Year	Available Supplies if Year Type Repeats	
		☐	Quantification of available supplies is not compatible with this table and is provided elsewhere in the UWMP. Location ______________
		☑	Quantification of available supplies is provided in this table as either volume only, percent only, or both.
		Volume Available (AF)	% of Average Supply
Average Year	2018-2019	-	100%
Single-Dry Year	2014	-	106%
Consecutive Dry Years 1st Year	2012	-	106%
Consecutive Dry Years 2nd Year	2013	-	106%
Consecutive Dry Years 3rd Year	2014	-	106%
Consecutive Dry Years 4th Year	2015	-	106%
Consecutive Dry Years 5th Year	2016	-	106%

NOTES:
Assumes an increase of six percent above average year demands in dry and multiple dry years based on the Demand Forecast TM (CDM Smith, 2021). 106% represents the percent of average supply needed to meet demands of a single-dry and multiple-dry years. Since all of MWDOC's supply comes from MET, the percent of average supply value reported is equivalent to the percent of average demand under the corresponding hydrologic condition.

7.2 Factors Affecting Reliability

In order to prepare realistic water supply reliability assessments, various factors affecting reliability were considered. These include climate change and environmental requirements, regulatory changes, water quality impacts, and locally applicable criteria.

7.2.1 Climate Change and the Environment

Changing climate patterns are expected to shift precipitation patterns and affect water supply availability. Unpredictable weather patterns will make water supply planning more challenging. Although climate change impacts are associated with exact timing, magnitude, and regional impacts of these temperature and precipitation changes, researchers have identified several areas of concern for California water planners (MET, 2021). These areas include:

- A reduction in Sierra Nevada Mountain snowpack.
- Increased intensity and frequency of extreme weather events.
- Prolonged drought periods.
- Water quality issues associated with increase in wildfires.
- Changes in runoff pattern and amount.
- Rising sea levels resulting in:
    - Impacts to coastal groundwater basins due to seawater intrusion.
    - Increased risk of damage from storms, high-tide events, and the erosion of levees.
    - Potential pumping cutbacks to the SWP and CVP.

Other important issues of concern due to global climate change include:

- Effects on local supplies such as groundwater.
- Changes in urban and agricultural demand levels and patterns.
- Increased evapotranspiration from higher temperatures.
- Impacts to human health from water-borne pathogens and water quality degradation.
- Declines in ecosystem health and function.
- Alterations to power generation and pumping regime.
- Increases in ocean algal blooms affected seawater desalination supplies.

The major impact in California is that without additional surface storage, the earlier and heavier runoff (rather than snowpack retaining water in storage in the mountains), will result in more water being lost to the oceans. A heavy emphasis on storage is needed in California.

In addition, the Colorado River Basin supplies have been inconsistent since about the year 2000, with precipitation near normal while runoff has been less than average in two out of every three years. Climate models are predicting a continuation of this pattern whereby hotter and drier weather conditions will result in continuing lower runoff, pushing the system toward a drying trend that is often characterized as long-term drought.

Dramatic swings in annual hydrologic conditions have impacted water supplies available from the SWP over the last decade. The declining ecosystem in the Delta has also led to a reduction in water supply deliveries, and operational constraints will likely continue until a long-term solution to these problems is identified and implemented (MET, 2021).

Legal, environmental, and water quality issues may have impacts on MET supplies. It is felt, however, that climatic factors would have more of an impact than legal, water quality, and environmental factors. Climatic conditions have been projected based on historical patterns, but severe pattern changes are still a possibility in the future (MET, 2021).

7.2.2 Regulatory and Legal

Ongoing regulatory restrictions, such as those imposed by the Biops on the effects of SWP and the federal CVP operations on certain marine life, also contributes to the challenge of determining water delivery reliability. Endangered species protection and conveyance needs in the Delta have resulted in operational constraints that are particularly important because pumping restrictions impact many water resources programs – SWP supplies and additional voluntary transfers, Central Valley storage and transfers, and in-region groundwater and surface water storage. Biops protect special-status species listed as threatened or endangered under the ESAs and imposed substantial constraints on Delta water supply operations through requirements for Delta inflow and outflow and export pumping restrictions.

In addition, the SWRCB has set water quality objectives that must be met by the SWP including minimum Delta outflows, limits on SWP and CVP Delta exports, and maximum allowable salinity level. SWRCB plans to fully implement the new Lower San Joaquin River (LSJR) flow objectives from the Phase 1 Delta Plan amendments through adjudicatory (water rights) and regulatory (water quality) processes by 2022. These LSJR flow objectives are estimated to reduce water available for human consumptive use. New litigation, listings of additional species under the ESAs, or regulatory requirements imposed by the SWRCB could further adversely affect SWP operations in the future by requiring additional export reductions, releases of additional water from storage, or other operational changes impacting water supply operations.

The difficulty and implications of environmental review, documentation, and permitting pose challenges for multi-year transfer agreements, recycled water projects, and seawater desalination plants. The timeline and roadmap for getting a permit for recycled water projects are challenging and inconsistently implemented in different regions of the state. IPR projects face regulatory restraints such as treatment, blend water, retention time, and Basin Plan Objectives, which may limit how much recycled water can feasibly be recharged into the groundwater basins. New regulations and permitting uncertainty are also barriers to seawater desalination supplies, including updated Ocean Plan Regulations, Marine Life Protected Areas, and Once-Through Cooling Regulations (MET, 2021).

7.2.3 Water Quality

The following sub-sections include narratives on water quality issues experienced in various water supplies, and the measures being taken to improve the water quality of these sources.

7.2.3.1 Imported Water

MET is responsible for providing high quality potable water throughout its service area. Over 300,000 water quality tests are performed per year on MET's water to test for regulated contaminants and additional contaminants of concern to ensure the safety of its waters. MET's supplies originate primarily from the CRA and from the SWP. A blend of these two sources, proportional to each year's availability of the source, is then delivered throughout MET's service area.

MET's primary water sources face individual water quality issues of concern. The CRA water source contains higher TDS and the SWP contains higher levels of organic matter, lending to the formation of disinfection byproducts. To remediate the CRA's high level of salinity and the SWP's high level of organic matter, MET blends CRA and SWP supplies and has upgraded all of its treatment facilities to include ozone treatment processes. In addition, MET has been engaged in efforts to protect its Colorado River supplies from threats of uranium, perchlorate, and chromium VI while also investigating the potential water quality impact of the following emerging contaminants: N-nitrosodimethylamine (NDMA), pharmaceuticals and personal care products (PPCP), microplastics, PFAS, and 1,4-dioxane (MET, 2021). While unforeseeable water quality issues could alter reliability, MET's current strategies ensure the delivery of high-quality water.

The presence of quagga mussels in water sources is a water quality concern. Quagga mussels are an invasive species that was first discovered in 2007 at Lake Mead, on the Colorado River. This species of mussels forms massive colonies in short periods of time, disrupting ecosystems and blocking water intakes. They can cause significant disruption and damage to water distribution systems. MET has had success in controlling the spread and impacts of the quagga mussels within the CRA, however the future could require more extensive maintenance and reduced operational flexibility than current operations allow. It also resulted in MET eliminating deliveries of CRA water into Diamond Valley Lake (DVL) to keep the reservoir free from quagga mussels (MET, 2021).

7.2.3.2 Groundwater

7.2.3.2.1 OCWD

OCWD is responsible for managing the OC Basin. To maintain groundwater quality, OCWD conducts an extensive monitoring program that serves to manage the OC Basin's groundwater production, control groundwater contamination, and comply with all required laws and regulations. A network of nearly 700 wells provides OCWD a source for samples, which are tested for a variety of purposes. OCWD collects samples each month to monitor Basin water quality. The total number of water samples analyzed varies year-to-year due to regulatory requirements, conditions in the basin, and applied research and/or special study demands. These samples are collected and tested according to approved federal and state procedures as well as industry-recognized quality assurance and control protocols (City of La Habra et al., 2017).

PFAS are of particular concern for groundwater quality, and since the summer of 2019, DDW requires testing for PFAS compounds in some groundwater production wells in the OCWD area. In February 2020, the DDW lowered its Response Levels (RL) for PFOA and PFOS to 10 and 40 parts per trillion (ppt) respectively. The DDW recommends Producers not serve any water exceeding the RL – effectively making the RL an interim MCL while DDW undertakes administrative action to set a MCL. In response to DDW's issuance of the revised RL, as of December 2020, approximately 45 wells in the OCWD service area have been temporarily turned off until treatment systems can be constructed. As additional wells are tested, OCWD expects this figure may increase to at least 70 to 80 wells. The state has begun the process of establishing MCLs for PFOA and PFOS and anticipates these MCLs to be in effect by the Fall of 2023. OCWD anticipates the MCLs will be set at or below the RLs.

In April 2020, OCWD as the groundwater basin manager, executed an agreement with the impacted Producers to fund and construct the necessary treatment systems for production wells impacted by PFAS compounds. The PFAS treatment projects includes the design, permitting, construction, and operation of PFAS removal systems for impacted Producer production wells. Each well treatment system will be evaluated for use with either GAC or ion exchange (IX) for the removal of PFAS compounds. These treatment systems utilize vessels in a lead-lag configuration to remove PFOA and PFOS to less than 2 ppt (the current non-detect limit). Use of these PFAS treatment systems are designed to ensure the groundwater supplied by Producer wells can be served in compliance with current and future PFAS regulations. With financial assistance from OCWD, the Producers will operate and maintain the new treatment systems once they are constructed.

To minimize expenses and provide maximum protection to the public water supply, OCWD initiated design, permitting, and construction of the PFAS treatment projects on a schedule that allows rapid deployment of treatment systems. Construction contracts were awarded for treatment systems for production wells in the City of Fullerton and Serrano in Year 2020. Additional construction contracts will likely be awarded in the first and second quarters of 2021. OCWD expects the treatment systems to be constructed for most of the initial 45 wells above the RL within the next 2 to 3 years.

As additional data are collected and new wells experience PFAS detections at or near the current RL, and/or above a future MCL, and are turned off, OCWD will continue to partner with the affected Producers and take action to design and construct necessary treatment systems to bring the impacted wells back online as quickly as possible.

Groundwater production in FY 2019-20 was expected to be approximately 325,000 acre-feet but declined to 286,550 acre-feet primarily due to PFAS impacted wells being turned off around February 2020. OCWD expects groundwater production to be in the area of 245,000 acre-feet in FY 2020-21 due to the currently idled wells and additional wells being impacted by PFAS and turned off. As PFAS treatment systems are constructed, OCWD expects total annual groundwater production to slowly increase back to normal levels (310,000 to 330,000 acre-feet) (OCWD, 2020a).

Salinity is a significant water quality problem in many parts of southern California, including Orange County. Salinity is a measure of the dissolved minerals in water including both TDS and nitrates.

OCWD continuously monitors the levels of TDS in wells throughout the OC Basin. TDS currently has a California Secondary MCL of 500 mg/L. The portions of the OC Basin with the highest levels are generally located in the cities of Irvine, Tustin, Yorba Linda, Anaheim, and Fullerton. There is also a broad area in the central portion of the OC Basin where TDS ranges from 500 to 700 mg/L. Sources of TDS include the water supplies used to recharge the OC Basin and from onsite wastewater treatment systems, also known as septic systems. The TDS concentration in the OC Basin is expected to decrease over time as the TDS concentration of GWRS water used to recharge the OC Basin is approximately 50 mg/L (City of La Habra et al., 2017).

Nitrates are one of the most common and widespread contaminants in groundwater supplies, originating from fertilizer use, animal feedlots, wastewater disposal systems, and other sources. The MCL for nitrate in drinking water is set at 10 mg/L. OCWD regularly monitors nitrate levels in groundwater and works with producers to treat wells that have exceeded safe levels of nitrate concentrations. OCWD manages the nitrate concentration of water recharged by its facilities to reduce nitrate concentrations in groundwater. This includes the operation of the Prado Wetlands, which was designed to remove nitrogen and other pollutants from the Santa Ana River before the water is diverted to be percolated into OCWD's surface water recharge system.

Although water from the Deep Aquifer System is of very high quality, it is amber-colored and contains a sulfuric odor due to buried natural organic material. These negative aesthetic qualities require treatment before use as a source of drinking water. The total volume of the amber-colored groundwater is estimated to be approximately 1 MAF.

There are other potential contaminants that are of concern to and are monitored by OCWD. These include:

- **MTBE –** MTBE is an additive to gasoline that increases octane ratings but became a widespread contaminant in groundwater supplies. The greatest source of MTBE contamination comes from underground fuel tank releases. The primary MCL for MTBE in drinking water is 13 µg/L.
- **Volatile Organic Compounds (VOC) –** VOCs come from a variety of sources including industrial degreasers, paint thinners, and dry-cleaning solvents. Locations of VOC contamination within the OC Basin include the former El Toro marine Corps Air Station, the Shallow Aquifer System, and portions of the Principal Aquifer System in the Cities of Fullerton and Anaheim.
- **NDMA –** NDMA is a compound that can occur in wastewater that contains its precursors and is disinfected via chlorination and/or chloramination. It is also found in food products such as cured meat, fish, beer, milk, and tobacco smoke. The California Notification Level for NDMA is 10 ng/L and the Response Level is 300 ng/L. In the past, NDMA has been found in groundwater near the Talbert Barrier, which was traced to industrial wastewater dischargers.
- **1,4-Dioxane –** 1,4-Dioxane is a suspected human carcinogen. It is used as a solvent in various industrial processes such as the manufacture of adhesive products and membranes.
- **Constituents of Emerging Concern (CEC) –** CECs are either synthetic or naturally occurring substances that are not currently regulated in water supplies or wastewater discharged but can be detected using very sensitive analytical techniques. The newest group of CECs include pharmaceuticals, personal care products, and endocrine disruptors. OCWD's laboratory is one of a few in the state of California that continuously develops capabilities to analyze for new compounds (City of La Habra et al., 2017).

7.2.3.2.2 San Juan Groundwater Basin

Groundwater quality from the San Juan Basin was determined through the analyses of available data from production and monitoring wells. Constituents of concern within the San Juan Basin include TDS, nitrate nitrogen, manganese, and iron. SJBA performs monthly water quality tests to ensure the safety of the water.

TDS consists of inorganic salts dissolved in water, with the major ions being sodium, potassium, calcium, magnesium, bicarbonates, chlorides, and sulfates under Title 22. The California secondary maximum contaminant level (MCL) for TDS is 500 mg/L. Four wells were tested for TDS and all of the wells exceeded the secondary MCL for TDS. The lower portion of the San Juan Basin exhibits relatively higher TDS levels due to irrigation return flows, fertilizer use, consumptive use, and dissolution of ions from weathered rock surfaces and salts (Wildermuth Environmental, Inc., 2013).

Chloride concentration levels vary across the basin. As of March 2020, concentrations at 220 mg/L, which is at the bottom of the range of observed concentrations since water quality returned to pre-seawater intrusion conditions in 2017 whereas others have concentrations at 1,600 mg/L, which is higher than the maximum observed chloride concentration of 1,200 mg/L at the seawater intrusion event in 2014. Based on available information, it is not possible to know if the high chloride concentrations currently observed are from a prior seawater intrusion event or representative of an active occurrence of seawater intrusion following adifferent preferential path than was observed in 2014. (Wildermuth Environmental, Inc., 2020).

Nitrate within groundwater can be both naturally occurring and can also be associated with agriculture and other synthetic production. The primary MCL for nitrate in drinking water is 10 mg/L. Most groundwater wells monitored for nitrate exhibited levels below MCL except for two wells.

Manganese is a naturally occurring inorganic constituent dissolved in water. Manganese is an essential micronutrient at low concentrations, but at higher concentrations in drinking water, manganese may lead to objectionable aesthetic qualities such as bitter taste and staining of clothes. The California secondary MCL for manganese is 0.5 mg/L. Most wells monitored for manganese exceeded the secondary MCL for manganese by as much as 40 times with the exception of two wells in the Oso and Lower Trabuco area (Wildermuth Environmental, Inc., 2013).

Iron is a naturally occurring inorganic constituent dissolved in water. Similar to manganese, iron in low concentrations is an essential micronutrient, but iron in higher concentrations in drinking water leads to the same objectionable aesthetic qualities as those of manganese. The California secondary drinking water MCL for iron is 0.3 mg/L. With the exception of one groundwater well in the Oso area, all wells exceeded the secondary MCL for iron by as much as 60 times (Wildermuth Environmental, Inc., 2013).

7.2.3.2.3 La Habra Groundwater Basin

TDS, hydrogen sulfide, iron, and manganese impair La Habra Groundwater's water supply. Investigations of water quality within the La Habra Basin have determined that the quality is extremely variable. Shallow regions within the central portion of the basin and areas recharged by surface water along the basin boundary are of a bicarbonate and chloride character. Historically, TDS concentrations have remained relatively stable, and in 2017, TDS concentration in La Habra wells was approximately 960 mg/L (City of La Habra et al., 2017).

The La Habra Basin has water quality concerns that require treatment or blending with higher quality water to meet the State's health standards. The quality of Idaho Street Well raw water requires treatment before entering the City of La Habra's distribution system. The treatment system includes chlorination, air-stripping to remove hydrogen sulfide and ammonia that may be present, and the addition of sodium hexametaphosphate to sequester iron and manganese. Water from the La Bonita Well and the Portola Well is chlorinated and then blended with CDWC purchased water in a 250,000-gallon forebay to reduce mineral concentration (La Habra, Groundwater Study, 2014).

7.2.3.2.4 Main San Gabriel Groundwater Basin

VOCs and nitrates are the most prevalent contaminants found in the Main San Gabriel Basin. As a result, the location and treatment methods are generally well understood. During FY 2019-20, 30 treatment plants treated approximately 75,000 AF of VOC-contaminated water from the Main San Gabriel Basin. Although VOC contamination is substantial, it is centered in just a few areas, leaving a large portion of the Main San Gabriel Basin unaffected.

The DDW lowered the notification level of perchlorate from 18 to 4 parts per billion (ppb) in January 2002. Subsequently, a total of 22 wells from the Main San Gabriel Basin were removed from service due to unacceptable levels of perchlorate. In October 2007, the DDW established an MCL of 6 ppb. Efforts to treat perchlorate by the Watermaster resulted in ion-exchange technology treatment facilities at five sites in the Baldwin Park Operable Unit (BPOU) and at two facilities in other parts of the Main San Gabriel Basin during FY 2019-20. In April 2020, DDW issued a Notice of Proposed Rulemaking to consider lowering the perchlorate Detection Limit for Purposes of Reporting (DLR) to 2 ppb, and in anticipation of this possible revision, Watermaster coordinated with Producers to conduct “low-level” detection sampling at a level of 0.1 ppb.

During 1998, eight local wells within the Main San Gabriel Basin had levels of NDMA above the notification level of 2 ppt at the time. Five of the wells with measurable levels of NDMA had already been taken out of service for other reasons, and the other three were taken offline as a direct result of NDMA levels above notification level. The Watermaster played a key role in the construction of NDMA treatment facilities within the Main San Gabriel Basin. Five facilities were operational during FY 2019-20.

1,2,3-TCP is a degreasing agent that has been detected in the BPOU during the winter of 2006. Its presence delayed the use of one treatment facility for potable purposes. The DDW determined 1,2,3-TCP is best treated through liquid phase GAC. Facilities to treat 1,2,3-TCP were operational during FY 2019-20.

The DDW required specific water systems to conduct water quality tests for PFAS and PFOS during 2019 and established the notification level at 5.1 ppt and 6.5 ppt for PFOA and PFOS, respectively. Watermaster is conducting PFAS sampling and monitoring as required by the SWRCB and working with the DDW to characterize the extent of PFAS in the Main San Gabriel Basin (Main San Gabriel Basin Watermaster, 2020b).

7.2.4 Locally Applicable Criteria

Within Orange County, there are no significant local applicable criteria that directly affect reliability. Through the years, the water agencies in Orange County have made tremendous efforts to integrate their systems to provide flexibility to interchange with different sources of supplies. There are emergency agreements in place to ensure all parts of the County have an adequate supply of water. In the northern part of the County, agencies have the ability to meet a majority of their demands through groundwater with very little limitation, except for the OCWD BPP. For the agencies in southern Orange County, most of their demands are met with imported water where their limitation is based on the capacity of their system, which is very robust.

However, if a major earthquake on the San Andreas Fault occurs, it will be damaging to all three key regional water aqueducts and disrupt imported supplies for up to six months. The region would likely impose a water use reduction ranging from 10-25% until the system is repaired. However, MET has taken proactive steps to handle such disruption, such as constructing DVL, which mitigates potential impacts. DVL, along with other local reservoirs, can store a six to twelve-month supply of emergency water (MET, 2021).

7.3 Water Service Reliability Assessment

This Section assesses the reliability of MWDOC's water service to its customers. This is completed by comparing the projected long-term water demand (Section 4), to the projected water supply sources available to MWDOC (Section 6), in five-year increments, for a normal water year, a single dry water year, and a drought lasting five consecutive water years.

7.3.1 Normal Year Reliability

The water demand forecasting model developed for the Demand Forecast TM (described in Section 4.3.1), to project the 25-year demand for Orange County water agencies, also isolated the impacts that weather and future climate can have on water demand through the use of a statistical model. The explanatory variables of population, temperature, precipitation, unemployment rate, drought restrictions, and conservation measures were used to create the statistical model. The impacts of hot/dry weather condition are reflected as a percentage increase in water demands from the average condition. The average (normal) demand is represented by the average water demand of FY 2017-18 and FY 2018-19 (CDM Smith, 2021).

MWDOC is 100 percent reliable for normal year demands from 2025 through 2045. MWDOC receives imported water from MET via connection to MET's regional distribution system. Although pipeline and connection capacity rights do not guarantee the availability of water, they do guarantee the ability to convey water into the local system when it is available to the MET distribution system.

A comparison between the supply and demand for projected years between 2025 and 2045 is shown in Table 7-2. As stated above, the available supply will meet projected demands due to a diversified supply and conservation measures limiting and reducing imported demands in the later years.

Table 7-2: Wholesale: Normal Year Supply and Demand Comparison

DWR Submittal Table 7-2 Wholesale: Normal Year Supply and Demand Comparison					
	2025	2030	2035	2040	2045
Supply totals	175,360	176,190	179,119	178,724	178,436
Demand totals	175,360	176,190	179,119	178,724	178,436
Difference	0	0	0	0	0
NOTES: Includes treated and untreated water from MET for M&I and non-M&I demands.					

7.3.2 Single Dry Year Reliability

A single dry year is defined as a single year of minimal to no rainfall within a period where average precipitation is expected to occur. The water demand forecasting model developed for the Demand Forecast TM (described in Section 4.3.1), isolated the impacts that weather and future climate can have on water demand through the use of a statistical model. The impacts of hot/dry weather condition are reflected as a percentage increase in water demands from the normal year condition (average of FY 2017-18 and FY 2018-19). For a single dry year condition (FY 2013-14), the model projects a six percent increase in demand for the MWDOC's service area (CDM Smith, 2021). Detailed information of the model is included in Appendix H.

MWDOC has documented that it is 100 percent reliable for single dry year demands from 2025 through 2045 with a demand increase of six percent from normal demand with significant reserves held by MET and conservation. A comparison between the supply and the demand in a single dry year is shown in Table 7-3.

Table 7-3: Wholesale: Single Dry Year Supply and Demand Comparison

DWR Submittal Table 7-3 Wholesale: Single Dry Year Supply and Demand Comparison					
	2025	2030	2035	2040	2045
Supply totals (AF)	182,545	183,425	186,530	186,110	185,806
Demand totals (AF)	182,545	183,425	186,530	186,110	185,806
Difference	0	0	0	0	0
NOTES: Includes treated and untreated water from MET for M&I and non-M&I demands. The single dry year projections estimate a 6% increase on imported M&I demand. Non-M&I demand (Irvine Lake and groundwater storage and replenishment) remain constant at 55,617AFY for all years because					

7.3.3 Multiple Dry Years Reliability

Multiple dry years are defined as five or more consecutive dry years with minimal rainfall within a period of average precipitation. The water demand forecasting model developed for the Demand Forecast TM (described in Section 4.3.1) isolated the impacts that weather and future climate can have on water demand through the use of a statistical model. The impacts of hot/dry weather condition are reflected as a percentage increase in water demands from the normal year condition (average of FY2017-18 and FY2018-19). For a single dry year condition (FY2013-14), the model projects a six percent increase in demand for the MWDOC's service area (CDM Smith, 2021). It is conservatively assumed that a five-year multi dry year scenario is a repeat of the single dry year over five consecutive years.

Even assuming a conservative demand increase of six percent each year for five consecutive years, MWDOC is capable of meeting all customers' demands from 2025 through 2045 (Table 7-4), with significant reserves held by MET and conservation.

Table 7-4: Wholesale: Multiple Dry Years Supply and Demand Comparison

DWR Submittal Table 7-4 Wholesale: Multiple Dry Years Supply and Demand Comparison (AF)						
		2025	2030	2035	2040	2045
First year	Supply totals	172,611	176,121	177,446	179,846	179,449
	Demand totals	172,611	176,121	177,446	179,846	179,449
	Difference	0	0	0	0	0
Second year	Supply totals	175,094	176,297	178,067	179,762	179,389
	Demand totals	175,094	176,297	178,067	179,762	179,389
	Difference	0	0	0	0	0
Third year	Supply totals	177,578	176,473	178,688	179,678	179,328
	Demand totals	177,578	176,473	178,688	179,678	179,328
	Difference	0	0	0	0	0
Fourth year	Supply totals	180,061	176,649	179,309	179,594	179,267
	Demand totals	180,061	176,649	179,309	179,594	179,267
	Difference	0	0	0	0	0
Fifth year	Supply totals	182,545	183,425	186,530	186,110	185,806
	Demand totals	182,545	183,425	186,530	186,110	185,806
	Difference	0	0	0	0	0

NOTES:
Includes treated and untreated water from MET for M&I and non-M&I demands. The multiple dry-year projections estimate a six percent increase on imported M&I demand. Non-M&I demand (Irvine Lake and groundwater storage and replenishment) remain constant at 55,617AFY because these demands are not affected by changes in hydrological conditions. The 2025 column assesses supply and demand for FY 2020-21 through FY 2024-25; the 2030 column assesses FY 2025-26 through FY 2029-30 and so forth, in order to end the water service reliability assessment in FY 2044-45.

7.4 Management Tools and Options

Existing and planned water management tools and options that seek to maximize local resources and results in minimizing the need to import water are described below.

- **Reduced Delta Reliance:** Both MWDOC and MET have demonstrated consistency with Reduced Reliance on the Delta Through Improved Regional Water Self-Reliance (Delta Plan policy WR P1) by reporting the expected outcomes for measurable reductions in supplies from the Delta. MET has improved its self-reliance through methods including water use efficiency, water recycling, stormwater capture and reuse, advanced water technologies, conjunctive use projects, local and regional water supply and storage programs, and other programs and projects. Similarly, MWDOC and its member agencies have further invested in water use efficiency, local water supply projects, and advanced water technologies to increase regional self-reliance. In 2020, MET had a 602,000 AF change in supplies contributing to regional-self-reliance, corresponding to a 15.3 percent change, and this amount is projected to increase through 2045 (MET, 2021). In 2020, MWDOC had a nearly 200,000 AF change in supplies contributing to regional-self-reliance, which represents a 30% change since the 2010 baseline. For detailed information on the Delta Plan Policy WR P1, refer to Appendix C.

- **The continued and planned use of groundwater:** The water supply resources within MWDOC's service area are enhanced by the existence of groundwater basins that account for the majority of local supplies available and are used as reservoirs to store water during wet years and draw from storage during dry years, subsequently minimizing MWDOC service area's reliance on imported water. Groundwater basins are managed within a safe basin operating range so that groundwater wells are only pumped as needed to meet water use. Although MWDOC does not manage any of the service area's groundwater basins, MWDOC supports and partners in efforts to maintain the health of the local basins through local groundwater recharge efforts such OCWD's GWRS program.

- **Groundwater storage and transfer programs:** MWDOC and OCWD's involvement in SARCCUP includes participation in a conjunctive use program that improves water supply resiliency and increases available dry-year yield from local groundwater basins. The groundwater bank has 137,000 AF of storage (OCWD, 2020b). MET has numerous groundwater storage and transfer programs in which MET endeavors to increase the reliability of water supplies, including the AVEK Waster Agency Exchange and Storage Program and the High Desert Water Bank Program. The IRWD Strand Ranch Water Banking Program has approximately 23,000 AF stored for IRWD's benefit, and by agreement, the water is defined to be an "Extraordinary Supply" by MET and counts essentially 1:1 during a drought/water shortage condition under MET's and MWDOC's WSAP. In addition, MET has encouraged storage through its cyclic and conjunctive use programs that allow MET to deliver water into a groundwater basin in advance of agency demands, such as the Cyclic Storage Agreements under the Main San Gabriel Basin Judgement.

- **Water Loss Program:** The water loss audit program reduces MWDOC's dependency on imported water from the Delta by implementing water loss control technologies after assessing audit data and leak detection.

- **Increased use of recycled water:** MWDOC partners with local agencies in recycled water efforts, including OCWD to identify opportunities for the use of recycled water for irrigation purposes, groundwater recharge and some non-irrigation applications. OCWD's GWRS and GAP allow southern California to decrease its dependency on imported water and create a local and reliable source of water that meet or exceed all federal and state drinking level standards. Expansion of the GWRS is currently underway to increase the plant's production to 130 MGD, and further reduce reliance on imported water.

- **Implementation of demand management measures during dry periods:** During dry periods, water reduction methods to be applied to the public through the retail agencies, will in turn reduce MWDOC's overall demands on MET and reliance on imported water. MWDOC assisted its retail agencies by leading the coordination of the 20% by 2020 Orange County Regional Alliance for all of the retail agencies in Orange County. MWDOC assisted each retail water supplier in Orange County in analyzing the requirements of and establishing their baseline and target water use, as guided by DWR.

7.5 Drought Risk Assessment

CWC Section 10635(b) requires every urban water supplier include, as part of its UWMP, a DRA for its water service as part of information considered in developing its demand management measures and water supply projects and programs. The DRA is a specific planning action that assumes MWDOC is experiencing a drought over the next five years and addresses MWDOC's water supply reliability in the context of presumed drought conditions. Together, the water service reliability assessment, DRA, and WSCP allow MWDOC to have a comprehensive picture of its short-term and long-term water service reliability and to identify the tools to address any perceived or actual shortage conditions.

CWC Section 10612 requires the DRA to be based on the driest five-year historic sequence for MWDOC's water supply. However, CWC Section 10635 also requires that the analysis consider plausible changes on projected supplies and demands due to climate change, anticipated regulatory changes, and other locally applicable criteria.

The following sections describe the methodology and results from MWDOC's DRA.

7.5.1 Methodology

The water demand forecasting model developed for the Demand Forecast TM (described in Section 4.3.1) isolated the impacts that weather and future climate can have on water demand through the use of a statistical model. The impacts of hot/dry weather condition are reflected as a percentage increase in water demands from the average condition (average of FY 2017-18 and FY 2018-19). For a single dry year condition (FY 2013-14), the model projects a six percent increase in demand for the MWDOC's service area (CDM Smith, 2021).

For MWDOC, the five consecutive years of FY 2011-12 to FY 2015-16 represent the driest five -consecutive year historic sequence for MWDOC's service area water supply. This period that spanned water years 2012 through 2016 included the driest four-year statewide precipitation on record (2012-2015) and the smallest Sierra-Cascades snowpack on record (2015, with five percent of average). It was marked by extraordinary heat: 2014, 2015 and 2016 were California's first, second and third warmest year in terms of statewide average temperatures. Locally, Orange County rainfall for the five-year period totaled 36 inches, the driest on record.

Water Demand Characterization

All of MWDOC's water supplies are purchased from MET, regardless of hydrologic conditions. As described in Section 6.2.1, MET's supplies are from the Colorado River, SWP, and in -region storage. In their 2020 UWMP, both MET's DRA concluded that even without activating WSCP actions, MET can reliably provide water to all of their member agencies, including MWDOC, through 2045, assuming a five -year drought from FY 2020-21 through FY 2024-25. Beyond this, MET's DRA indicated a surplus of supplies that would be available to all of its member agencies, including MWDOC, should the need arise. Therefore, any increase in demand that is experienced in MWDOC's service area will be met by MET's water supplies.

Based on MWDOC's Demand Forecast TM, in a single dry year, demand is expected to increase by six percent above a normal year. MWDOC's projected normal water use is presented annually for the next five years in Table 7-5. MWDOC's DRA conservatively assumes a drought from FY 2020-21 through FY 2024-25 is a repeat of the single dry year over five consecutive years.

MWDOC developed its demand forecast in a number of steps. First, MWDOC estimated total retail demands for its service area. This was based on estimated future demands using historical water use trends, future expected water use efficiency measures, additional projected land-use development, and changes in population. Next, MWDOC estimated the projections of local supplies derived from current and expected local supply programs from MWDOC member agencies. Finally, MWDOC used its demand model to calculate the difference between total forecasted demands and local supply projections. The resulting difference between total demands net of savings from conservation and local supplies is the expected regional demands on MWDOC. The sum of the 1) M&I demand estimated from the model and the 2) non-M&I water for surface water storage and groundwater replenishment, equate MWDOC's demand, which is supplied by MET.

Table 7-5: MWDOC's Projected Normal M&I and Non-M&I Water Demand

MWDOC's Projected Normal M&I and Non-M&I Water Demand					
	2021	2022	2023	2024	2025
Water Use (AF)	164,316	167,077	169,838	172,599	175,360
NOTES: Source – Linearly interpolated from MWDOC Service Area Water Supply Projections					

Water Supply Characterization

MWDOC's assumptions for its supply capabilities are discussed and presented in 5-year increments under its water reliability assessment in Section 7.3. For MWDOC's DRA, these supply capabilities are further refined and presented annually for the years 2021 to 2025 by assuming a repeat of historic conditions from FY 2011-12 to FY 2015-16. For its DRA, MWDOC assessed the reliability of supplies available to MWDOC through MET using historical supply availability under dry-year conditions. MET's supply sources under the CR, SWP, and In-Region supply categories are individually listed and discussed in detail in MET's UWMP. Future supply capabilities for each of these supply sources are also individually tabulated in Appendix 3 of MET's UWMP, with consideration for plausible changes on projected supplies under climate change conditions, anticipated regulatory changes, and other factors. For simplicity, the supply capabilities presented in Table 7-6 constitute the total of MWDOC's water supplies made available by MET. MWDOC's supplies are used to meet consumptive use, surface water and groundwater recharge needs that are in excess of locally available supplies. In addition, MWDOC has access to supply augmentation actions through MET. MET may exercise these actions based on regional need, and in accordance with their WSCP, and may include the use of supplies and storage programs within the Colorado River, SWP, and in-region storage.

7.5.2 Total Water Supply and Use Comparison

MWDOC's anticipated total water use and supply under a five-year drought from FY 2020-21 through FY 2024-25, are compared in Table 7-6. MWDOC's assessment reveals that its supply capabilities are expected to balance with its projected water use for the next five years, from 2021 to 2025, under a repeat of a five consecutive-year drought.

Table 7-6: Five-Year Drought Risk Assessment Tables to Address Water Code Section 10635(b)

DWR Submittal Table 7-5: Five-Year Drought Risk Assessment Tables to address Water Code Section 10635(b)	
2021	**Total**
Total Water Use	172,611
Total Supplies	172,611
Surplus/Shortfall w/o WSCP Action	0
Planned WSCP Actions (use reduction and supply augmentation)	
WSCP - supply augmentation benefit	0
WSCP - use reduction savings benefit	0
Revised Surplus/(shortfall)	0
Resulting % Use Reduction from WSCP action	0%
2022	**Total**
Total Water Use	175,094
Total Supplies	175,094
Surplus/Shortfall w/o WSCP Action	0
Planned WSCP Actions (use reduction and supply augmentation)	
WSCP - supply augmentation benefit	0
WSCP - use reduction savings benefit	0
Revised Surplus/(shortfall)	0
Resulting % Use Reduction from WSCP action	0%
2023	**Total**
Total Water Use	177,578
Total Supplies	177,578
Surplus/Shortfall w/o WSCP Action	0
Planned WSCP Actions (use reduction and supply augmentation)	
WSCP - supply augmentation benefit	0

DWR Submittal Table 7-5: Five-Year Drought Risk Assessment Tables to address Water Code Section 10635(b)	
WSCP - use reduction savings benefit	0
Revised Surplus/(shortfall)	0
Resulting % Use Reduction from WSCP action	0%
2024	**Total**
Total Water Use	180,061
Total Supplies	180,061
Surplus/Shortfall w/o WSCP Action	0
Planned WSCP Actions (use reduction and supply augmentation)	
WSCP - supply augmentation benefit	0
WSCP - use reduction savings benefit	0
Revised Surplus/(shortfall)	0
Resulting % Use Reduction from WSCP action	0%
2025	**Total**
Total Water Use	182,545
Total Supplies	182,545
Surplus/Shortfall w/o WSCP Action	0
Planned WSCP Actions (use reduction and supply augmentation)	
WSCP - supply augmentation benefit	0
WSCP - use reduction savings benefit	0
Revised Surplus/(shortfall)	0
Resulting % Use Reduction from WSCP action	0%

7.5.3 Water Source Reliability

As detailed in Section 8, MWDOC has in place a robust WSCP and comprehensive shortage response planning efforts that include demand reduction measures and supply augmentation actions. However, since MWDOC's DRA shows a balance, no water service reliability concern is anticipated, and no shortfall mitigation measures are expected to be exercised over the next five years. Additionally, while a balance of supplies and demands are shown in the previously displayed Table 7-6, it is important to note that MET's DRA shows a surplus of supplies that would be available all of its Member Agencies, including MWDOC, should the need for additional supplies arise. MWDOC will periodically revisit its representation of both individual supply sources and of the gross water use estimated for each year and will revise its DRA if needed.

8 WATER SHORTAGE CONTINGENCY PLANNING

8.1 Layperson's Description

Water shortage contingency planning is a strategic planning process that MWDOC engages to prepare for and respond to water shortages. A water shortage, when water supply available is insufficient to meet the normally expected customer water use at a given point in time, may occur due to a number of reasons, such as water supply quality changes, climate change, drought, and catastrophic events (e.g., earthquake). The MWDOC WSCP provides a water supply availability assessment and structured steps designed to respond to actual conditions. This level of detailed planning and preparation will help maintain reliable supplies and reduce the impacts of supply interruptions.

The Water Code Section 10632 requires that every urban water supplier that serves more than 3,000 acre-feet per year or have more than 3,000 connections prepared and adopt a standalone WSCP as part of its UWMP. The WSCP is required to plan for a greater than 50% supply shortage. This WSCP due to be updated based on new requirements every five years and will be adopted as a current update for submission to DWR by July 1, 2021.

8.2 Overview of the Water Shortage Contingency Plan

The WSCP serves as the operating manual that MWDOC will use to prevent catastrophic service disruptions through proactive, rather than reactive, mitigation of water shortages. The WSCP contains the processes and procedures that will be deployed when shortage conditions arise so that the MWDOC governing body, its staff, and its retail agencies can easily identify and efficiently implement pre-determined steps to mitigate a water shortage to the level appropriate to the degree of water shortfall anticipated.

A copy of the MWDOC WSCP is provided in Appendix I and includes the steps to assess if a water shortage is occurring, and what level of demand reduction actions to trigger the most appropriate response to the water shortage conditions. MWDOC, as a wholesaler of MET's treated water supply, has an interdependent relationship with MET documents related to planning for, and responding to, water shortage; therefore, the MWDOC WSCP includes the MET Water Supply Allocation Plan[1] (WSAP). The MET WSAP outlines how MET will determine and implement each of its wholesale and retail agencies' allocation during a time of shortage. MWDOC also has its own version of a WSAP the outlines how MWDOC will determine and implement each of its retail agency's allocation during a time of shortage.

Figure 8-1 illustrates the interdependent relationship between the MET and MWDOC procedural documents related to planning for and responding to water shortages.

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[1] MET's Water Shortage Contingency Plan, which includes Water Surplus and Drought Management Plan and WSAP, Appendix 4 of the 2020 UWMP

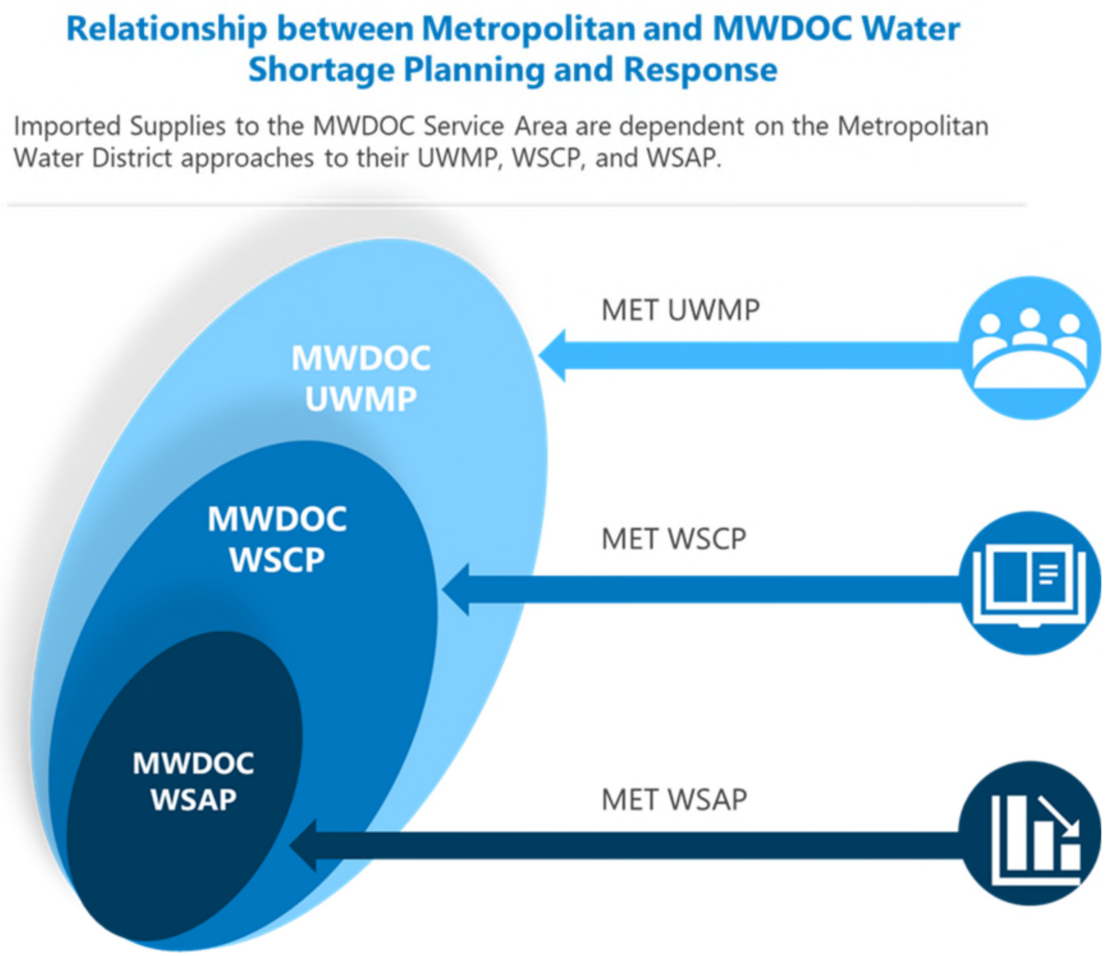

Figure 8-1: Relationship Between MET and MWDOC Water Shortage Planning and Response

WSCP has prescriptive elements, including an analysis of water supply reliability; the drought shortage actions for each of the six standard water shortage levels, that correspond to water shortage percentages ranging from 10 percent to greater than 50 percent; an estimate of potential to close supply gap for each measure; protocols and procedures to communicate identified actions for any current or predicted water shortage conditions; procedures for an annual water supply and demand assessment; reevaluation and improvement procedures for evaluating the WSCP.

During past shortages MWDOC has adopted Board Resolutions urging its retail agencies to develop and implement water shortage plans, calling upon each agency to adopt and enforce regulations prohibiting the waste of water, and implementing an allocation plan for available imported water consistent with reductions, incentives, and allocation surcharges imposed on MWDOC by MET. As part of the 2020 UWMP, MWDOC has worked with retail agencies to develop and align individual WSCPs.

8.3 Summary of Water Shortage Response Strategy and Required DWR Tables

This WSCP is organized into three main sections with Section 3 aligned with the California Water Code Section 16032 requirements.

Section 1 Introduction and WSCP Overview gives an overview of the WSCP fundamentals.

Section 2 Background provides a background on the MWDOC's water service area.

Section 3 Water Shortage Contingency Plan

Section 3.1 Water Supply Reliability Analysis provides a summary of the water supply analysis and water reliability findings from the 2020 UWMP.

Section 3.2 Annual Water Supply and Demand Assessment Procedures provide a description of procedures to conduct and approve the Annual Assessment.

Section 3.3 Six Standard Water Shortage Stages explains the WSCP's six standard water shortage levels corresponding to progressive ranges of up to 10, 20, 30, 40, 50, and more than 50 percent shortages.

Section 3.4 Shortage Response Actions describes the WSCP's shortage response actions that align with the defined shortage levels.

Section 3.5 Communication Protocols addresses communication protocols and procedures to inform customers, the public, interested parties, and local, regional, and state governments, regarding any current or predicted shortages and any resulting shortage response actions.

Section 3.6 Compliance and Enforcement is not required by wholesaler agencies.

Section 3.7 Legal Authorities is a description of the legal authorities that enable MWDOC to implement and enforce its shortage response actions.

Section 3.8 Financial Consequences of the WSCP provides a description of the financial consequences of and responses for drought conditions.

Section 3.9 Monitoring and Reporting is not required by wholesaler agencies.

Section 3.10 WSCP Refinement Procedures addresses reevaluation and improvement procedures for monitoring and evaluating the functionality of the WSCP.

Section 3.11 Special Water Feature Distinction.

Section 3.12 Plan Adoption, Submittal, and Implementation provides a record of the process MWDOC followed to adopt and implement its WSCP.

The WSCP is based on adequate details of demand reduction and supply augmentation measures that are structured to match varying degrees of shortage will ensure the relevant stakeholders understand what to expect during a water shortage situation. MWDOC adopted water shortage levels consistent with the requirements identified in Water Code Section 10632 (a)(3)(A) (Table 8-1).

The supply augmentation actions that align with each shortage level are described in DWR Table 8-3 (Appendix B). These augmentations represent short-term management objectives triggered by the WSCP and do not overlap with the long-term new water supply development or supply reliability enhancement projects.

The demand reduction measures that align with each shortage level are described in DWR Table 8-2 (Appendix B). This table also estimates the extent to which that action will reduce the gap between supplies and demands to demonstrate to the that choose suite of shortage response actions can be expected to deliver the expected outcomes necessary to meet the requirements of a given shortage level.

Table 8-1: Water Shortage Contingency Plan Levels

DWR Submittal Table 8-1 Water Shortage Contingency Plan Levels		
Shortage Level	**Percent Shortage Range**	**Shortage Response Actions**
0	0% (Normal)	A Level 0 Water Supply Shortage –Condition exists when MWDOC notifies its water users that no supply reductions are anticipated in this year. MWDOC proceeds with planned water efficiency best practices to support consumer demand reduction in line with state mandated requirements and local MWDOC goals for water supply reliability.
1	Up to 10%	A Level 1 Water Supply Shortage – Condition exists when no supply reductions are anticipated, a consumer imported demand reduction of up to 10% is recommended to make more efficient use of water and respond to existing water conditions. Upon the declaration of a Water Aware condition, MWDOC shall implement the mandatory Level 1 conservation measures identified in this WSCP. The type of event that may prompt MWDOC to declare a Level 1 Water Supply Shortage may include, among other factors, a finding that its wholesale water provider (MET) calls for extraordinary water conservation efforts.
2	Up to 20%	A Level 2 Water Supply Shortage – Condition exists when MWDOC notifies its member agencies that due to drought or other supply reductions, a consumer imported demand reduction of up to 20% is necessary to make more efficient use of water and respond to existing water conditions. Upon declaration of a Level 2 Water Supply Shortage condition, MWDOC shall implement the mandatory Level 2 conservation measures identified in this WSCP.

DWR Submittal Table 8-1 Water Shortage Contingency Plan Levels		
3	Up to 30%	A Level 3 Water Supply Shortage – Condition exists when MWDOC declares a water shortage emergency condition pursuant to California Water Code section 350 and notifies its member agencies that up to 30% consumer imported demand reduction is required to ensure sufficient supplies for human consumption, sanitation, and fire protection. MWDOC must declare a Water Supply Shortage Emergency in the manner and on the grounds provided in California Water Code section 350.
4	Up to 40%	A Level 4 Water Supply Shortage – Condition exists when MWDOC declares a water shortage emergency condition pursuant to California Water Code section 350 and notifies its member agencies that up to 40% consumer imported demand reduction is required to ensure sufficient supplies for human consumption, sanitation, and fire protection. MWDOC must declare a Water Supply Shortage Emergency in the manner and on the grounds provided in California Water Code section 350.
5	Up to 50%	A Level 5 Water Supply Shortage – Condition exists when MWDOC declares a water shortage emergency condition pursuant to California Water Code section 350 and notifies its member agencies that up to 50% or more consumer imported demand reduction is required to ensure sufficient supplies for human consumption, sanitation, and fire protection. MWDOC must declare a Water Supply Shortage Emergency in the manner and on the grounds provided in California Water Code section 350.
6	>50%	A Level 6 Water Supply Shortage – Condition exists when MWDOC declares a water shortage emergency condition pursuant to California Water Code section 350 and notifies its member agencies that greater than 50% or more consumer imported demand reduction is required to ensure sufficient supplies for human consumption, sanitation, and fire protection. MWDOC must declare a Water Supply Shortage Emergency in the manner and on the grounds provided in California Water Code section 350.
NOTES:		

9 DEMAND MANAGEMENT MEASURES

The goal of the Demand Management Measures (DMM) section is to provide a comprehensive description of the water conservation programs that a supplier has implemented, is currently implementing, and plans to implement in order to meet its urban water used reduction targets. The reporting of DMMs were significantly modified in 2014 by Assembly Bill 2067 to streamline the DMM reporting requirements. For retail suppliers the requirements changed from 14 specific measures to six more general requirements plus an “other” category:

- Water waste prevention ordinances;
- Metering;
- Conservation pricing;
- Public education and outreach;
- Programs to assess and manage distribution system real loss;
- Water conservation program coordination and staffing support;
- Other demand management measures that have a significant impact on water use as measured in GPCD, including innovative measures, if implemented;
- Programs to assist retailers with Conservation Framework Compliance

Wholesale agencies must now provide narrative descriptions of metering, public education and outreach, water conservation program coordination and staffing support, and other DMMs, as well as a narrative of asset management and the wholesale supplier assistance programs.

9.1 Overview

MWDOC demonstrated its commitment to water use efficiency in 1991 by voluntarily signing the MOU Regarding Urban Water Conservation in the California Urban Water Conservation Council. As a signatory to the MOU, MWDOC has committed to a good-faith-effort to implement all cost-effective best management practices (BMPs) as demand management measures DMMs.

An ethic of efficient use of water has been developing over the last 30 years of implementing water use efficiency programs. Retail water agencies throughout Orange County also recognize the need to use existing water supplies efficiently – implementation of water efficiency programs makes good economic sense and reflects responsible stewardship of the region’s water resources. All retail water agencies in Orange County are actively implementing DMM-based programs.

MWDOC still honors its commitment to urban water efficiency, and continues to implement BMP-based DMMs through multi-faceted, holistic water use efficiency programs today. As a wholesaler, to help facilitate implementation of DMM throughout Orange County, MWDOC’s efforts focus on the following three areas: Regional Program Implementation, Local Program Assistance, and Research and Evaluation. This both complies with and goes beyond the Foundational BMPs of Utility Operations Programs requirements:

Regional Program Implementation - MWDOC develops, obtains funding for, and implements regional water savings programs on behalf of all retail water agencies in Orange County. This approach minimizes confusion to consumers by providing the same programs with the same participation guidelines, maintains a consistent message to the public to use water efficiently, and provides support to retail water agencies by acting as program administrators for the region. As a leader of water efficiency in Orange County, MWDOC provides a holistic suite of programs that are accessible by all consumer groups in the region. Many of these programs have been structured through Integrated Regional Water Management Planning processes in north, central and south Orange County.

Local Program Assistance - When requested, MWDOC assists retail agencies in developing and implementing local programs within their service areas. This assistance includes collaboration with each retail agency to design a program to fit that agency's local needs, including providing staffing, targeting customer classes, acquiring grant funding from a variety of sources, and implementing, marketing, reporting, and evaluating the program. MWDOC assists with a variety of local programs including, but not limited to: Pressure Regulation Valve Replacement Pilot, regional Smart Timer Distributions, Sub-Metering, Custom Commercial Retrofits, various public information, and outreach campaigns, K-12 Choice School Programs, Conservation Pricing, Leak Detection, and Water Waste Prohibitions..

Research and Evaluation - An integral component of MWDOC's water use efficiency program is the research and evaluation of potential and existing programs. Research allows an agency to measure the water savings benefits of a specific program and then compare those benefits to the costs of implementing the program in order to evaluate the economic feasibility of the program when compared to other efficiency projects or existing or potential sources of supply. MWDOC regularly conducts statistical water savings (impact evaluations) and program process evaluations to determine how to best invest and run its water efficiency programs. From 2016-2020, MWDOC conducted process and impact evaluations on its Spray-to-Drip Program, the results of which have created a starting point of a standardized rebate program throughout the MET service area, and its Landscape Design Assistance Program. Additionally, an evaluation was conducted of MWDOC's Comprehensive Landscape Water Use Efficiency (CLWUE) Program, which included smart timers, rotating nozzles, turf removal, drip irrigation, and recycled water conversions. This study evaluated how much water was saved at properties implementing these measures and compared savings among landscapes that implemented one versus two of the measures (e.g., a turf removal site compared to a turf removal site that also installed a smart irrigation timer). Additionally, MWDOC is currently piloting a research program investigating water savings associated with the replacement of broken pressure regulating valves at residential homes. The results of this study are expected in 2023.

Furthermore, in 2013 MWDOC published its first Orange County Water Use Efficiency Master Plan to define how Orange County will comply with, or exceed, the state mandate of a 20 percent reduction in water use by 2020, and how MWDOC will achieve its share of MET's Integrated Resources Plan water savings goal. The Master Plan is being used to achieve the water savings goal at the lowest possible costs while maintaining a mix of programs desired by water agencies and consumers throughout Orange County. MWDOC is planning an update to the 2013 Orange county Water Use Efficiency Master Plan in 2023 that will integrate all necessary measures relevant to SB 606 and AB 1668.

Table 9-1 summarizes DMM implementation responsibilities of MWDOC as Orange County's wholesale supplier and responsibilities of MWDOC's retail agencies.

Table 9-1: DMM Implementation Responsibility and Regional Programs in Orange County

Efficiency Measure	Applies to: Retailer	Applies to: MWDOC as a Wholesaler	MWDOC Regional Program and Activities
Operations Practices			
Wholesale Agency Assistance Programs	-	✓	✓
Conservation Pricing	✓	✓	✓
Conservation Coordinator	✓	✓	✓
Water Waste Prevention	✓	-	✓
Water Loss Control (System Water Audits, Leak Detection and Repair)	✓	(1)	✓
Metering with Commodity Rates	✓	(1)	(1)
Commercial, Industrial, and Institutional (CII) Programs	✓	-	✓
Large Landscape Conservation Programs	✓		✓
Landscape Programs			
Residential and CII Landscape Rebate Programs (Turf Removal, Spray-to-Drip, Smart Timer, High Efficiency Sprinkler Nozzles (HENs), Rain Barrels, Large Rotary Nozzles, In-stem Flow Regulators)	✓	-	✓
Residential Landscape Design and Maintenance Assistance Programs	✓	-	✓
Qualified Water Efficient Landscaper (QWEL) Training Program	✓	✓	✓
Residential Implementation			
High-Efficiency Washing Machine Rebate Program	✓	-	✓

Efficiency Measure	Applies to:		MWDOC Regional Program and Activities
	Retailer	MWDOC as a Wholesaler	
WaterSense Specification Toilets (Residential Plumbing Fixture Retrofits[(1)])	✓	-	✓
WaterSense Specification for Residential Development	✓	-	-
Commercial, Industrial, Institutional Implementation			
Water Savings Incentive Program	✓	-	✓
On-site Retrofit Program	✓	-	✓
Direct Install High Efficiency Toilets (HET) (DAC and Non-DAC)	✓	-	✓
CII Rebate Programs (HET and Urinals, Plumbing Flow Control Valves, Connectionless Food Steams, Air-cool Ice Machines, Cooling Tower Conductivity Controllers and pH Controllers, Dry Vacuum Pumps, Laminar Flow Restrictors	✓	-	✓
Education Programs			
Public Outreach Programs	✓	✓	✓
Choice K-12 School Programs	✓	✓	✓
Boy Scouts Soil and Water Conservation Badge Program	✓	✓	✓
Girl Scouts Water Resources and Conservation Patch Program	✓	✓	✓
Water Energy Education Alliance	✓	✓	✓

(1) MWDOC does not own or operate a distribution system; water wholesaled by MWDOC is delivered through the MET distribution system and meters.

9.2 DMM Implementation in MWDOC Service Area

Successful strategies are built by leveraging opportunities and creating customer motivation to take action to begin a market transformation. For Water Use Efficiency programs specifically, this starts by selecting the highest water consuming sectors and then creating an attractive implementation package. The next step is to identify ways to break through traditional market barriers by testing out innovative technologies and/or delivery mechanisms. Additionally, a program marketing campaign is launched, employing a full spectrum of varying outreach methods. Furthermore, Programs are thoroughly evaluated to maximize water savings, break down barriers to participation, or other ways that effectiveness may be increased. The Implementation Design Steps are illustrated on Figure 9-1.

Figure 9-1: Implementation Design Steps

MWDOC's water use efficiency programs cut across all consumer segments and differ in their delivery formats. There are intentional reasons for this varied approach. Through evaluation of past programs, it has been shown that there are three implementation approaches that are particularly effective at securing water savings in a cost-effective and persistent manner. These implementation approaches have been built into each of MWDOC's program offerings and matched up with the appropriate program sector as follows:

Performance based incentives - This payment format works especially well for the large landscape and CII sectors due to the array of site-specific needs and custom processes and equipment at these sites. This program pays a flat incentive per acre foot saved that scales to the water saved at each site so the more they save the higher the incentive. This approach provides an avenue for high water using sites that will save the most water through a custom approach that works for each particular site. Additionally, this method provides an even greater incentive for the highest water users to engage in water savings activity and create a most attractive return on investment for site decision makers.

Standardized device rebates - Rebates are most applicable for the more "cookie cutter" type measures where there is a limited number of products and styles and well-defined water savings rates. These incentives are the predominant payment method for residential, small commercial, and small to medium sized landscape markets. There are a wide variety of standardized device rebates available to all water-users of all water sectors.

Technical assistance, surveys, and education - All customer segments benefit from additional technical support services. MWDOC offers water efficiency educational programs to primary school-age children, residential homeowners, property managers, professional landscapers, or any other interested water-user. These programs provide public awareness of the importance of water efficiency and provide the technical support to implement appropriate water savings measures.

Figure 9-2 shows MWDOC's programs under each of the three implementation approaches.

	Field Implementation Approaches		
Program Segments:	Performance Based Incentives	Device Based Incentives	Audits, Assistance & Education
Commercial, Industrial, & Institutional	Water Savings Incentive Program On-site Retrofit Program	• DAC/Non-DAC Direct Install HET • SoCal Water$mart Device Rebates • ULV Urinals • HET • Food Steamers • Ice Machines • pH & Conductivity Controllers • Laminar Flow Restrictors • Dry Vacuum Pumps	Large Landscape Surveys QWEL
Landscape	Water Savings Incentive Program On-site Retrofit Program	• SoCal Water$mart Device Rebates (Commercial and Residential) • Smart Controllers • Large Rotary Nozzles • In-stem Flow Regulators • Turf Removal Incentive Program	Landscape Design Assistance Landscape Maintenance Assistance CA Friendly Landscape Classes

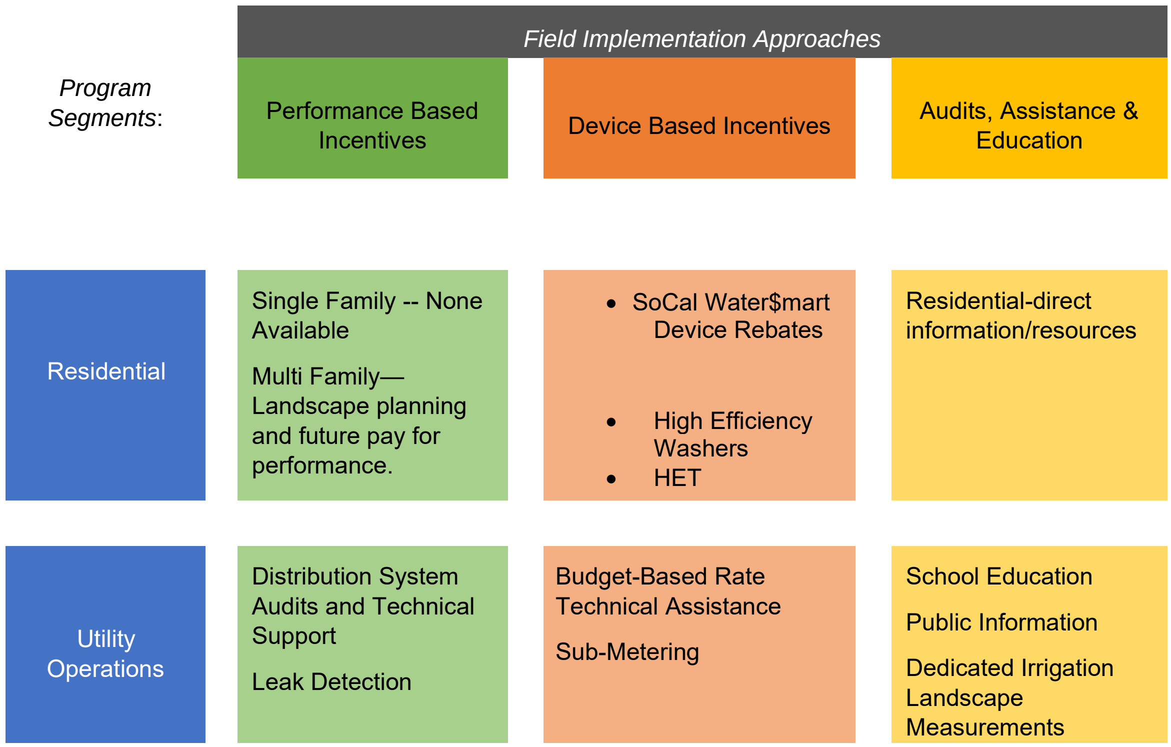

Figure 9-2: Demand Management Measure Implementation Approaches

9.3 Wholesale Supplier Assistance Programs

As described in the sections above, MWDOC provides financial incentives, conservation-related technical support, and regional implementation of a variety of demand management programs. In addition, MWDOC is providing assistance with compliance of the Conservation Framework and conducts research projects to evaluate implementation of both existing programs and new pilot programs. On behalf of its member agencies, MWDOC also organizes and provides the following:

- Monthly coordinator meetings
- Marketing materials
- Public speaking
- Community events
- Legislation compliance assistance

The many programs that MWDOC offers to Orange County on behalf of retail water agencies are described in detail in Appendix K.

9.4 Water Use Objectives (Future Requirements)

To support Orange County retailers with compliance of SB 606 and AB 1668 (Conservation Framework), MWDOC is providing multi-level support to assist agencies meet the primary goals of the legislation including to Use Water More Wisely and to Eliminate Water Waste. Beginning in 2023, Urban water suppliers are required to calculate and report their annual urban water use objective (WUO), submit validated water audits annually, and to implement and report BMP CII performance measures.

Urban Water Use Objective

An Urban Water Supplier's urban water use objective (WUO) is based on efficient water use of the following:

- Aggregate estimated efficient **indoor residential** water use;
- Aggregate estimated efficient **outdoor residential** water use;
- Aggregate estimated efficient **outdoor** irrigation landscape areas with dedicated irrigation meters or equivalent technology in connection with **CII** water use;
- Aggregate estimated efficient **water losses;**
- Aggregate estimated water use for variances approved the State Water Board;
- Allowable **potable reuse water** bonus incentive adjustments.

MWDOC offers a large suite of programs, described in detail throughout Section 9.3, that will assist Orange County retailers in meeting and calculating their WUO.

Table 9-2 describes MWDOC's programs that will assist agencies in meeting their WUO through both direct measures: programs/activities that result in directly quantifiable water savings; and indirectly: programs that provide resources promoting water efficiencies to the public that are impactful but not directly measurable.

Table 9-2: MWDOC Programs to Help Agencies Meet their WUO

WUO Component	Calculation	Program	Impact
Indoor Residential	Population and GPCD standard	**<u>Direct Impact</u>** • High Efficiency Washer • HET • Multi-Family HET (DAC/ non-DAC)	**<u>Direct Impact</u>** Increase of indoor residential efficiencies and reductions of GPCD use

WUO Component	Calculation	Program	Impact
Outdoor Residential	Irrigated/irrigable area measurement and a percent factor of local ETo	**<u>Direct Impact</u>** • Turf Removal • Spray-to-Dip • Smart Timer • HEN • Rain Barrels/Cisterns **<u>Indirect Impact</u>** • Landscape Design and Maintenance Assistance • OC Friendly Gardens Webpage • CA Friendly/Turf Removal Classes • QWELL	**<u>Direct Impact</u>** Increase outdoor residential efficiencies and reductions of gallons per ft^2 of irrigated/ irrigable area used **<u>Indirect Impact</u>** Provide information, resources, and education to promote efficiencies in the landscape
Outdoor Dedicated Irrigation Meters	Irrigated/irrigable area measurement and a percent factor of local ETo	**<u>Direct Impact</u>** • Turf Removal • Spray-to-Dip • Smart Timer • HEN • Central Computer Irrigation Controllers • Large Rotary Nozzles • In-Stem Flow Regulators **<u>Indirect Impact</u>** • OC Friendly Gardens Webpage • CA Friendly/Turf Removal Classes • QWELL	**<u>Direct Impact</u>** Increase outdoor residential efficiencies and reductions of gallons per ft^2 of irrigated/ irrigable area used **<u>Indirect Impact</u>** Provide information, resources, and education to promote efficiencies in the landscape

WUO Component	Calculation	Program	Impact
Water Loss	Following the AWWA M36 Water Audits and Water Loss Control Program, Fourth Edition and AWWA Water Audit Software V5	**Direct Impact** • Water Balance Validation • Customer Meter Accuracy Testing • Distribution System Pressure Surveys • Distribution System Leak Detection • No-Discharge Distribution System Flushing • Water Audit Compilation • Component Analysis	**Direct Impact** Identify areas of the distribution system that need repair, replacement, or other action
Bonus Incentives	**One of the following:** 1. Volume of potable reuse water from existing facilities, not to exceed 15% of WUO 2. Volume of potable reuse water from new facilities, not to exceed 10% of WUO	**Direct Impact** • GWRS **Indirect Impact** • On Site Retrofit Program (ORP)	**Direct Impact** The GWRS (run by OCWD) significantly increases the availability of potable reuse water **Indirect Impact** The ORP expands the recycled water supply grid that will be used for future projects

In addition, MWDOC is providing support to agencies to assist with the calculation of WUOs. DWR will provide residential outdoor landscape measurements; however, Urban Water Suppliers are responsible for measuring landscape that is irrigated/irrigable by dedicated irrigation meters. MWDOC is contracting for consultant services to assist agencies in obtaining these measurements. Services may include but are not limited to:

- Accounting/database clean up (e.g., data mining billing software to determine dedicated irrigation customers);
- Geolocation of dedicated irrigation meters;
- In-field measurements;
- GIS/Aerial imagery measurements;
- Transformation of static/paper maps to digital/GIS maps.

These services will help agencies organize and/or update their databases to determine which accounts are dedicated irrigation meters and provide landscape area measurements for those accounts. These data points are integral when calculating the WUO. MWDOC is also exploring funding options to help reduce retail agencies' costs of obtaining landscape area measurements for dedicated irrigation meters.

CII Performance Measures

Urban water supplies are expected to report BMPs and more for CII customers. MWDOC offers a broad variety of programs and incentives to help CII customers implement BMPs and increase their water efficiencies (Table 9-3).

Table 9-3: MWDOC BMP and Water Efficiency Programs and Incentives

Component	Program Offered	Impact
CII Performance Measures	• Water Savings Incentive Program (WSIP) • HET • High Efficiency Urinals • Plumbing Flow Control Valves • Connectionless Food Steamers • Air-cooled Ice Machines • Cooling Tower Conductivity controllers • Cooling Tower pH Controllers • Dry Vacuum Pumps • Laminar Flow Restrictors	WSIP incentivizes customized CII water efficiency projects that utilize BMPS. Additional CII rebates based on BMPS increase the economic feasibility of increasing water efficiencies.

These efforts to assist OC retail agencies have successfully assisted the retail agencies in OC in using water more efficiently over time. Our plan is to ensure that all agencies are fully ready to begin complying with the new water use efficiency standards framework called for in SB 606 and SB 1668 by the start date of 2023.

10 PLAN ADOPTION, SUBMITTAL, AND IMPLEMENTATION

The Water Code requires the UWMP to be adopted by the Supplier's governing body. Before the adoption of the UWMP, the Supplier has to notify the public and the cities and counties within its service area per the Water Code and hold a public hearing to receive input from the public on the UWMP. Post adoption, the Supplier submits the UWMP to DWR and the other key agencies and makes it available for public review.

This section provides a record of the process MWDOC followed to adopt and implement its UWMP.

10.1 Overview

Recognizing that close coordination among other relevant public agencies is key to the success of its UWMP, MWDOC worked closely with many other entities, including representation from diverse social, cultural, and economic elements of the population within MWDOC's service area, to develop and update this planning document. MWDOC also encouraged public involvement through its public hearing process, which provided residents with an opportunity to learn and ask questions about their water supply management and reliability. Through the public hearing, the public has an opportunity to comment and put forward any suggestions for revisions of the Plan.

Table 10-1 summarizes external coordination and outreach activities carried out by MWDOC and their corresponding dates. The UWMP checklist to confirm compliance with the Water Code is provided in Appendix A.

Table 10-1: External Coordination and Outreach

External Coordination and Outreach	Date	Reference
Notified city or county within supplier's service area that water supplier is preparing an updated UWMP (at least 60 days prior to public hearing)	2/24/2021	Appendix L
Public Hearing Notice	5/3/2021 - 5/10/2021	Appendix L
Held Public Hearing	5/19/2021	Appendix L
Adopted UWMP and WSCP	5/19/2021	Appendix M
Submitted UWMP to DWR (no later than 30 days after adoption)	7/1/2021	-
Submitted UWMP to the California State Library (no later than 30 days after adoption)	7/1/2021	-
Submitted UWMP to the cities and county within the supplier's service area (no later than 30 days after adoption)	7/1/2021	-
Made UWMP available for public review (no later than 30 days after filing with DWR)	8/1/2021	-

This UWMP was adopted by the MWDOC Board of Directors on May 19, 2021. A copy of the adopted resolution is provided in Appendix M.

10.2 Agency Coordination

The Water Code requires the Suppliers preparing UWMPs to notify any city or county within their service area at least 60 days prior to the public hearing. As shown in Table 10-2, MWDOC sent a Letter of Notification to the County of Orange and the cities within its service area on February 2, 2021 to state that it was in the process of preparing an updated UWMP (Appendix L).

Table 10-2: Wholesale: Notification to Cities and Counties

DWR Submittal Table 10-1 Wholesale: Notification to Cities and Counties		
☑	Supplier has notified more than 10 cities or counties in accordance with Water Code Sections 10621 (b) and 10642. **Completion of the table below is not required. Provide a separate list of the cities and counties that were notified.**	
Appendix L	Provide the page or location of this list in the UWMP.	
☐	Supplier has notified 10 or fewer cities or counties. **Complete the table below.**	
City Name	60 Day Notice	Notice of Public Hearing
County Name	60 Day Notice	Notice of Public Hearing
NOTES:		

The MWDOC's water supply planning relates to the policies, rules, and regulations of its regional and local water providers. The MWDOC is dependent on imported water from MET. As such, MWDOC involved MET and other relevant agencies in this 2020 UWMP at various levels of contribution as summarized in Table 10-3.

Table 10-3: Coordination with Appropriate Agencies

	Participated in Plan Development	Commented on Draft	Attended Public Meetings	Contacted for Assistance	Sent Copy of Draft Plan	Sent Notice of Public Hearing	Not Involved/ No Information
Cities within service area	-	-	-	-	✓	✓	✓
County of Orange	-	-	-	-	✓	✓	✓
MET	✓	-	-	✓	✓	✓	✓
MWDOC 28 Retail Agencies	✓	✓	✓	✓	✓	✓	✓
OC San	✓	-	-	✓	✓	-	-
OCWD	✓	-	-	✓	✓	✓	✓
Public Library	-	-	-	-	-	✓	-
SJBA	✓	-	-	✓	✓	-	-
SOCWA	✓	-	-	✓	✓	-	-

MET - As a member agency of MET, MWDOC developed this UWMP in collaboration with MET's 2020 UWMP to ensure consistency between the two documents.

MWDOC Retail Agencies - MWDOC provided assistance to its retail agencies' 2020 UWMP development by providing much of the data and analysis such as population projections from the California State University at Fullerton CDR and the information quantifying water availability to meet the retailers' projected demands for the next 25 years, in five-year increments. Additionally, MWDOC led the effort to develop a Model Water Shortage Ordinance that its retail suppliers can adopt as is or customize and adopt as part of developing their WSCPs.

Groundwater Management Agencies - MWDOC also worked with the following five agencies to obtain information for the five groundwater basin resources in its service area: OCWD for Lower Santa Ana River Basin, SJBA for San Juan Basin, City of La Habra for La Habra Basin, City of San Clemente for

San Mateo Basin, and LBCWD for Laguna Canyon Basin. Details of the basin information are described in Section 6.3.

Wastewater Management Agencies - To meet the requirements of the Act in the preparation of this UWMP, MWDOC contacted individual wastewater collection and treatment providers and other water agencies within its service area for data on recycled water and associated projects in the region. The information MWDOC obtained was then combined with a review of several completed Orange County studies. The information MWDOC obtained from wastewater collection and treatment providers allows the UWMP to describe wastewater discharge methods, treatment levels, discharge volumes, and recycled use in the region.

10.3 Public Participation

MWDOC encouraged community and public interest involvement in the Plan update through a public hearing and inspection of the draft document on May 19 2021. Copies of the draft 2020 UWMP were placed for public inspection at MWDOC's office and made available for the public on MWDOC's website.

Public hearing notifications were sent to retail agencies and other interested parties. A copy of the Notice of Public Hearing is included in Appendix L.

The hearing was conducted during a regularly scheduled meeting of the MWDOC Board of Directors. A staff report and presentation reviewed the process, key components of the UWMP and the conclusions that served as the basis of the UWMP. The President of the Board of Directors then opened the Public Hearing where all comments were recorded.

10.4 UWMP Submittal

The Board of Directors reviewed and approved the 2020 UWMP at its May 19, 2021 meeting after the public hearing. See Appendix M for the resolution approving the Plan.

By July 1, 2021, the Adopted 2020 MWDOC UWMP was filed with DWR, California State Library, County of Orange, and cities within MWDOC's service area. The submission to DWR was done electronically through the online submittal tool – WUE Data Portal. MWDOC will make the Plan available for public review on its website no later than 30 days after filing with DWR.

10.5 Amending the Adopted UWMP or WSCP

Based on DWR's review of the UWMP, MWDOC will make any amendments in its adopted UWMP, as required and directed by DWR and will follow each of the steps for notification, public hearing, adoption, and submittal for the amending the adopted UWMP.

If MWDOC revises its WSCP after UWMP is approved by DWR, then an electronic copy of the revised WSCP will be submitted to DWR within 30 days of its adoption.

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APPENDICES

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A Review of Water Demand Forecasts for the Orange County Water District

By James Fryer, Environmental Scientist

July, 2016

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About the Author

James Fryer is an environmental scientist who provides environmental and water resource management expertise, research, and analysis to a variety of governmental and non-governmental clients focused on conservation, sustainable watershed, and water resource management projects. He has over 27 years of experience working on freshwater, estuarine, and marine conservation policies, programs, and projects. He has produced numerous papers and reports on water management policies, practices, and economics, and conducted sophisticated GIS analyses of watershed and water management issues, and helped establish and conducted research and monitoring on marine protected areas. He has a M.S. in Environmental Management from the University of San Francisco, where his thesis project developed an Integrated Floodplain Management model for the San Francisco Bay-Delta watershed.

Acronyms and Abbreviations

AF	Acre-feet, 325,851 gallons or enough water to cover an acre of land to a depth of one foot
AFY	Acre-feet per year
GPCD	Gallons per capita per day
IRWD	Irvine Ranch Water District
LTFP	The Orange Country Water District's Long-Term Financial Plan 2015 Update
MET	Metropolitan Water District of Southern California
MWD	Metropolitan Water District of Southern California
MWDOC	Municipal Water District of Orange County
OCWD	Orange County Water District
Reliability Study	The Orange County Reliability Study being conducted by the Municipal Water District of Orange County
UWMP	Urban Water Management Plan

Purpose of the Review

This analysis and report was developed to assess the demand forecasts used by the Orange County Water District as the rationale for new water supply projects.

Summary of Findings & Conclusions

The Orange County Water District uses outdated water demand forecasts for the year 2035 that are 91,846 acre-feet per year, or 17.5%, higher than the more recent water demand forecasts for its service area retailers. In its Long-Term Financial Plan 2014 Update and Groundwater Management Plan 2015 Update, the Orange County Water District (OCWD) uses water demand forecasts derived from its retailers' 2010 Urban Water Management Plans (UWMPs). In the more recent 2016 demand forecasts in the Orange County Reliability Study, used for the updated 2015 UWMPs for the retailers, collectively the water demand forecasts are reduced 17.5% compared earlier forecasts used in the Long-Term Financial Plan 2014 Update.

The previous Urban Water Management Plans consistently overestimated future demand. Starting in the year 2000, for each cycle of the 5-year UWMPs, based on declining actual demand trends the retailers repeatedly reduced demand forecasts for subsequent years compared to previous forecasts.

The Orange County Reliability Study used by the retailers water for their new water demand forecasts, uses multiple instances of conservative assumptions that, as with past UWMPs, can be expected to overestimate future demand. The Reliability Study forecasts are the basis of the Municipal Water District of Orange County and OCWD retailers' 2015 UWMP forecasts. Some fundamental assumptions in the water demand model are inconsistent with historic and recent water use patterns. The assumptions that may lead to overestimates of future demand, and discussed in more detail in this report, include:

Population forecasts
Demand during multiple drought year events
Demand rebound after drought
Drought vs. recession water use patterns
Infill development
Price elasticity of demand
Future conservation innovation

The Long-Term Financial Plan 2014 Update does not account for an additional 65,000 acre-feet per year of high quality treated wastewater that is expected to become available within the next 5 to 10 years. The new source of treated wastewater would be equal or better than the quality of water that is currently used to replenish groundwater basins and would not be subject to shortages during drought. About 65,000 acre-feet per years is expected to become available for groundwater recharge into the Orange County Water District basin.

Water users have repeatedly demonstrated the willingness and ability to substantially curtail water use during serious, multi-year drought events. Many of the early year UWMPs acknowledged that water users would curtail use during serious drought years. But by the 2005 UWMPs, water use was generally assumed to increase 6% to 9% during single and multiple drought years. Since water shortages during drought drives the need for new supplies, underestimating the ability and willingness of water users to curtail demand during serious drought years can lead to unnecessary and expensive new supply projects and financial difficulty for water suppliers.

The retailers' 2015 Urban Water Management Plan demand forecasts, as with the earlier plans, do not account for ongoing conservation innovation. Ongoing conservation innovation, unforeseen at the time of past demand forecasts, is now a well-established pattern that has contributed to actual demand remaining well below forecasted levels. Ongoing innovations in conservation devices and practices can be expected to continue reducing urban per capita water demand during the demand forecast period.

The retailers' 2015 Urban Water Management Plans indicate that most of the service areas are at or near build-out. Since there is relatively little undeveloped space in the OCWD service area, most future development will be in-fill development. This can be expected to lower average per-capita water use and will be an important dynamic that should be addressed in water demand projections.

Water providers with service areas at or near buildout that substantially overestimate future demand risk inefficient use of limited financial resources on unnecessary capital projects, revenue stability problems, and ratepayer backlash. Historically, water demand forecasts used multiple conservative assumptions in an effort to reduce the risk of uncertainties, particularly for rapid growing service areas. However, the situation is different for service areas not experiencing rapid growth, and at or near buildout. Overestimating future demand for service areas at or near build-out creates long-term risks that should be carefully considered.

Methodology

This assessment was done using two fundamental approaches: 1) a review of the accuracy of past UWMP forecasts for future demand for UWMPs from 1995 through 2015, and 2) a review of the demand forecasts in the Municipal Water District of Orange County's "Orange County Supply Reliability Study" (hereinafter Reliability Study) currently in underway during 2016. This includes consideration of assumptions and demand forecasting methodology in the Reliability Study and 2015 UWMPs that affect the accuracy of demand forecasts when compared to past and present day trends. This report is not a comprehensive review of all aspects of the Reliability Study, UWMPs and related demand forecasts. It is more focused on the accuracy of past forecasts and areas where refinements may improve the accuracy of the latest demand forecasts.

The project team collected and reviewed all the UWMPs from 1995 through 2015 that were available for the 19 OCWD retailers. We extracted the present and forecasted population, present and forecasted demand (including losses and direct recycled water use when delineated in the UWMPs), reviewed service area development trends and the supply reliability planning during drought years. We then developed tables and graphs which show the actual and forecasted population and demand trends. Tables and graphs combining the retailers into three groups by similar size are provided in the main body of this report. Tables and graphs for all the individual retailers (except for two, Golden State and Serrano which did not have an adequate number of UWMPs available) are included in Appendix A.

The project team also collected and reviewed numerous relevant documents including, but not limited to:

The Orange County Water District's Long-Term Financial Plan 2014 Update
The Orange County Water District's Groundwater Basin Management Plan 2015 Update
Technical memos and presentations for the Orange County Reliability Study

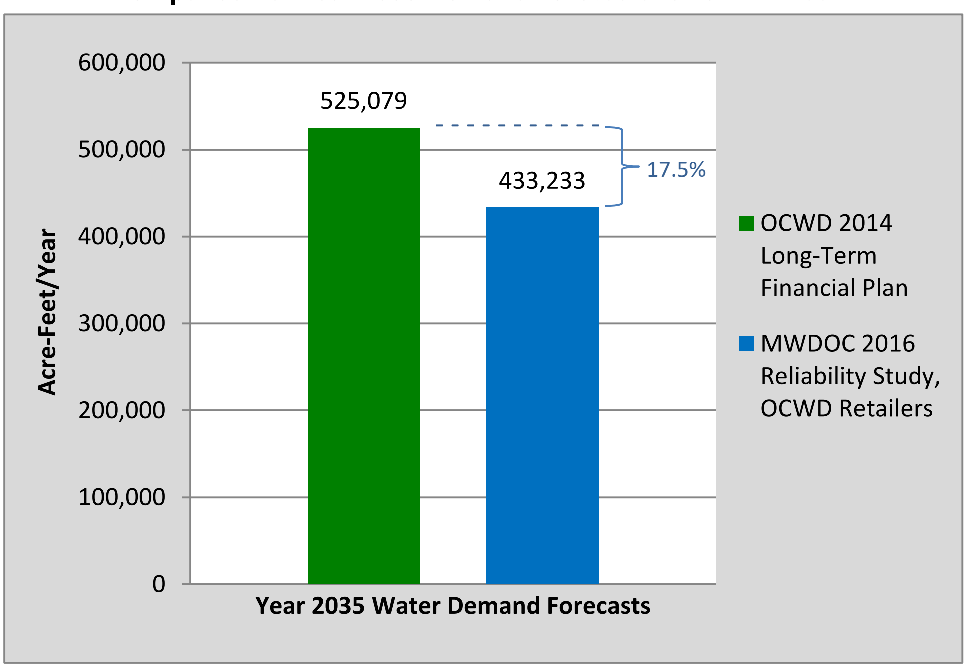
Water recycling documents describing the proposed new 65,000 AFY supply of treated wastewater to the OCWD groundwater basin for indirect potable reuse

Review of Long-Term Financial Plan 2014 Update

The Long-Term Financial Plan (LTFP) was updated by the Orange County Water District in 2014. The LTFP states the water demand forecasts are based primarily on past Urban Water Management Plan (UWMP) forecasts for each retailer.[1] The 2014 updated LTFP plan indicates “One of the key factors influencing water demand is population growth” and indicates population is expected to increase from 2.38 million to 2.54 million, or 6.7% by the year 2035.[2] The plan also notes “Another factor affecting demands is growth of the District’s service area through annexations.”[3] The 2014 LTFP identifies a year 2035 water demand of 525,079 AFY, including 8,000 AFY for non-agency use.[4]

As shown in the following section reviewing the 1995 through 2015 UWMPs, and for reasons discussed later in this report, UWMP demand forecasts had a consistent pattern of overestimating future demand. With a new round of 2015 UWMPs being readied for release in 2016, and the effects of the recent Great California Drought on water demand, the LTFP is based on obsolete demand forecasts. Both the 2014 Long-Term Financial Plan and OCWD’s more recent 2015 Groundwater Basin Management Plan rely on demand forecasts that are substantially higher than the updated demand forecasts for the OCWD retailers in the Municipal Water District of Orange County’s Orange County Reliability Study. The LTFP forecasts a year 2035 water demand of 525,079 AFY. This compares to the more recent Orange County Reliability Study forecast of 433,233 AFY for the OCWD retailers in the year 2035.[5] These water demand forecasts are compared in Figure 1 below.

Figure 1
Comparison of Year 2035 Demand Forecasts for OCWD Basin



The more recent water demand forecast represents a reduction of 91,846 afy, or 17.5%, in water demand in the year 2035.

Additional Recycled Water for Groundwater Recharge

Another important consideration is that the 2014 LTFP does not account for a new project expected to increase the availability of indirect potable reuse of highly treated wastewater for OCWD retailers. The Metropolitan Water District of Southern California (MWD) in partnership with the Sanitation Districts of Los Angeles County is developing a new regional indirect potable reuse program that is expected to make available up to 168,000 acre-feet per year of new recycled water for recharging the Orange County and Los Angeles groundwater basins. The presently available planning documents and OCWD staff indicate that at least 65,000 acre-feet per year of new indirect potable reuse water is expected to become available to the OCWD within 5 to 10 years.[6]

Publicly released information by the partnership indicates “Under a partnership with the Sanitation Districts of Los Angeles County, Metropolitan would build a new purification plant and distribution lines to groundwater basins in Los Angeles and Orange counties.”

“The first operational phase will produce about 67,000 acre-feet of recycled water per year and the construction of about 30 miles of distribution lines to replenish groundwater basins in Los Angeles and Orange counties. Additional operational phases could produce up to 168,000 acre-feet per year of purified water for groundwater replenishment.”[7]

A MWD board packet item notes “This program would purify secondary effluent from Sanitation Districts’ Joint Water Pollution Control Plant (JWPCP) using advanced treatment technologies to produce water, which is near distilled quality and would be equal or better than the quality of water that is currently used to replenish groundwater basins in the Southern California region.”[8]

The MWD has approved moving forward with the pilot project for this supply, and indirect potable reuse projects are a proven technology already utilized for the OCWD groundwater basin. Technical Memo #4 for the Orange County Reliability Study identifies this project as “Very Achievable” and “Highly Reliable” in its rankings of new supply project options.[9] This would provide a substantial new high quality water supply for recharging the Orange County Water District groundwater basin. Along with what can reasonably be expected to be lower than forecasted demand, based on the historic water demand forecasting pattern and multiple conservative assumptions in the Reliability Study, this would provide considerable supply reliability improvement for the OCWD retailers beyond what is forecasted in the 2014 LTFP.

Review and Analysis of Retailer Urban Water Management Plans

California's Urban Water Management Planning Act requires water retailers with annual water use over 3,000 acre-feet or more than 3,000 customers to prepare and update an Urban Water Management Plan (UWMP) every 5 years. The UWMPs are required to include a description of the service area, a description of supply sources, present and future demand and population forecasts, and an analysis of supply reliability during single and multiple drought years.

UWMPs that were available for each Orange County Water District retailer for each 5-year cycle from 1995 through 2015 were collected and reviewed. Table 1 below, indicates the UWMPs that were available.

Table 1
Urban Water Management Plans Obtained

Water Retailer	LTFP 2035 Demand (AFY)	Group	1995	2000	2005	2010	2015
IRWD	88,008	1	Yes	Yes	Yes	Yes	Yes
Anaheim	77,700	1	NA	Yes	Yes	Yes	Yes
Santa Ana	50,400	1	NA	Yes	Yes	Yes	Yes
Orange	34,713	2	Yes	Yes	Yes	Yes	Yes
Huntington Beach	34,657	2	Yes	Yes	Yes	Yes	Yes
Fullerton	32,792	2	Yes	Yes	Yes	Yes	Yes
Golden State Water Co.	32,774	2	NA	NA	NA	Yes	NA
Garden Grove	30,907	2	1996	Yes	Yes	Yes	Yes
Yorba Linda WD	27,784	2	Yes	Yes	Yes	Yes	Yes
Buena Park	19,900	3	NA	Yes	Yes	Yes	Yes
Mesa	19,700	3	Yes	Yes	Yes	Yes	Yes
Newport Beach	18,474	3	Yes	Yes	Yes	Yes	yes
Tustin	15,194	3	Yes	Yes	Yes	Yes	Yes
Westminster	12,337	3	Yes	Yes	Yes	Yes	Yes
Fountain Valley	10,165	3	Yes	Yes	Yes	Yes	Yes
Seal Beach	4,880	4	NA	2002	Yes	Yes	Yes
Serrano WD	2,852	4	NA	NA	NA	Yes	Wholesale
La Palma	2,742	4	Yes	NA	Yes	Yes	Yes
East OCWD	1,100	4	NA	NA	Yes	Yes	Yes

Of particular interest for this analysis were the present and forecasted populations and demand figures. We also noted annexes and expansions of the service area and the drought year supply reliability planning.

Review of the UWMPs found that past projections consistently overestimated future demand. The UWMPs indicate actual total demand has generally been decreasing in the more recent 5-year cycles. Nonetheless, the forecasts for demand moving forward from each UWMP starting year continues to increase, but from a lower starting point for each 5-year cycle.

Appendix A contains tables with present and forecasted population and total water demand (including losses and direct recycled) for each of the retailers that had adequate data available. Included are graphs with the population and demand trends and tables providing the percentages of predicted compared to actual population and demand, along with the percent change compared to the 2015 UWMP forecasts. The following pages contain the UWMP data and trends aggregated into similar water use Groups 1 through 3, as in Table 1 above. Since Group 4 had very limited years of UWMPs available and is a small portion of the cumulative water use, tables and graphs of the data for Group 4 retailers are only provided individually in Appendix A.

Table 2

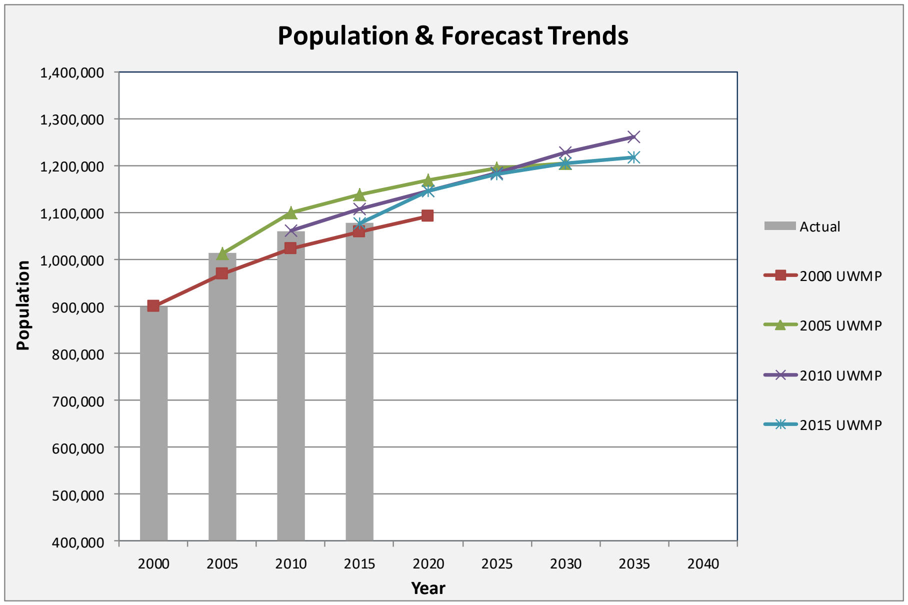
Group 1 - Irvine Ranch, Anaheim and Santa Ana

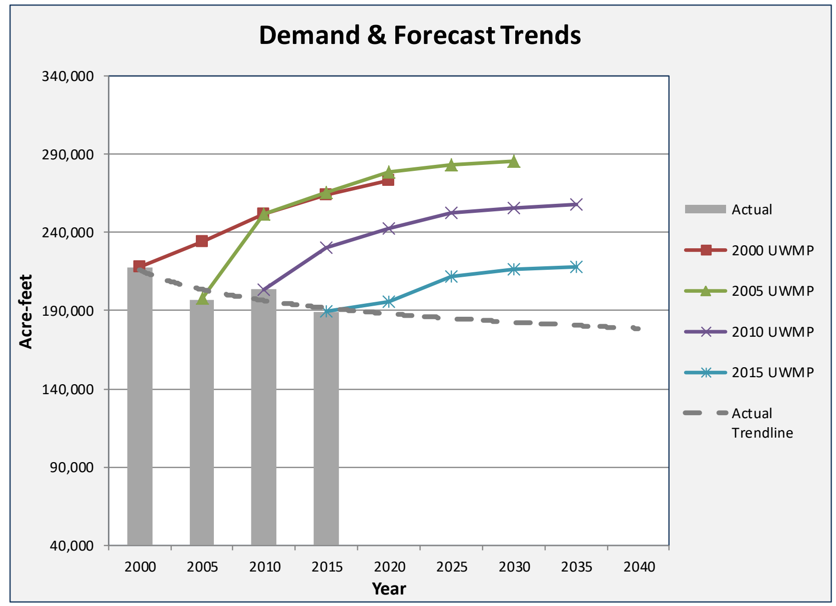
Population
Actual and Forecasted

Year	2000	2005	2010	2015	2020	2025	2030	2035	2040
Actual	899,785	1,013,557	1,060,933	1,076,904					
2000 UWMP	899,785	969,539	1,022,088	1,058,128	1,091,139				
2005 UWMP		1,013,557	1,099,876	1,139,315	1,169,527	1,194,639	1,205,541		
2010 UWMP			1,060,933	1,106,422	1,145,066	1,185,035	1,227,140	1,262,173	
2015 UWMP				1,076,904	1,144,894	1,180,979	1,203,439	1,218,559	

Demand
Actual and Forecasted (AF)

Year	2000	2005	2010	2015	2020	2025	2030	2035	2040
Actual	217,972	197,113	203,567	189,393					
2000 UWMP	217,972	234,209	251,865	264,093	273,383				
2005 UWMP		197,705	251,530	265,690	278,453	283,478	285,380		
2010 UWMP			203,567	230,499	242,206	252,728	255,908	257,772	
2015 UWMP				189,393	195,338	212,131	216,330	218,147	





	Predicted Compared to Subsequent Actual Population			Change in 2015 Forecasts Compared to Previous UWMPs			
2000 UWMP	95.7%	96.3%	98.3%	4.9%			
2005 UWMP		103.7%	105.8%	-2.1%	-1.1%	-0.2%	
2010 UWMP			102.7%	0.0%	-0.3%	-1.9%	-3.5%

	Predicted Compared to Subsequent Actual Demand			Change in 2015 Demand Forecasts Compared to Previous UWMPs			
2000 UWMP	118.5%	123.7%	139.4%	-28.5%			
2005 UWMP		123.6%	140.3%	-29.8%	-25.2%	-24.2%	
2010 UWMP			121.7%	-19.4%	-16.1%	-15.5%	-15.4%

The Irvine Ranch Water District, the largest in population and water use (see Appendix A), experienced annexes and consolidations that were not part of previous forecasts nearly every 5-year cycle of UWMPs. This skewed the population and demand forecasts. But even so, the total demand trendline is down for subsequent year UWMPs. Also Irvine Ranch converted a large portion of its demand to direct recycled use. Therefore, potable water demand for Irvine Ranch and the combine group 1 retailers declined further than the total demand figures used in these tables and graphs.

Table 3

Group 2 - Fullerton, Garden Grove, Huntington Beach, Orange, and Yorba Linda

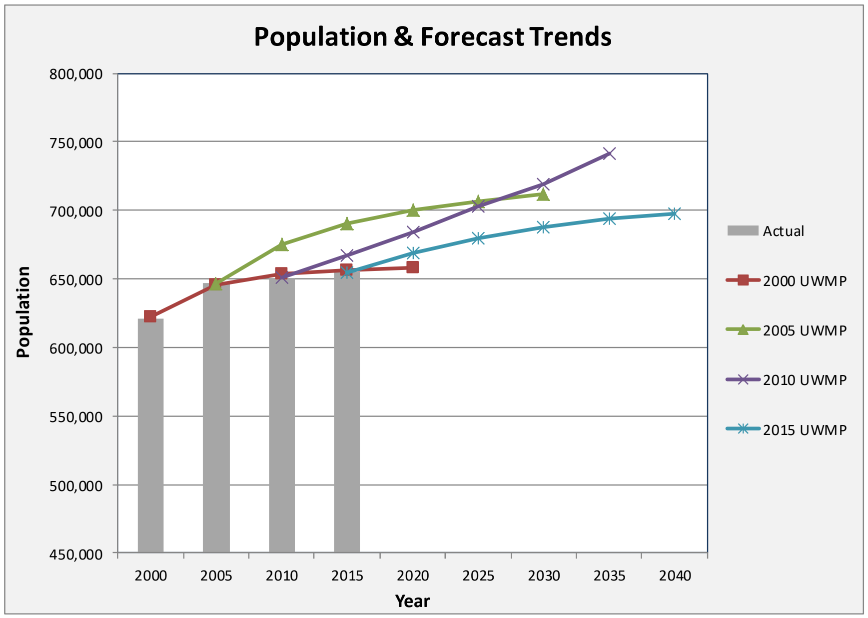
Population
Actual and Forecasted

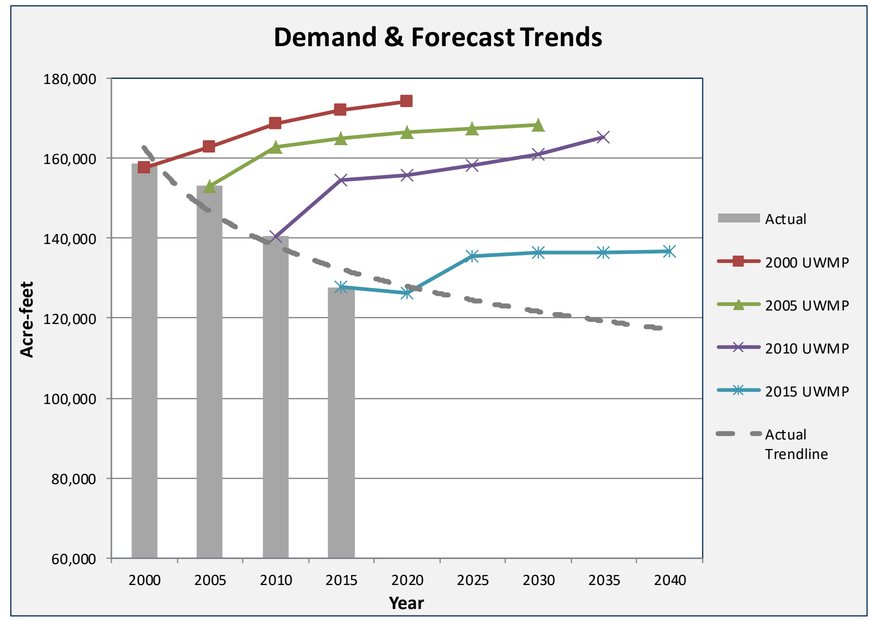
Year	2000	2005	2010	2015	2020	2025	2030	2035	2040
Actual	620,683	646,695	650,776	654,892					
2000 UWMP	622,303	646,041	653,607	656,709	658,334				
2005 UWMP		646,695	675,100	690,558	700,462	706,512	711,713		
2010 UWMP			650,776	667,454	684,172	702,594	719,199	741,065	
2015 UWMP				654,892	668,563	679,225	687,834	693,726	697,854

Yorba Linda population and forecast not included in 2000 UWMP, so excluded from population table

Demand
Actual and Forecasted (AF)

Year	2000	2005	2010	2015	2020	2025	2030	2035	2040
Actual	158,645	153,030	140,487	127,708					
2000 UWMP	157,658	162,896	168,736	171,927	174,277				
2005 UWMP		153,030	162,943	165,075	166,556	167,575	168,499		
2010 UWMP			140,487	154,437	155,613	158,308	160,876	165,418	
2015 UWMP				127,708	126,313	135,571	136,300	136,289	136,694





	Predicted Compared to Subsequent Actual Population			Change in 2015 Forecasts Compared to Previous UWMPs			
2000 UWMP	99.9%	100.4%	100.3%	1.6%			
2005 UWMP		103.7%	105.4%	-4.6%	-3.9%	-3.4%	
2010 UWMP			101.9%	-2.3%	-3.3%	-4.4%	-6.4%

	Predicted Compared to Subsequent Actual Demand			Change in 2015 Demand Forecasts Compared to Previous UWMPs			
2000 UWMP	106.4%	120.1%	134.6%	-27.5%			
2005 UWMP		116.0%	129.3%	-24.2%	-19.1%	-19.1%	
2010 UWMP			120.9%	-18.8%	-14.4%	-15.3%	-17.6%

Table 4

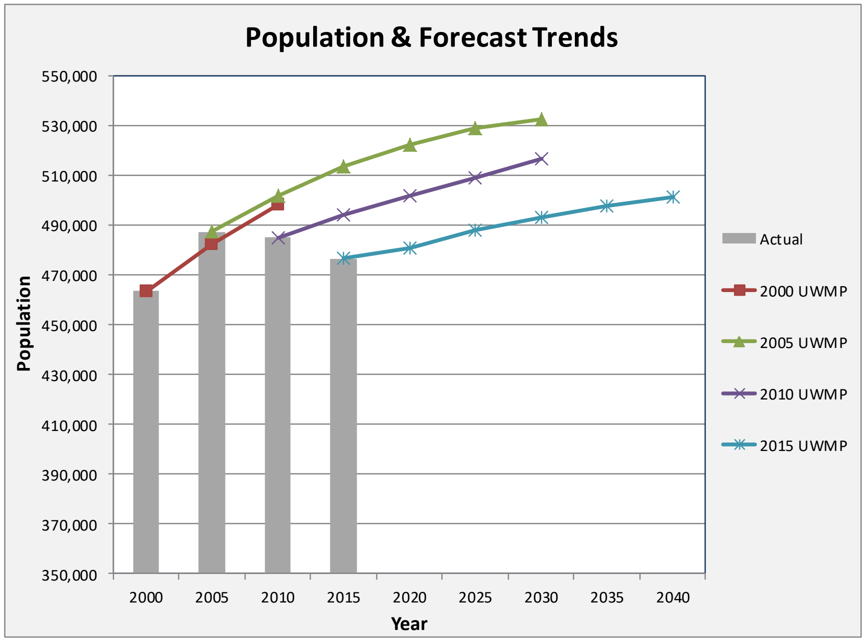
Group 3 - Buena Park, Fountain Valley, Mesa, Newport Beach, Tustin and Westminster

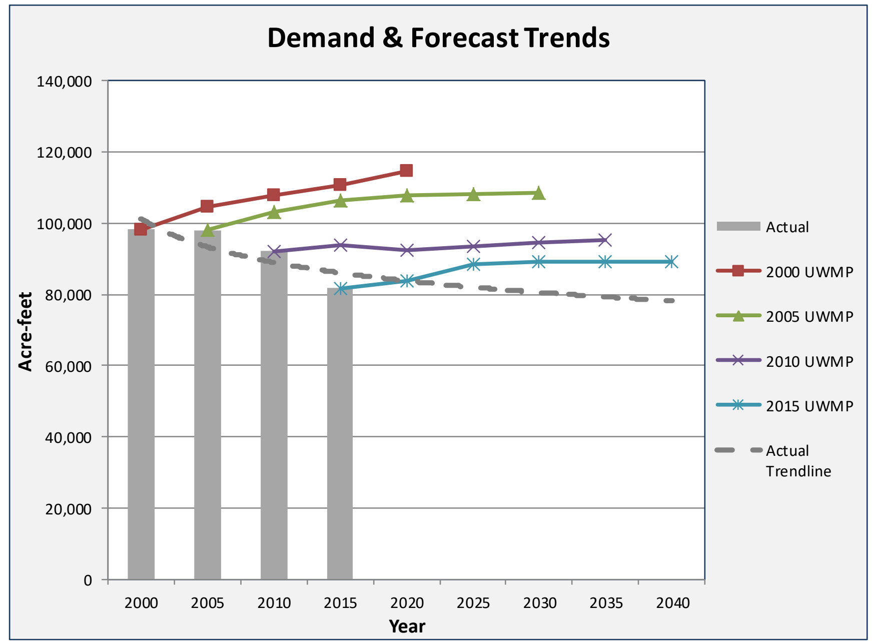
Population
Actual and Forecasted

Year	2000	2005	2010	2015	2020	2025	2030	2035	2040
Actual	463,456	487,200	484,958	476,379					
2000 UWMP	463,456	482,425	498,195						
2005 UWMP		487,200	501,711	513,314	522,159	528,909	532,585		
2010 UWMP			484,958	493,837	501,664	508,788	516,728		
2015 UWMP				476,379	480,897	488,009	493,167	497,851	501,287

Demand
Actual and Forecasted (AF)

Year	2000	2005	2010	2015	2020	2025	2030	2035	2040
Actual	98,145	97,956	92,018	81,755					
2000 UWMP	98,145	104,707	107,631	110,486	114,520				
2005 UWMP		97,956	102,956	106,384	107,617	108,135	108,504		
2010 UWMP			92,018	93,675	92,426	93,368	94,425	95,297	
2015 UWMP				81,755	83,730	88,605	89,114	89,162	89,312





	Predicted Compared to Subsequent Actual Population			Change in 2015 Forecasts Compared to Previous UWMPs		
2000 UWMP	99.0%	102.7%				
2005 UWMP		103.5%	107.8%	-7.9%	-7.7%	-7.4%
2010 UWMP			103.7%	-4.1%	-4.1%	-4.6%

	Predicted Compared to Subsequent Actual Demand			Change in 2015 Demand Forecasts Compared to Previous UWMPs			
2000 UWMP	106.9%	117.0%	135.1%	-26.9%			
2005 UWMP		111.9%	130.1%	-22.2%	-18.1%	-17.9%	
2010 UWMP			114.6%	-9.4%	-5.1%	-5.6%	-6.4%

Past UWMPs often overestimated future populations. But even when future populations were higher than forecast, demand was substantially lower than forecast. Underestimates of populations were sometimes due to subsequent annexes or consolidations, particularly for Group 1 which includes Irvine Ranch Water District and its frequent annexes and service are expansions.

Some of the UWMPs noted 2005 was a particularly wet year and indicated this suppressed demand. Many 2010 and 2015 UWMPs noted that recent drought years suppressed recent demand. That may be so, but the demand forecasts tended to decline substantially for each subsequent 5-year cycle of UWMPs indicating the wet and drought years do not fully explain the trends.

Most retailers in the Orange County Water District service area indicated they are at or near buildout (see Appendix A for buildout status of individual OCWD retailers). For these retailers, infill development will generally result in reduced average per capita demand, and possibly reduced overall demand since interior water use fixtures are becoming much more efficient and less outdoor area will be available for irrigated landscaping.

Review of Orange County Reliability Study

The Municipal Water District of Orange County (MWDOC) is a regional water wholesaler that provides water to retailers in the Orange County Water District (OCWD) service area, along with additional retailers outside the OCWD boundaries. MWDOC is presently conducting an Orange County Reliability Study (hereinafter Reliability Study) "to comprehensively evaluate current and future water supply and system reliability for all of Orange County."[10] The Reliability Study includes a water demand forecast model that separately delineates the Orange Basin water retailers. The OCWD retailers indicate they are using the water demand forecasts from this model in their 2015 UWMPs.

Since past UWMPs consistently overestimated future water demands, the Reliability Study demand forecasting methodology and assumptions were reviewed. The Reliability Study was not yet final, so this review was based on detailed technical memos and presentation materials provided by MWDOC.

The Reliability Study developed a statistical demand forecasting model with a number of inputs and assumptions. The model is described in Technical Memorandum #1 which states "The explanatory variables for this statistical model included population, temperature, precipitation, unemployment rate, presence of mandatory drought restrictions on water use, and a cumulative measure of passive and active conservation."[11]

The Reliability Study defines "passive conservation" as conservation which "results from codes and ordinances, such as plumbing codes or model landscape water efficient ordinances. This type of conservation requires no financial incentives and grows over time based on new housing stock and remodeling of existing homes."[12] "Active conservation" is defined as conservation "which requires incentives for participation. The SoCal Water$mart grant that is administered by MET, through its member agencies, provides financial incentives for approved active water conservation programs such as high efficiency toilets and clothes washer retrofits."[13] Technical Memorandum #1 for the Reliability Study indicates the passive conservation forecasts are based solely on code requirements for high efficiency toilets and high efficiency clothes washers, and the new California Model Water Efficient Landscape Ordinance that becomes effective in 2016.[14] These are well-proven conservation measures, but many more exist and are known to be effective and in use by consumers, particularly during drought years.[15]

While the technical methods for the demand model in the Reliability Study may be more sophisticated than water demand forecasts in many past UMWPs, any model is only as good as its algorithms, inputs and assumptions. To be manageable, or due to limitations in data or budget constraints, models tend to be simplifications of real world dynamics. Trends in real world water demand dynamics over several decades may be considerably more complex than what is represented with the 6 or 7 explanatory variables used in the Reliability Study water demand model. So it is important to understand the limitations of the model and likely sources of error. Some of the inputs and assumptions appear subject to the same problems and errors as past water demand forecasts, which resulted in overestimating future water demand. Key inputs and assumptions that may introduce errors and overstate future demand are reviewed below.

Population Forecasts

The past UWMPs often overestimated future populations. Some underestimates are due to cases of unforeseen annexes or expansions. But even for the cases where populations exceed forecasts (see Appendix A), and when unforeseen service area annexes and expansions occurred, water demand forecasts consistently exceeded actual demand in future years. Clearly more factors than erroneous population forecasts are driving the overestimates of future demand.

Demand During Multiple Drought Year Events

There are problems and inconsistencies in how the Reliability Study is addressing water conservation dynamics during serious, multi-year droughts. The statistical demand model described in Technical Memorandum #1 attributes only a -6% impact from “drought conservation” during “mandatory drought restrictions” which are generally only enacted during serious, multi-year droughts.[16] Soon thereafter the report states that California instituted a “statewide call for mandatory water use restrictions in April 2015, with a target reduction of 25 percent. Water customers across the state responded to this mandate, with most water agencies seeing water demands reduced by 15 to 30 percent during the summer of 2015.”[17] Table 5 below provides the 2015 drought year conservation during mandatory restrictions reported by the OCWD retailers to the California State Water Resources Control Board.

Table 5
2015 Drought Response[18]

Retailer	Drought Conservation Target	Drought Conservation Achieved June - Dec 2015
Anaheim	20.0%	22.5%
Buena Park	20.0%	22.9%
East OCWD	36.0%	36.5%
Fountain Valley	20.0%	22.9%
Fullerton	28.0%	21.7%
Garden Grove	20.0%	21.2%
Golden State Water Co.	16.0%	22.4%
Huntington Beach	20.0%	23.1%
IRWD	16.0%	17.5%
La Palma	20.0%	23.9%
Mesa	20.0%	18.5%
Newport Beach	28.0%	20.2%
Orange	28.0%	28.0%
Santa Ana	12.0%	17.5%
Seal Beach	8.0%	17.4%
Serrano WD	36.0%	39.4%
Tustin	28.0%	27.6%
Westminster	20.0%	18.8%
Yorba Linda WD	36.0%	37.8%
Average %	**22.7%**	**24.2%**

The Reliability Study water demand model described in Technical Memorandum #1 also assumes “demands during dry years would be 6 to 9 percent greater.”[19] The OCWD retailers use this assumption in their 2015 UWMP supply reliability planning. Assuming water demand will increase in single dry years may be accurate since single dry years are frequent in California and do not necessarily signify a serious drought situation. However, abundant real world evidence, including Table 5 above and Figures 2, 3 and 4 below, demonstrate that water users in California and the OCWD service area can and will substantially curtail water use during serious multiple year drought events. In fact, due to widespread drought messaging some service areas, including Irvine Ranch Water District during the in 2007 through 2010 drought years, and the Marin Municipal Water District in 2015, experienced substantial demand reductions during drought years even when no local water supply shortage existed.[20]

The drought conservation reported by OCWD retailers in Table 5 makes clear that the drought assumptions in the Reliability Study need refinement to better reflect real world events. Water use may increase during single dry year occurrences, and may also increase in multiple dry year events that are not so dry and severe that serious water shortages occur. However, it is clear that in serious multi-year drought water demand may decrease 20% or more.

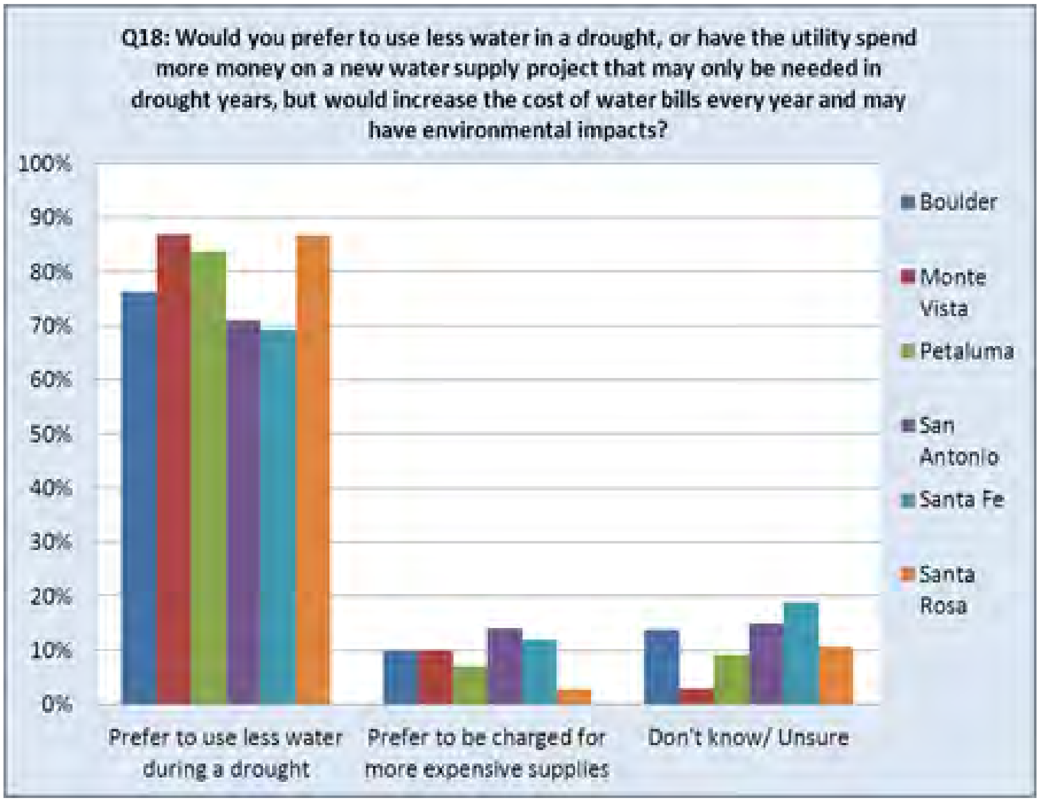
These assumptions regarding water use patterns during serious drought years have an important effect on the calculations that determine need for new water supply. Another key input is the yield of the water supply system. The typical definition of "Net Safe Yield" for a water supply system is the quantify of water from the various supply supplies during "drought of record" conditions (the worst drought) experienced by the utility's water supply sources. In response to climate uncertainty, some California utilities have started adding hypothetical additional drought years to their actual Drought of Record conditions to determine supply reliability, which reduces the theoretical yield.

The Net Safe Yield is then compared to total water demand to determine the need for new supply. If total water demand is assumed to increases 6% to 9% during drought years, this requires 6% to 9% more Net Safe Yield water supply during Drought of Record conditions to achieve 100% supply reliability. However, if water users actually curtail demand 25% during drought of record (or theoretical worse) conditions, instead of needing to supply 6% to 9% more than normal year demand, the utility would need 25% less than normal year demand. This results in a 31% to 34% difference in needed supply for drought of record conditions. Less severe droughts may occur on a less frequent basis, and require less, if any, water use curtailment.

Of course, a valid question exists as to whether water users would prefer to pay for full water supply reliability, even for drought years, or whether they would prefer to conserve water during droughts. The recent report “An Assessment of Demand Elasticity during Drought”[21] (hereinafter Demand during Drought Report) explored this question in phone surveys for water retailers in the Western states that had experienced serious drought. As shown in Figure 2 below, respondents expressed a very strong preference to conserve water during drought compared to paying for costly new water supplies that would only be needed for drought years. It should be noted that respondents for this question had experienced recent drought and this question occurred near the end of a lengthy survey in which respondents were asked a series of very specific questions about 17 water conserving steps they took in a past drought and which specific steps they would consider doing in a future drought. Therefore, the specific steps necessary to conserve additional water were not a vague notion for respondents at this point of the survey.

Furthermore, the same detailed phone surveys of drought affected areas in in California and other Western states found that not only do water users curtail water use during serious drought events, and prefer that compared to paying for new water supply only needed for drought years, but they adopt water saving technologies at a more rapid rate during serious drought events, which essentially accelerates "passive" conservation and can be expected to persist after the drought subsides.[22]

Figure 2
2012 Phone Survey: Conservation vs New Supply during Drought



In Technical Memorandum #4 for the Reliability Study, some of the model runs recognize that a 10% demand curtailment during severe drought is possible and a viable policy alternative.[23] This is an improvement over drought year assumptions in Technical Memorandum #1. However, the 2015 UWMPs for the individual retailers still indicate that demand will increase between 6% and 9% during multi-year droughts which is inconsistent with actual events.

As previously noted, drought year water use assumptions have an important effect on the calculations that determine need for new water supply. Each service area needs to carefully consider the acceptable frequency and depth of water shortages from drought, or the OCWD retailers may decide the most appropriate drought policy for the region as a group. But 100% supply reliability may be economically inefficient use of capital and unnecessary since water users have repeatedly demonstrated that they will curtail demand during serious drought years. In some documented cases in California and the OCWD service areas (noted in the subsequent section of this report), consumers curtailed water use during serious drought years even when a local water shortage did not occur.

Demand Rebound after Drought

Technical Memorandum #1 for the Reliability Study discusses three types of water conservation, passive and active as previously noted, and a third type from drought:

> "The third type is extraordinary conservation that results from mandatory restrictions on water use during extreme droughts. This type of conservation is mainly behavioral, in that water customers change how and when they use water in response to the mandatory restrictions. In droughts past, this type of extraordinary conservation has completely dissipated once water use restrictions were lifted—in other words curtailed water demands fully "bounced back" (returned) to pre-curtailment use levels (higher demand levels, within a relatively short period of time (1-2 years)."[24]

However, no source is cited to corroborate the assumption of fully "bounced back" demand within "1-2 years." In its water demand forecasts, the Reliability Study assumes that after the recent "Great California Drought" demand will rebound 85% in 5 years, and 90% in 10 years.

After the 1976-77 drought in California, many water retailers experienced a fairly rapid rebound to pre drought per capita demand levels. This was because relatively few new conservation technologies were available to be installed during the drought. Instead water users focused on behavioral modifications, and temporary measures such as placing bricks in toilet tanks and reducing landscape irrigation.

Another 6-year drought occurred in California from 1987 to 1992. During this drought, numerous new water savings technologies became available and water savings were based on a combination of new hard-wired efficiency devices and behavioral modifications. Additional drought years occurred during 2007 through 2009, and again in 2014 and 2015. Figures 3 and 4 examine per-capita water use rebound after drought for a couple of California service areas.

Figure 3
Irvine Ranch Water District Drought Rebound

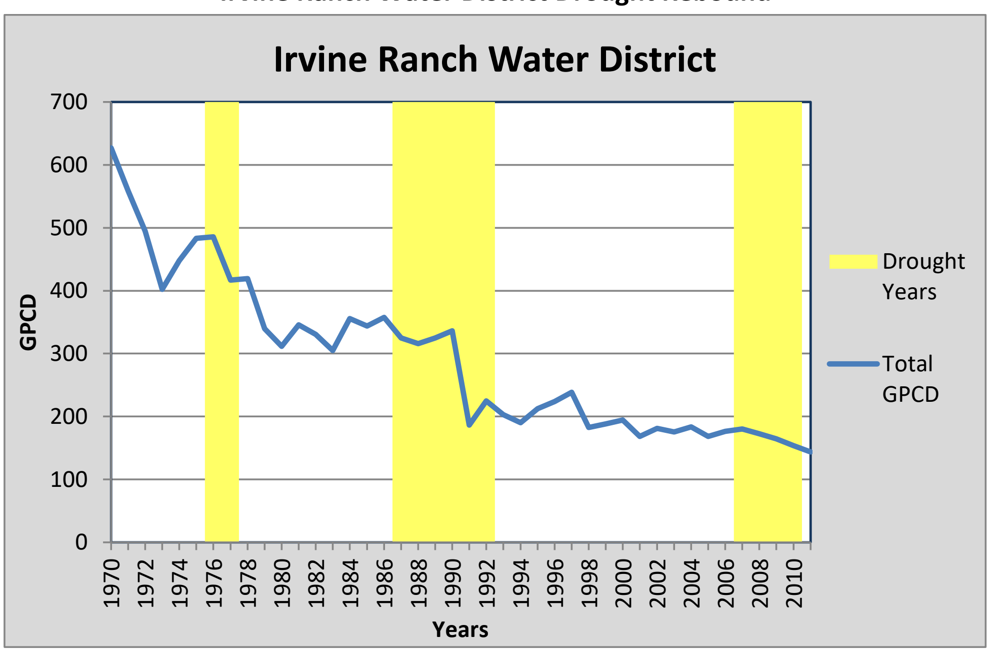
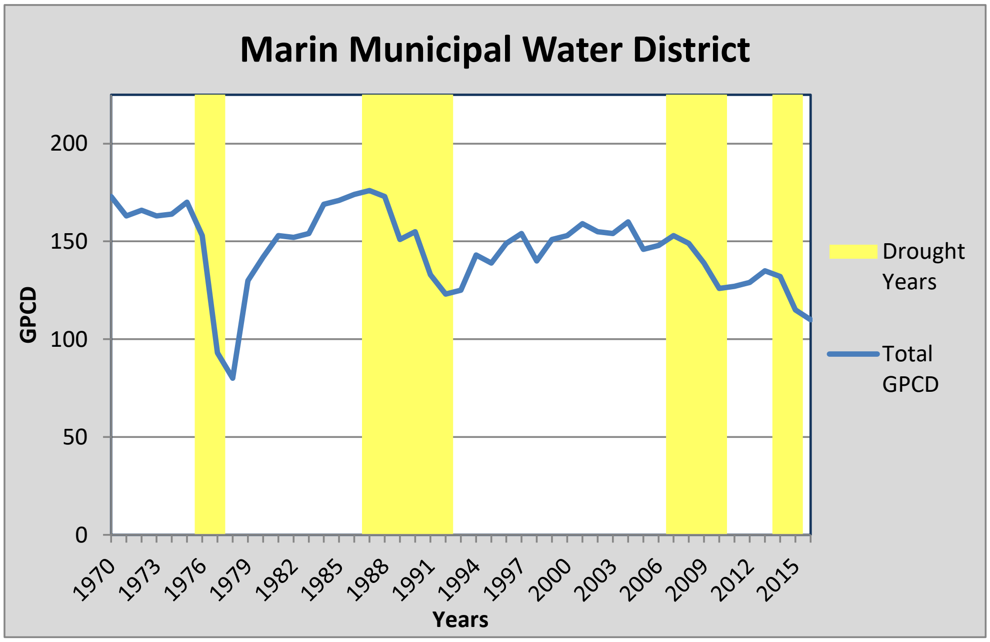


Figure 4
Marin Municipal Water District Drought Rebound



The Marin Municipal Water District data are particularly useful for examining drought rebound since Marin's local watershed and reservoirs only contain a 2- to 3-year carryforward supply, thus the service area is sensitive to drought. Marin's reservoir system is also very efficient at refilling with even a single wet year. So drought years may be of more immediate concern, but also end faster compared with many of California's urban water supply sources.[25]

Both Irvine Ranch and Marin experienced an obvious decline in per capita use during the 1976-77 drought. A relatively wet series of years followed, and over the next 10 years, per-capita water use rebounded to pre-drought levels for Marin, while Irvine Ranch per-capita water use remained at a much lower level (this may have in large part been due to declining agricultural water use in the service area at that time[26]).

When another series of drought years occurred between 1987 through 1992, both Irvine Ranch and Marin experienced a sharp decline in per-capita water use. When a series of wet years followed, per-capita water use for Irvine Ranch again remained below pre-drought levels, apparently due to a new rate structure instituted during the drought years and ongoing active and passive conservation in the service area.[27] During the 15-year wet year interval after 1992, Marin's per capita water use slowly rebounded, but remained well below the pre-drought peak in the mid-1980s.

California experienced another series of dry years between 2007 and 2010, which resulted in widespread concern over water shortages from drought, coinciding with an economic recession (addressed in the next section of this report). Again, both Irvine Ranch and Marin experienced a marked reduction in per-capita water use. Per-capita water use for Irvine Ranch again remained low for the years data were available after this drought, but a noticeable rebound occurs for Marin. With the widely publicized Great California Drought years of 2014 and 2015, Marin's per-capita water use again exhibits a marked decline, even though relatively little rebound had occurred since the previous series of drought years.

The phone surveys in the report "An Assessment of Demand Elasticity during Drought" documented widespread adoption of more efficient water use practices and technologies during recent drought events, essentially accelerating the rate of passive implementation of long-term conservation measures identified in the Reliability Study demand model.[28] Along with the trends in Figures 3 and 4, this suggests that as new conservation technologies and practices – many not considered in the Reliability Study's calculations for passive or active conservation -- are adopted by water users, the Reliability Study's assumption of a 90% rebound is likely to overestimate actual rebound. Additionally, if another series of drought years occurs during the assumed 10-year rebound period, it may significantly reverse the predicted rebound. Given the stretched water supply situation in California and competition for it, even a series of modestly dry years may drive increased adoption of new conservation innovations diminishing rebound after drought.

With a greater range of new conservation devices, technologies and practices available during the recent Great California Drought and widespread concern regarding climate change, if anything, water users can be expected to more strongly adopt and retain water saving devices and practices compared to past drought events. This would result in more persistent water savings from drought years, or less rebound than assumed in the Reliability Study. Though not likely, it is possible that a very long period of wet years will occur during which drought concerns become a distant memory, or a new generation of residents move in and grow up without having experienced a drought. In that unlikely event, increased rebound from growing careless water use would also provide the potential for more demand curtailment during future serious drought years.

Presently, there do not appear to be any thorough studies focused specifically on demand rebound after drought, particularly for recent drought events. But the information available suggests the Reliability Study's assumption of 90% rebound after the recent Great California Drought is likely to significantly contribute to overestimating future demand.

Drought vs. Economic Recession Water Use Patterns

The Reliability Study assumes a demand impact of -13% due to recession, and -6% due to drought.[29] However, recent events in California, the drought response figures in Table 5, and the previously referenced Demand during Drought Report which contains an analysis of water use during the recent simultaneous drought and recession, suggests these assumptions are in error.

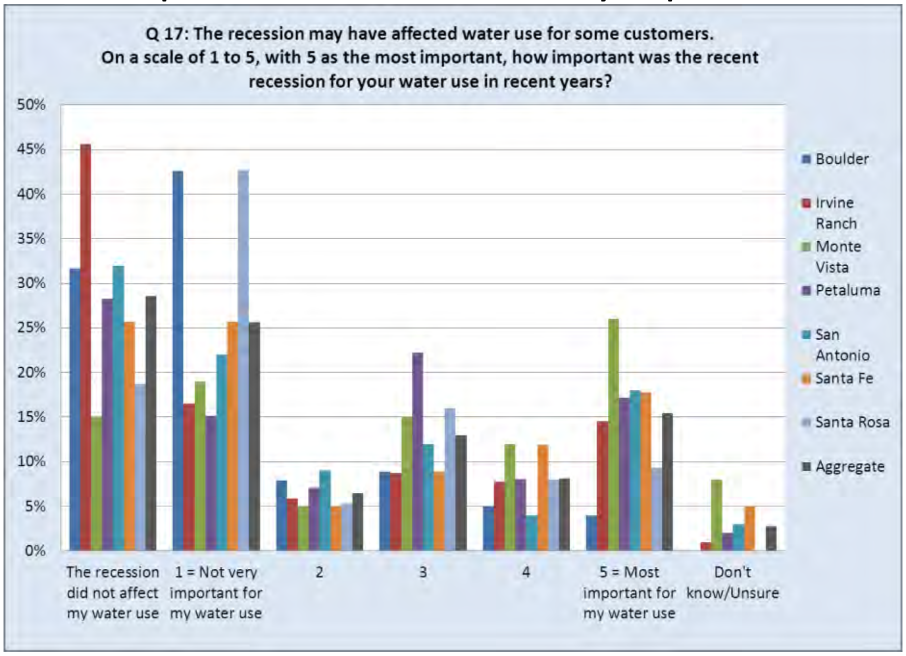
Questioning the long held view that urban water use closely correlates with economic trends is sure to trigger a Semmelweis Reflex from some water managers and analysts.[30] But economic conditions have evolved considerably in recent decades. Process water use for manufacturing and industrial purposes is becoming much less common and on-site recycled water use by remaining large industrial facilities much more common. Much non-residential water use is now for light commercial sites such as office parks, retail stores and restaurants. During economic downturns, much of the water use from these sectors may load shift back to residential sites since local residents may spend relatively more time at home compared to time working, shopping, eating out and other forms of entertainment away from the home. This load shifting will result in less overall impact on water demand during recession compared to the past era of widespread heavy industry and manufacturing.

The disconnect between economic trends and per capita water use has become so striking that in August, 2015 an Op-Ed by prominent water author Charles Fishman appeared in the New York Times. The piece noted that it had been an exceptionally dry 4-year period in California, but that California's economy had grown 27% faster than the nation, and faster every year of the drought.[31]

The relative influence of drought vs. recession in recent years was investigated in the report "An Assessment of Demand Elasticity during Drought" when both occurred simultaneously during the 2007-2010 drought. Some relevant excerpts from the report follow.

> To better understand economic conditions for the seven case studies, and how economic trends may have influenced water use, we collected data on economic trends and compared them to use patterns for each of the seven case studies. The economic indicators included:
>
> Annual unemployment rate
> Annual per-capita income
> Annual home value index
> Median household income
> Median home value
> Percent of population below poverty line
>
> For many of the case studies, in the 1980s there was a period when per-capita water use and economic indicator trends roughly coincided. However, starting in the early 1990s for many case studies, and by the late 1990s for nearly all of them, per-capita water use began a distinctive and persistent downward trend, with only relatively small perturbations during times of recession. As often as not, water use declined in periods of economic expansion and declining unemployment, and particularly during the economic expansion in the 1990s.[32]
>
> We found the economic indicators correlated poorly with the per-capita water use trends. In the last two decades in particular, there was no substantial and sustained correlation between economic vitality and per-capita water use trends. Water use trends appear to correlate much more closely with the ongoing implementation of water conservation programs, including the influence of state and national plumbing codes, the rising cost of water bills, and the influence of drought conditions. This conclusion is consistent with the responses in the phone surveys as noted in Figure 5 below. Most participants indicated that the recession did not affect or was not very important to their water use. Some of the participants who indicated the recession was important to water use may have been impacted in ways that increased use, such as more people living or spending time in the household.

Figure 5
Impact of Recession in Phone Survey Responses[33]



There are many reasons that overall water use for a service area may not sharply decline during a recession when more than the usual number of businesses and water meters are inactive. It is likely that a considerable amount of "load shifting" occurs. Water not used at one site is used somewhere else. Some possible examples include:

- Many more people may be unemployed and spending more time at home rather than in the work place or shopping malls. These unemployed people may be flushing toilets at home more often rather than at work or at the malls.
- Many people may be eating out less frequently, but preparing food and washing dishes more frequently at home. Depending on dishwashing methods, home dishwashing may be less water efficient than in a restaurant.
- There may be more than the normal level of unoccupied dwelling units in a service area, but people may be living more densely in other single-family and multi-family dwelling units (populations did not appear to decline for our case study service areas during the recent recession). Many unoccupied residences and business sites appear to continue watering the landscape with an automatic irrigation system to save landscaping and make the site more attractive to rent or sell. In the case of unoccupied sites that are automatically irrigated, the irrigation management may be less efficient than if the site was occupied.[34]

With regard to the long-term and persistent decline in per capita water use experienced by all the case studies in the study, the report noted "declining per-capita water use did not appear to impose a constraint on economic vitality during periods of economic expansion."[35] This further indicates a growing disconnect between economic trends and overall per capita water use.

Figure 6 below, from the Demand during Drought Study, provides a comparison on aggregate per capita water use trends equally weighted for the seven case studies (four were in California) with economic trends based on real per-capita income.[36]

Figure 6

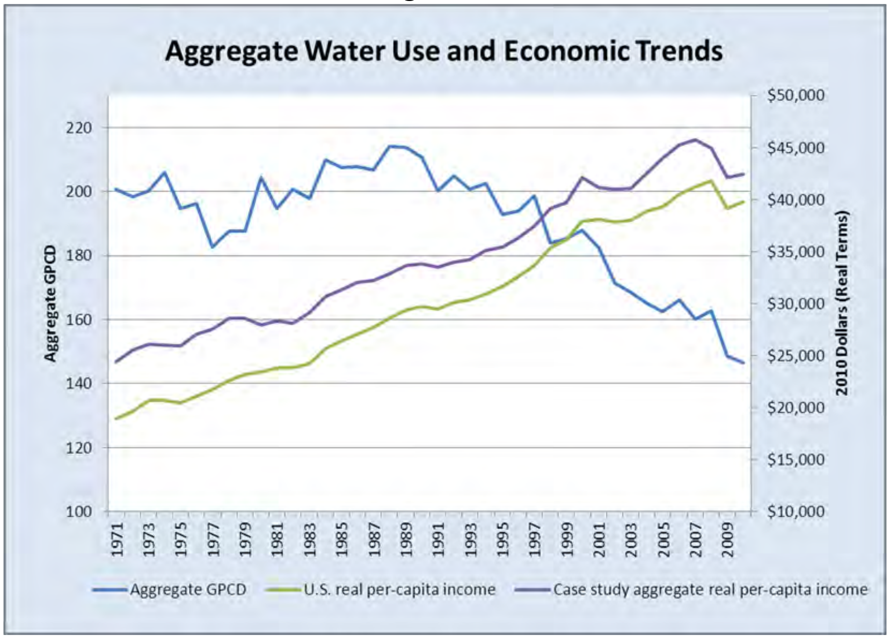


Figure 5 in the Reliability Study Technical Memorandum #1 provides a verification curve of the statistical water use model along with actual water demand.[37] The model appears to predict lower than actual per capita water use for the OCWD basin retailers during the recession years in the early 1990s and early 2000s. The predicted and actual curves appear to match more closely during the late 2000s when the Great Recession and a series of drought years also known to have reduced demand occurred simultaneously. This suggests the impact of recession is over estimated and drought underestimated in the model's assumptions.

Infill Development

As noted in their 2015 Urban Water Management Plans, most Orange County Water District retailers are at or near build-out condition in their service areas (see Appendix A). Future development will consist mostly of infill and higher density development of existing developed areas. This will displace landscape water use, which historically has contained a large percentage of high-water-use plantings and inefficient irrigation systems and practices. The higher density in-fill development pattern is noted in MWDOC's 2015 UWMP; "housing, in particular within the cities, is becoming denser with new multi-storied residential units."[38]

The Demand during Drought Report states "As water utility service areas approach or reach build-out, the trend in declining per-capita water use has important implications for water supply planning."[39] Per capita water use for residents in multi-unit housing stock has historically been lower than in single-family housing. Higher density residential housing stock generally equates to lower per capita demand.

According to Technical Memorandum #1 for the Reliability Study, the "unit use" water use factors used in the model are based on fiscal-year 2013-14 figures provided by the retailers.[40] It is not clear that the trend identified in the UWMPs to higher density, lower per-capita water use housing stock is adequately accounted for in demand forecasts.

Price Elasticity of Demand

Technical Memorandum #1 for the Reliability Study states:

> Price elasticity of water demand reflects the impact that changes in retail cost of water has on water use. Theory states that if price goes up, customers respond by reducing water use. A price elasticity value of -0.2 implies that if the real price of water increases by 10%, water use would decrease by 2%. Price elasticity is estimated by detailed econometric water demand models, where price can be isolated from all other explanatory variables. Many times price is correlated with other variables making it difficult to estimate a significant statistical value. In addition, there is a potential for double counting reduction in water demand if estimates of future conservation from active programs are included in a demand forecast because customers who respond to price take advantage of utility-provided incentives for conservation. MET's 2015 IRP considers the impact of price elasticity in their future water demand scenarios, but does not include future active conservation in its demand forecast. The OC Study included future estimates of water conservation from active conservation, and thus did not include a price elasticity variable in its statistical modeling of water demand. Including both price elasticity and active conservation would have resulted in "double counting" of the future water savings.

While there may be a potential for double counting some active conservation program savings for people motivated by price increases, to entirely disregard the price elasticity of demand is almost certain to under count its effects. Participants in active conservation programs may also be motivated to modify behavior to conserve water in addition to the water savings from the active conservation retrofits. These can both occur simultaneously and result in separate water savings. In addition, many water users may be motivated to conserve based solely on price, without any participation in the active conservation programs. These price only motivated conservers will be lost from the accounting.

The Demand during Drought Study found real marginal prices increased substantially during the last 10 to 20 years.[41] Technical Memorandum #4 for the Reliability Study states "the cost of water will continue to increase over time, and at higher rates than the cost of inflation to deal with these reliability issues."[42] If water prices continue rising in real terms, as water industry analysts predict, this problem will be magnified, particularly for utilities developing more expensive new supply sources. The demand model in the Reliability Study would be better served by reasonable assumptions to address double counting concerns, rather than categorically ignoring a known important water use influence on all of a service area's customers.

F**uture conservation innovation**

> "Everything than can be invented has been invented"
>
> > Quote often erroneously attributed to Charles Holland Duell, commissioner of the United States Patent and Trademark Office in 1898 to 1901 (the quote can be sourced to an 1899 edition of Punch Magazine)[43]
>
> In fact, in 1902 Duell is known to have said:
>
> "In my opinion, all previous advances in the various lines of invention will appear totally insignificant when compared with those which the present century will witness. I almost wish that I might live my life over again to see the wonders which are at the threshold."[44]

Conservation assumptions in demand forecasts tend to underestimate future conservation for a number of reasons. As previously noted, Technical Memorandum #1 for the Reliability Study includes a limited range of presently available conservation measures in its passive conservation projections. Nonetheless, water users employ a broader range of conservation measures, particularly during drought years, which are not considered in the demand forecasts. But even for demand forecasts with the most thorough analysis of conservation measures, it is important to recognize that only present day conservation measures have been included. However, as abundantly clear in recent decades, conservation technologies are rapidly developing. Given well-established trends, future conservation innovations can safely be expected to increase future conservation beyond present day forecasts.

Many examples exist, but the evolution of toilet efficiency is particularly illustrative. During California's 1976-77 drought, the cutting-edge technology was to place a brick (maybe sealed in a plastic bag for the most technologically advanced) in the tank of a 5 to 7 gallon per flush toilet to reduce flushing volume. This soon gave way in the 1980s to 3.5 gallon per flush toilets, and considerable skepticism from plumbing interests. In the early 1990s, 1.6 gallon per flush toilets became available. Conservation skeptics suggested they would never work properly and create havoc with wastewater plumbing. Numerous studies were launched to investigate the dangers of using this new generation of toilets, and prove they could not possibly be practical for widespread use and represent future toilet technology. Water analysts in the 1990s were often hesitant to consider the water savings from 1.6 gallon toilets reliable enough to include in demand forecasts. In a sense they were right, but only because a new, more efficient generation soon superseded the 1.6 gallon toilets.

By the late 2000s, more efficient toilets using 1.28 gallons-per-flush became the new efficiency standard, replacing the 1.6 gallon toilets. Now, the 2015 MWDOC Reliability Study assumes all new and remodeled households will use 1 gallon-per-flush toilets, replacing even those old, inefficient 1.6 gallon toilets. Toilets using 0.8 gallon per flush toilet are now widely available. As populations increase, and more people flush more toilets, seemingly small improvements in toilet efficiency have important cumulative effect on demand. Many other water using technologies such as clothes washers and dishwashers are also advancing in efficiency.

Of course, the demand forecasts from the 1990s and 2000s never contemplated these efficiency innovations that regularly occurred within the planning horizons of the forecasts. For many widely recognized reasons including population increases, over allocated river systems, rising cost of water and concern about climate change, much interest exists in advancing innovative efficient water use technologies. In fact, the Metropolitan Water District of Southern California has for many years provided grants designed specifically to help drive innovation in conservation technologies and practices.

There can be little doubt that conservation innovation has been an important influence in reducing water use below earlier demand forecasts, and all signs suggest that will continue to be the case for the foreseeable future and the planning horizon for the Reliability Study. We may not be able to predict exactly what new innovations will emerge, but we now have a long enough track record of new technologies and efficiencies reducing demand below previous forecasts that water demand modelers can begin to recognize and quantify this variable and develop model runs that incorporate it in a range of alternative demand scenarios.

Risk in Overestimating Future Demand

Water demand forecasters traditionally use conservative estimates for many forecasting assumptions. This is generally done to reduce the risk from uncertainty in the forecasts and to reduce the risk of underestimating water supplies for a growing service area. However, as multiple instances and layers of conservative estimates are incorporated into demand forecasts, the forecasts diverge from real world trends and can lead water agencies to pursue unnecessary or overly costly supplies. Much of water utility costs may be fixed, but the fixed costs become hard-wired from previous capital expenditures in new supplies and facilities.

For service areas undergoing rapid growth and expansions, increased demand may eventually justify overestimated demand forecasts. However, for service areas at or near built-out conditions, as is the case for OCWD retailers, over estimating future demand and pursuing unneeded or overly costly new supplies can place the water utility at considerable financial risk and vulnerable to ratepayer backlash.

Financial risk can result from poor investment strategies and financial instability when water demand is less than forecasted. As water use declines below forecasted levels, revenues needed to pay for capital costs and debt service decline. Further raising rates to generate additional revenue can further suppress demand and create a downward financial spiral for the utility. Likewise, large capital investments for water supply only needed for infrequent serious drought years places additional financial burden on the utility, and financial risk when water users substantially reduce water use during serious drought events, as occurs in California. Political risk can increase as a consequence of ratepayer revolts triggered by rate increases and dissatisfaction regarding past supply investments by utility decision-makers. Risk may also occur when water utilities with a history of overestimating demand are justifiably greeted with skepticism by agencies responsible for permitting new supply projects and facilities, and public interest groups and ratepayers whose approval may be necessary for new projects to move forward.

Many service areas at or near build-out, as is the case for Orange County Water District retailers, may have now reached a point where multiple instances and layers of conservative assumptions for demand forecasts leading to inflated future demand estimates no longer provides the intended risk reduction. Utilities with service areas at or new build-out would be wise to much more carefully scrutinize water demand forecasts and the assumptions on which they are based in order to more closely represent real world events and trends.

Appendix A: Analysis of Individual Retailer Urban Water Management Plans

The below table indicates which UWMPs, from 1995 through 2015 were available for each OCWD retailer, which were used in the analysis of UWMP future populations and demand.

Urban Water Management Plans Obtained

Water Retailer	LTFP 2035 Demand (AFY)	Group	1995	2000	2005	2010	2015
IRWD	88,008	1	Yes	Yes	Yes	Yes	Yes
Anaheim	77,700	1	NA	Yes	Yes	Yes	Yes
Santa Ana	50,400	1	NA	Yes	Yes	Yes	Yes
Orange	34,713	2	Yes	Yes	Yes	Yes	Yes
Huntington Beach	34,657	2	Yes	Yes	Yes	Yes	Yes
Fullerton	32,792	2	Yes	Yes	Yes	Yes	Yes
Golden State Water Co.	32,774	2	NA	NA	NA	Yes	NA
Garden Grove	30,907	2	1996	Yes	Yes	Yes	Yes
Yorba Linda WD	27,784	2	Yes	Yes	Yes	Yes	Yes
Buena Park	19,900	3	NA	Yes	Yes	Yes	Yes
Mesa	19,700	3	Yes	Yes	Yes	Yes	Yes
Newport Beach	18,474	3	Yes	Yes	Yes	Yes	yes
Tustin	15,194	3	Yes	Yes	Yes	Yes	Yes
Westminster	12,337	3	Yes	Yes	Yes	Yes	Yes
Fountain Valley	10,165	3	Yes	Yes	Yes	Yes	Yes
Seal Beach	4,880	4	NA	2002	Yes	Yes	Yes
Serrano WD	2,852	4	NA	NA	NA	Yes	Wholesale
La Palma	2,742	4	Yes	NA	Yes	Yes	Yes
East OCWD	1,100	4	NA	NA	Yes	Yes	Yes

For some of the UWMPs, and particularly the earlier years, population or demand figures were missing. These data gaps are apparent in the individual retailer tables below.

When a subsequent year UWMP had updated demand or population figures for the previous starting year, for example the 2000 UWMP had updated 1995 demand figures, the updated figures were assumed to be more accurate and used. Since the horizontal and vertical scales used in graphs to provide a clearer representation of trends can introduce some distortion, tables providing percent changes are provided below the graphs for each retailer.

UWMP data for each retailer follows (with the exceptions of Golden State and Serrano due to lack of an adequate number of UWMPs) in the order noted in the above table, which is descending water use.

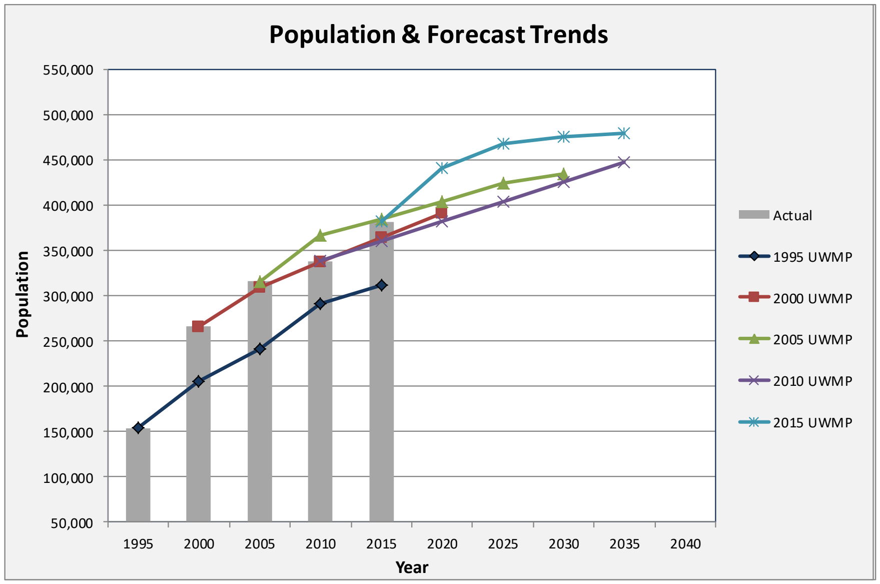
Irvine Ranch

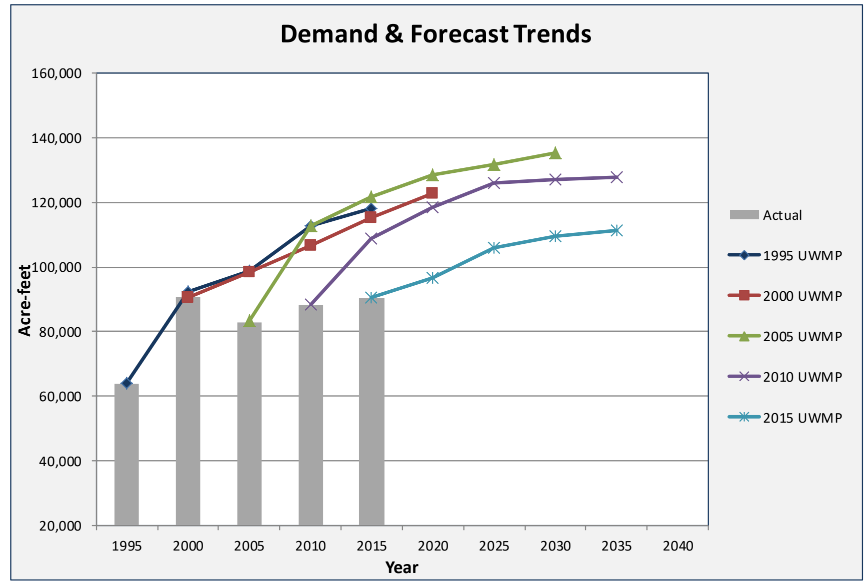
Population
Actual and Forecasted

Year	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040
Actual	154,000	266,000	316,000	337,876	381,463					
1995 UWMP	154,000	205,784	240,757	290,839	312,000					
2000 UWMP		266,000	308,653	337,569	364,018	390,467				
2005 UWMP			316,000	366,192	384,502	403,727	423,914	434,511		
2010 UWMP				337,876	359,627	381,379	403,130	424,882	446,633	
2015 UWMP					381,463	440,981	467,483	475,346	479,783	

Demand
Actual and Forecasted (AF)

Year	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040
Actual	63,992	90,660	82,916	88,347	90,403					
1995 UWMP	63,992	92,176	98,578	112,716	118,014					
2000 UWMP		90,660	98,339	106,785	115,133	122,833				
2005 UWMP			83,508	112,710	121,620	128,563	131,708	135,130		
2010 UWMP				88,347	108,626	118,512	126,009	126,968	127,908	
2015 UWMP					90,403	96,445	105,961	109,431	111,277	





	Predicted Compared to Subsequent Actual Population				Change in 2015 Forecasts Compared to Previous UWMPs			
1995 UWMP	77.4%	78.0%	86.1%	81.8%				
2000 UWMP		97.7%	99.9%	95.4%	12.9%			
2005 UWMP			108.4%	100.8%	9.2%	10.3%	9.4%	
2010 UWMP				94.3%	15.6%	16.0%	11.9%	7.4%

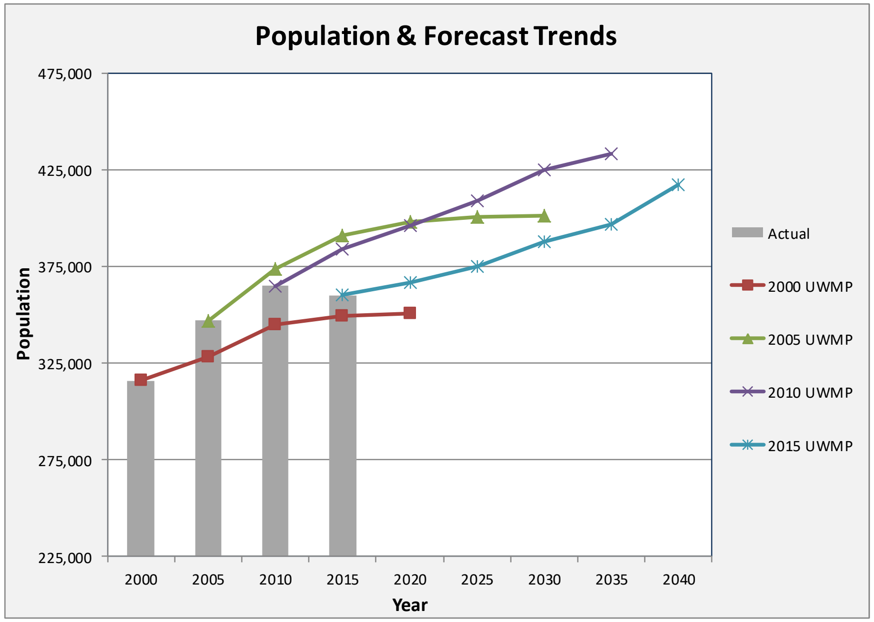
	Predicted Compared to Subsequent Actual Demand				Change in 2015 Demand Forecasts Compared to Previous UWMPs			
1995 UWMP	101.7%	118.0%	127.6%	130.5%				
2000 UWMP		117.8%	120.9%	127.4%	-21.5%			
2005 UWMP			127.6%	134.5%	-25.0%	-19.5%	-19.0%	
2010 UWMP				120.2%	-18.6%	-15.9%	-13.8%	-13.0%

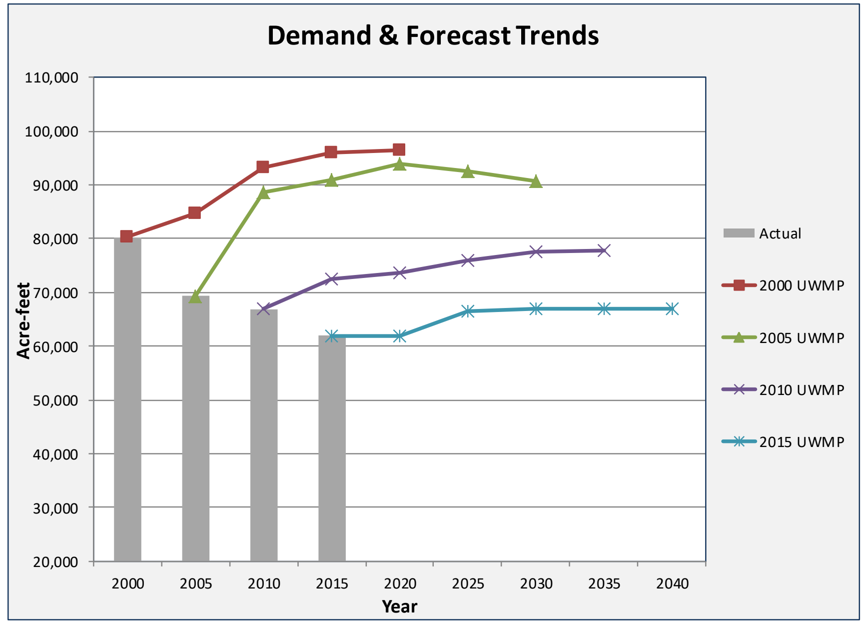
The Irvine Ranch service area experienced annexes and expansions nearly every 5-year cycle of UWMP updates which were generally not accounted for in earlier population and demand forecasts. The 2000 UWMP included both IRWD and the Los Alisos which were being merged. The 2000 UWMP figures represent the combined service areas. Recycled water use is included in demand and represents about 1/3 of total use, therefore potable water use is much lower.

Anaheim

Population Actual and Forecasted									
Year	2000	2005	2010	2015	2020	2025	2030	2035	2040
Actual	316,100	346,932	364,921	360,142					
2000 UWMP	316,100	328,300	345,100	349,700	350,500				
2005 UWMP		346,932	373,852	390,764	397,774	400,529	400,900		
2010 UWMP			364,921	383,768	395,769	409,096	424,558	432,949	
2015 UWMP				360,142	366,938	374,836	387,739	396,721	417,456

Demand Actual and Forecasted (AF)									
Year	2000	2005	2010	2015	2020	2025	2030	2035	2040
Actual	80,200	69,277	66,829	61,982					
2000 UWMP	80,200	84,700	93,300	96,000	96,400				
2005 UWMP		69,277	88,630	90,890	93,920	92,490	90,710		
2010 UWMP			66,829	72,400	73,600	75,900	77,500	77,700	
2015 UWMP				61,982	61,895	66,453	66,910	66,892	66,988





Predicted Compared to Subsequent Actual Population				Change in 2015 Population Forecasts Compared to Previous			
Year	2005	2010	2015	2020	2025	2030	2035
2000 UWMP	94.6%	94.6%	97.1%	4.7%			
2005 UWMP		102.4%	108.5%	-7.8%	-6.4%	-3.3%	
2010 UWMP			106.6%	-7.3%	-8.4%	-8.7%	-8.4%

Predicted Compared to Subsequent Actual Demand				Change in 2015 Demand Forecasts Compared to Previous UWMPs			
Year	2005	2010	2015	2020	2025	2030	2035
2000 UWMP	122.3%	139.6%	154.9%	-35.8%			
2005 UWMP		132.6%	146.6%	-34.1%	-28.2%	-26.2%	
2010 UWMP			116.8%	-15.9%	-12.4%	-13.7%	-13.9%

A 1995 UWMP was not available for Anaheim.

The 2015 UWMP indicates “the City is almost completely built-out” and “housing is becoming denser and new residential units are multi-storied.” (p 2-2)

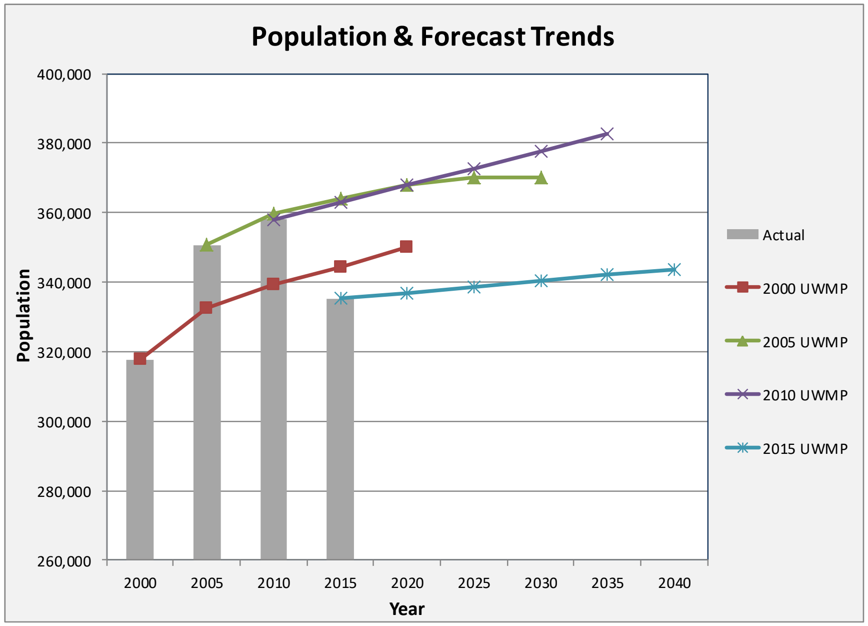
Santa Ana

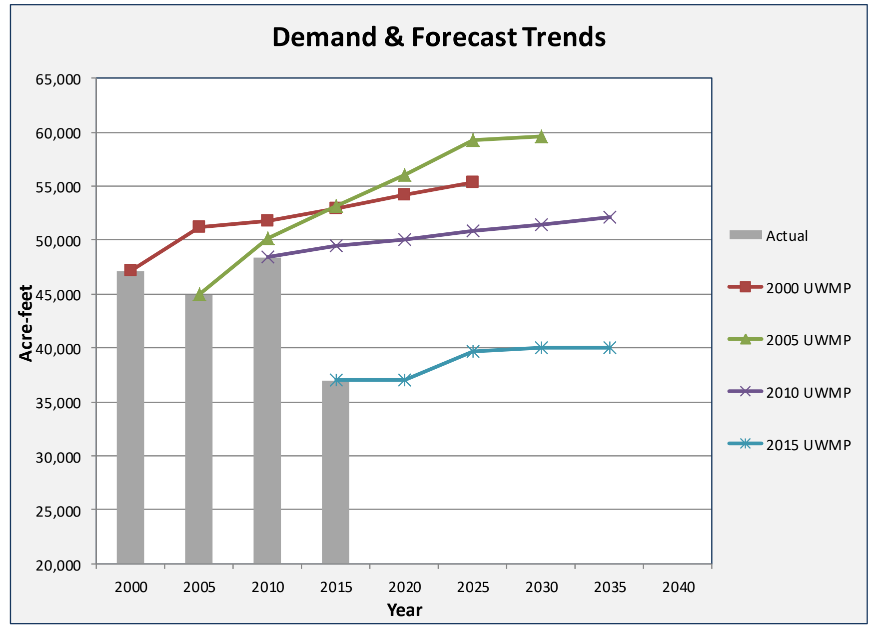
Population
Actual and Forecasted

Year	2000	2005	2010	2015	2020	2025	2030	2035	2040
Actual	317,685	350,625	358,136	335,299					
2000 UWMP	317,685	332,586	339,419	344,410	350,172				
2005 UWMP		350,625	359,832	364,049	368,026	370,196	370,130		
2010 UWMP			358,136	363,027	367,918	372,809	377,700	382,591	
2015 UWMP				335,299	336,975	338,660	340,354	342,055	343,766

Demand
Actual and Forecasted (AF)

Year	2000	2005	2010	2015	2020	2025	2030	2035	2040
Actual	47,112	44,920	48,391	37,008					
2000 UWMP	47,112	51,170	51,780	52,960	54,150	55,370			
2005 UWMP		44,920	50,190	53,180	55,970	59,280	59,540		
2010 UWMP			48,391	49,473	50,094	50,819	51,440	52,164	
2015 UWMP				37,008	36,998	39,717	39,989	39,978	





	Predicted Compared to Subsequent Actual Population			Change in 2015 Forecasts Compared to Previous UWMPs			
Year	2005	2010	2015	2020	2025	2030	2035
2000 UWMP	94.9%	94.8%	102.7%	-3.8%			
2005 UWMP		100.5%	108.6%	-8.4%	-8.5%	-8.0%	
2010 UWMP			108.3%	-8.4%	-9.2%	-9.9%	-10.6%

	Predicted Compared to Subsequent Actual Demand			Change in 2015 Demand Forecasts Compared to Previous UWMPs			
Year	2005	2010	2015	2020	2025	2030	2035
2000 UWMP	113.9%	107.0%	143.1%	-31.7%			
2005 UWMP		103.7%	143.7%	-33.9%	-33.0%	-32.8%	
2010 UWMP			133.7%	-26.1%	-21.8%	-22.3%	-23.4%

A 1995 UWMP was not available.

The 2015 UWMP states, “the City is almost completely built-out" and "vacant land within the City is very limited while existing housing is becoming denser and new residential units are multi-storied." (p 2-2)

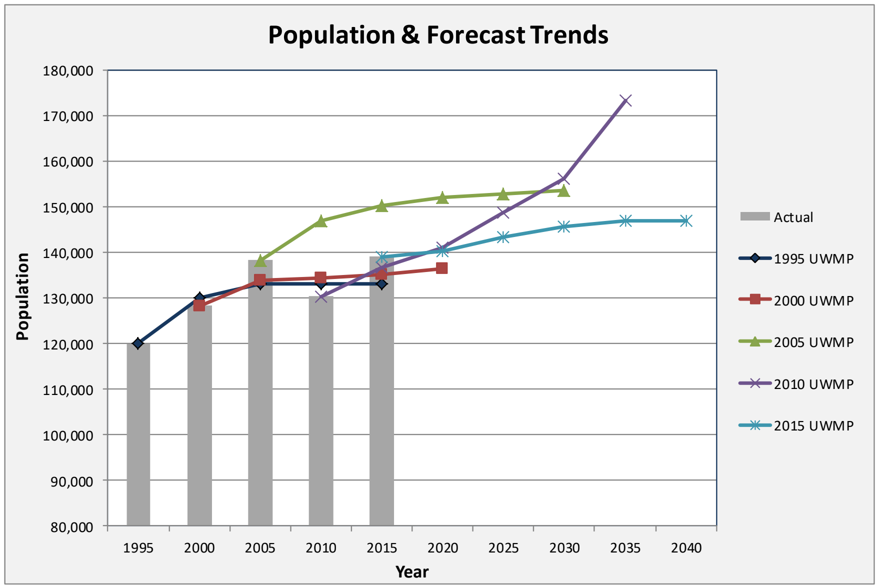
Orange

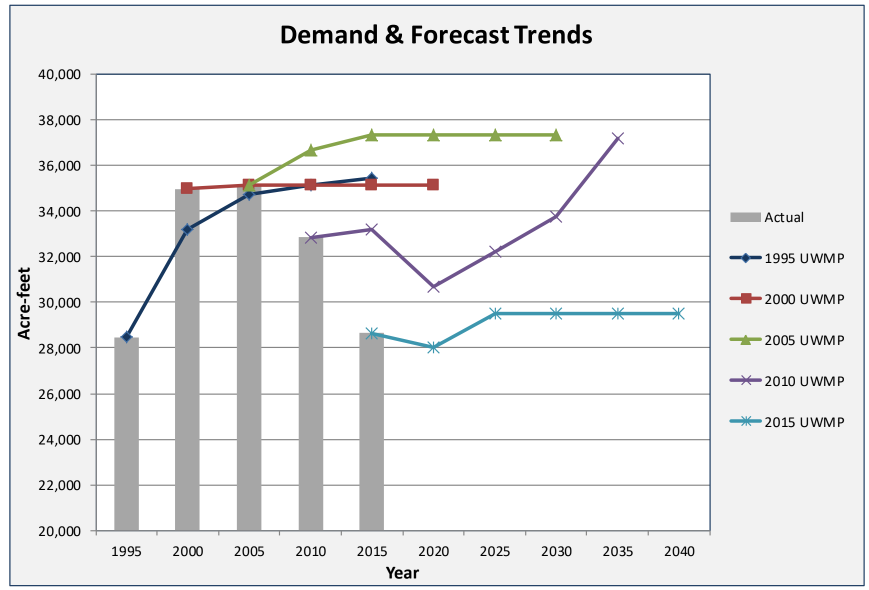
Population
Actual and Forecasted

Year	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040
Actual	120,000	128,309	138,289	130,325	138,987					
1995 UWMP	120,000	130,000	133,000	133,000	133,000					
2000 UWMP		128,309	133,793	134,474	135,230	136,346				
2005 UWMP			138,289	146,950	150,152	151,910	152,792	153,576		
2010 UWMP				130,325	136,703	141,094	148,709	156,125	173,212	
2015 UWMP					138,987	140,203	143,429	145,735	146,916	146,795

Demand
Actual and Forecasted (AF)

Year	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040
Actual	28,464	34,978	35,156	32,854	28,643					
1995 UWMP	28,464	33,200	34,710	35,160	35,460					
2000 UWMP		34,978	35,156	35,156	35,156	35,156				
2005 UWMP			35,156	36,663	37,319	37,319	37,319	37,319		
2010 UWMP				32,854	33,201	30,681	32,236	33,746	37,165	
2015 UWMP					28,643	28,000	29,500	29,500	29,500	29,500





	Predicted Compared to Subsequent Actual Population				Change in 2015 Forecasts Compared to Previous UWMPs			
1995 UWMP	101.3%	NA	102.1%	95.7%				
2000 UWMP		96.7%	103.2%	97.3%	2.8%			
2005 UWMP			112.8%	108.0%	-7.7%	-6.1%	-5.1%	
2010 UWMP				98.4%	-0.6%	-3.6%	-6.7%	-15.2%

	Predicted Compared to Subsequent Actual Demand				Change in 2015 Demand Forecasts Compared to Previous UWMPs			
1995 UWMP	94.9%	98.7%	107.0%	123.8%				
2000 UWMP		100.0%	107.0%	122.7%	-20.4%			
2005 UWMP			111.6%	130.3%	-25.0%	-21.0%	-21.0%	
2010 UWMP				115.9%	-8.7%	-8.5%	-12.6%	-20.6%

The 2015 UMMP states "The City is almost completely built-out, (note: the City continues to see limited development on the very east side with the Santiago Hills II tract development of approximately 1,180 new homes, but this development lies outside of the City of Orange water service area and is in IRWD’s service area)" (p 2-2)

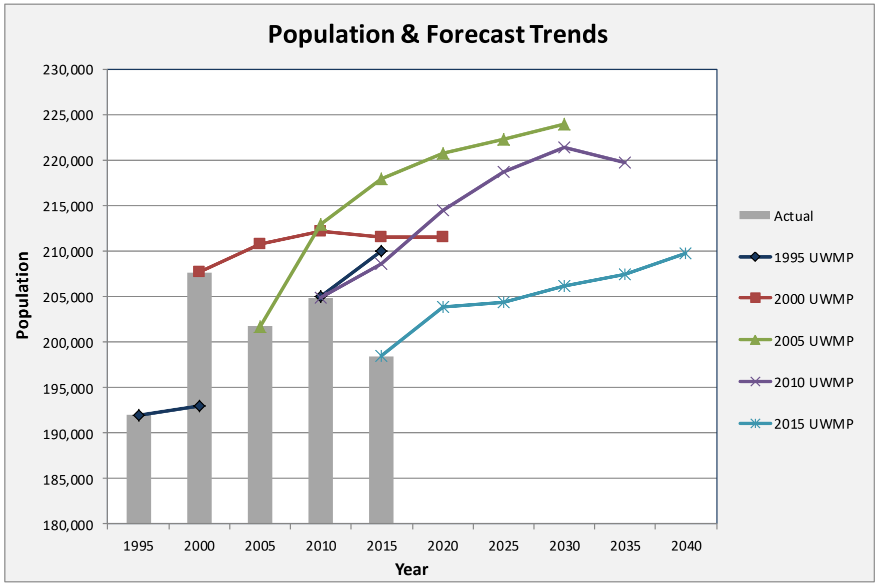
Huntington Beach

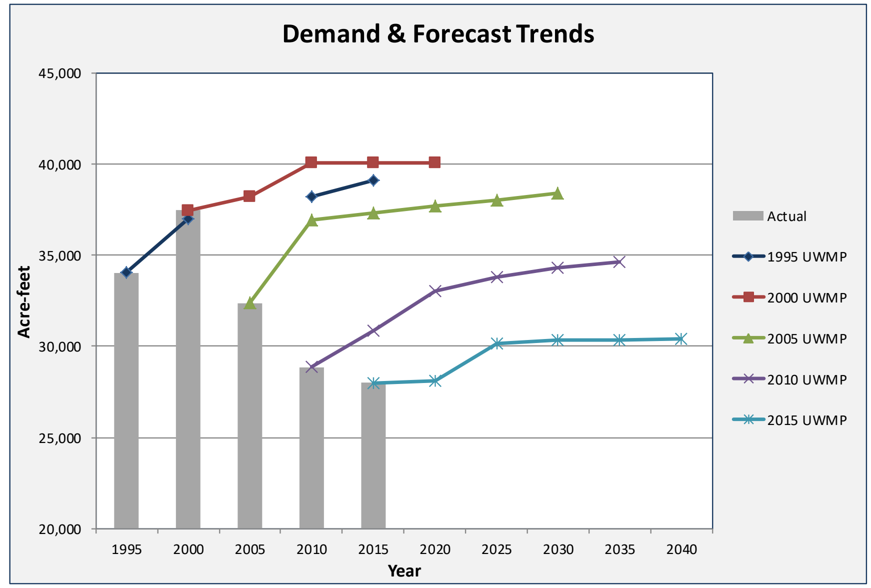
Population — Actual and Forecasted

Year	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040
Actual	192,000	207,639	201,692	204,831	198,429					
1995 UWMP	192,000	193,000		205,000	210,000					
2000 UWMP		207,639	210,734	212,181	211,558	211,581				
2005 UWMP			201,692	212,893	217,957	220,759	222,274	223,992		
2010 UWMP				204,831	208,622	214,441	218,739	221,420	219,690	
2015 UWMP					198,429	203,840	204,330	206,207	207,387	209,689

Demand — Actual and Forecasted (AF)

Year	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040
Actual	34,063	37,460	32,374	28,879	27,996					
1995 UWMP	34,063	37,000		38,200	39,135					
2000 UWMP		37,460	38,200	40,075	40,100	40,100				
2005 UWMP			32,374	36,931	37,304	37,696	38,059	38,400		
2010 UWMP				28,879	30,888	33,036	33,823	34,324	34,657	
2015 UWMP					27,996	28,090	30,153	30,360	30,352	30,396





	Predicted Compared to Subsequent Actual Population				Change in 2015 Forecasts Compared to Previous UWMPs			
1995 UWMP	92.9%	NA	100.1%	105.8%				
2000 UWMP		104.5%	103.6%	106.6%	-3.7%			
2005 UWMP			103.9%	109.8%	-7.7%	-8.1%	-7.9%	
2010 UWMP				105.1%	-4.9%	-6.6%	-6.9%	-5.6%

	Predicted Compared to Subsequent Actual Demand				Change in 2015 Demand Forecasts Compared to Previous UWMPs			
1995 UWMP	98.8%	NA	132.3%	139.8%				
2000 UWMP		118.0%	138.8%	143.2%	-30.0%			
2005 UWMP			127.9%	133.2%	-25.5%	-20.8%	-20.9%	
2010 UWMP				110.3%	-15.0%	-10.9%	-11.5%	-12.4%

The Huntington Beach 1995 UWMP did not contain a population forecast for the year 2005.

The 2015 UWMP states Huntington Beach is a “predominately residential community” (p 1-3) and “housing is becoming denser and new residential units are multi-storied.” (p 2-2)

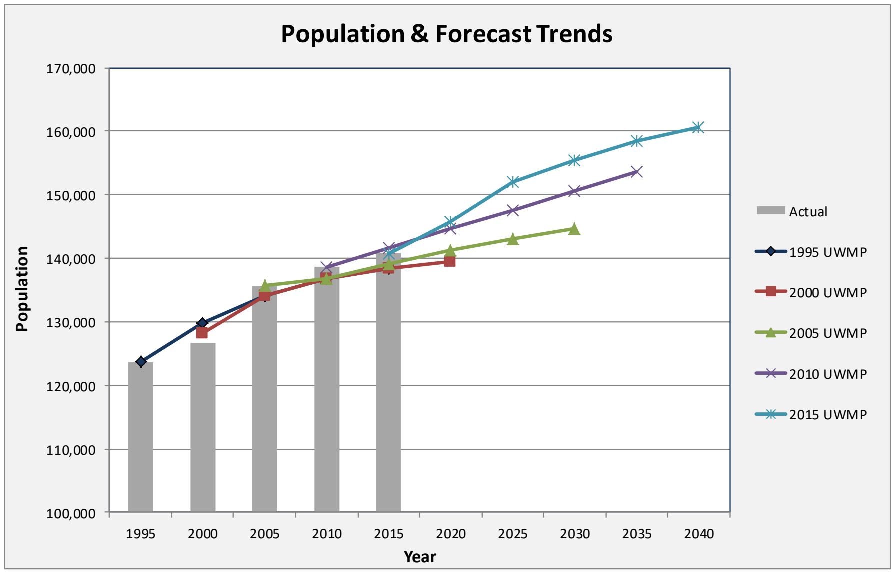
Fullerton

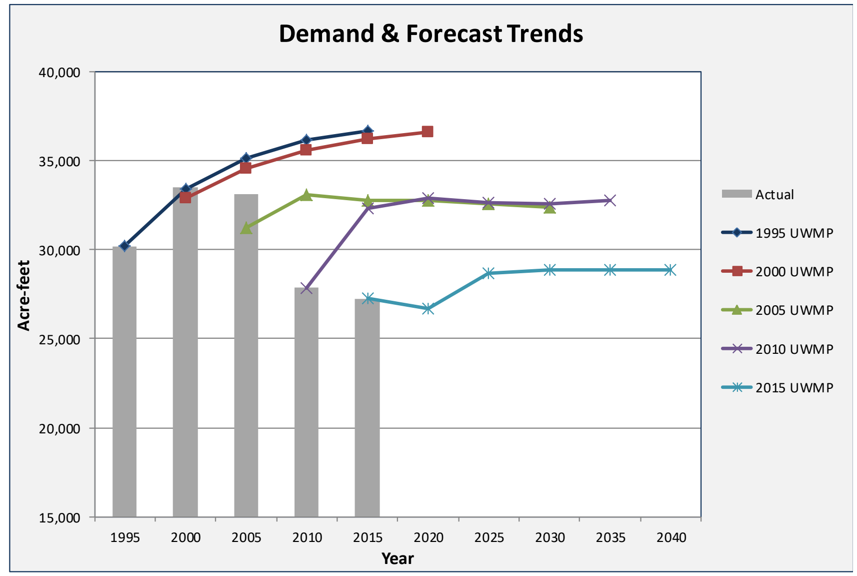
Population
Actual and Forecasted

Year	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040
Actual	123,692	126,635	135,672	138,600	140,827					
1995 UWMP	123,692	129,804	134,175	136,845	138,442					
2000 UWMP		128,255	134,175	136,845	138,442	139,556				
2005 UWMP			135,672	136,800	139,200	141,200	143,000	144,700		
2010 UWMP				138,600	141,603	144,605	147,608	150,610	153,613	
2015 UWMP					140,827	145,791	152,026	155,464	158,421	160,545

Demand
Actual and Forecasted (AF)

Year	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040
Actual	30,195	33,530	33,136	27,860	27,244					
1995 UWMP	30,195	33,442	35,169	36,176	36,675					
2000 UWMP		32,913	34,538	35,608	36,210	36,595				
2005 UWMP			31,249	33,100	32,800	32,800	32,600	32,400		
2010 UWMP				27,860	32,305	32,881	32,658	32,602	32,792	
2015 UWMP					27,244	26,699	28,661	28,858	28,850	28,891





	Predicted Compared to Subsequent Actual Population				Change in 2015 Forecasts Compared to Previous UWMPs			
1995 UWMP	101.2%	101.1%	98.7%	98.3%				
2000 UWMP		98.9%	98.7%	98.3%	4.5%			
2005 UWMP			98.7%	98.8%	3.3%	6.3%	7.4%	
2010 UWMP				100.6%	0.8%	3.0%	3.2%	3.1%

	Predicted Compared to Subsequent Actual Demand				Change in 2015 Demand Forecasts Compared to Previous UWMPs			
1995 UWMP	101.6%	112.5%	129.8%	134.6%				
2000 UWMP		110.5%	127.8%	132.9%	-27.0%			
2005 UWMP			118.8%	120.4%	-18.6%	-12.1%	-10.9%	
2010 UWMP				118.6%	-18.8%	-12.2%	-11.5%	-12.0%

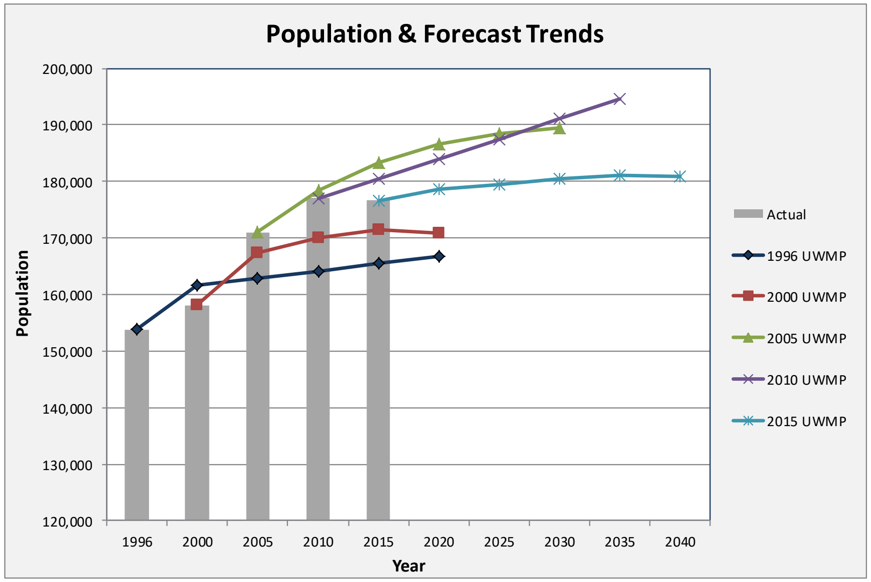
Actual demand for the year 2000 is from the 2005 UWMP. Actual demand for the year 2005 is form the 2010 UWMP.

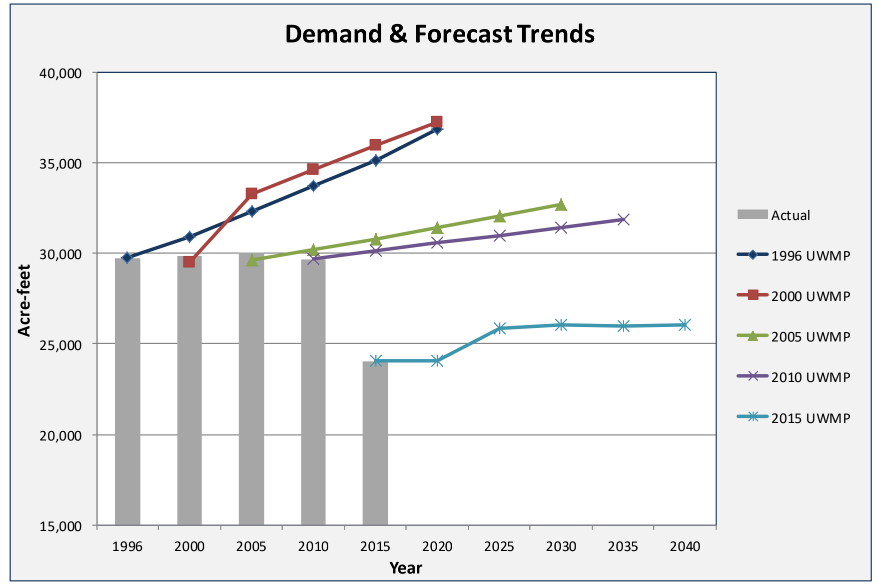
The 2015 UWMP describes the service area as "a predominately residential single and multi-family community” and “multi-family housing units are expected to increase at a faster rate than the single-family housing units. In the older areas of the City, multi-family and mixed use units are increasingly replacing older single-family dwellings." (p 2-2)

Garden Grove

Population Actual and Forecasted										
Year	1996	2000	2005	2010	2015	2020	2025	2030	2035	2040
Actual	153,800	158,100	171,042	177,020	176,649					
1996 UWMP	153,800	161,635	162,914	164,193	165,471	166,750				
2000 UWMP		158,100	167,339	170,107	171,479	170,851				
2005 UWMP			171,042	178,457	183,249	186,593	188,446	189,445		
2010 UWMP				177,020	180,526	184,032	187,538	191,044	194,550	
2015 UWMP					176,649	178,729	179,440	180,428	181,002	180,825

Demand Actual and Forecasted (AF)										
Year	1996	2000	2005	2010	2015	2020	2025	2030	2035	2040
Actual	29,748	29,857	30,027	29,698	24,049					
1996 UWMP	29,748	30,888	32,312	33,737	35,162	36,856				
2000 UWMP		29,487	33,312	34,637	35,961	37,286				
2005 UWMP			29,620	30,210	30,814	31,431	32,060	32,700		
2010 UWMP				29,698	30,164	30,631	30,986	31,453	31,909	
2015 UWMP					24,049	24,078	25,847	26,024	26,017	26,055





	Predicted Compared to Subsequent Actual Population				Change in 2015 Forecasts Compared to Previous UWMPs			
1995 UWMP	102.2%	NA	92.8%	93.7%				
2000 UWMP		97.8%	96.1%	97.1%	4.6%			
2005 UWMP			100.8%	103.7%	-4.2%	-4.8%	-4.8%	
2010 UWMP				102.2%	-2.9%	-4.3%	-5.6%	-7.0%

	Predicted Compared to Subsequent Actual Demand				Change in 2015 Demand Forecasts Compared to Previous UWMPs			
1995 UWMP	104.8%	109.1%	113.6%	146.2%				
2000 UWMP		112.5%	116.6%	149.5%	-35.4%			
2005 UWMP			101.7%	128.1%	-23.4%	-19.4%	-20.4%	
2010 UWMP				125.4%	-21.4%	-16.6%	-17.3%	-18.5%

The 2015 UWMP indicates the service area is “a predominately single and multi-family residential community” and states “the City is almost completely built-out” and "housing is becoming denser and new residential units are multi-storied" (p. 2-2)

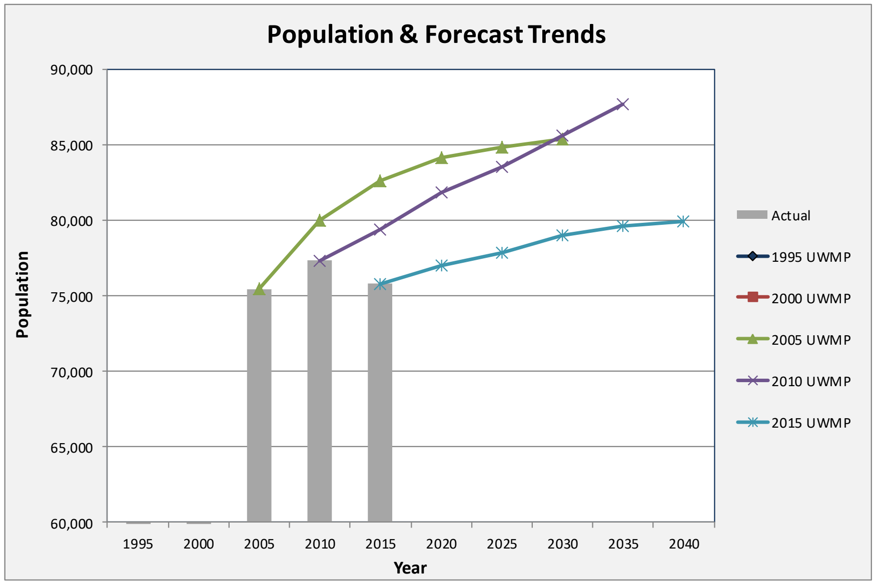
Yorba Linda

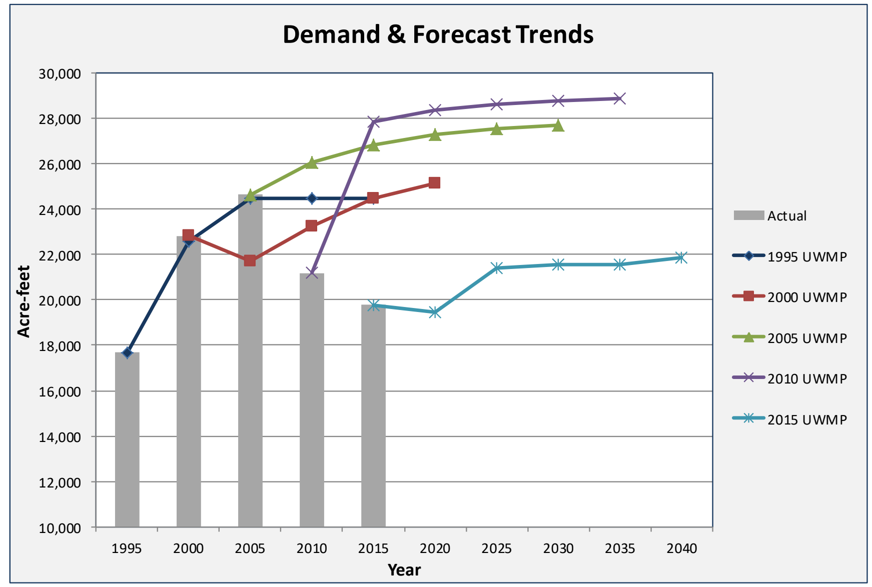
Population
Actual and Forecasted

Year	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040
Actual	NA	NA	75,445	77,320	75,773					
1995 UWMP	NA									
2000 UWMP		NA								
2005 UWMP			75,445	80,007	82,584	84,155	84,860	85,355		
2010 UWMP				77,320	79,391	81,862	83,533	85,604	87,675	
2015 UWMP					75,773	76,998	77,840	78,961	79,640	79,926

Demand
Actual and Forecasted (AF)

Year	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040
Actual	17,673	22,820	24,631	21,196	19,776					
1995 UWMP	17,673	22,590	24,480	24,480	24,480					
2000 UWMP		22,820	21,690	23,260	24,500	25,140				
2005 UWMP			24,631	26,039	26,838	27,310	27,537	27,680		
2010 UWMP				21,196	27,879	28,384	28,605	28,751	28,895	
2015 UWMP					19,776	19,446	21,410	21,558	21,570	21,852





	Predicted Compared to Subsequent Actual Population				Change in 2015 Forecasts Compared to Previous UWMPs			
1995 UWMP	NA	NA	NA	NA				
2000 UWMP		NA	0.0%	0.0%	NA			
2005 UWMP			103.5%	109.0%	-8.5%	-8.3%	-7.5%	
2010 UWMP				104.8%	-5.9%	-6.8%	-7.8%	-9.2%

	Predicted Compared to Subsequent Actual Demand				Change in 2015 Demand Forecasts Compared to Previous UWMPs			
1995 UWMP	99.0%	99.4%	115.5%	123.8%				
2000 UWMP		88.1%	109.7%	123.9%	-22.6%			
2005 UWMP			122.8%	135.7%	-28.8%	-22.3%	-22.1%	
2010 UWMP				141.0%	-31.5%	-25.2%	-25.0%	-25.4%

Yorba Linda's 1995 and 2000 UWMPs did not contain population figures.

The 2015 UWMP indicates Yorba Linda is "a predominately single and multi-family residential community" and "the District is almost completely built-out." (p. 2-2)

Buena Park

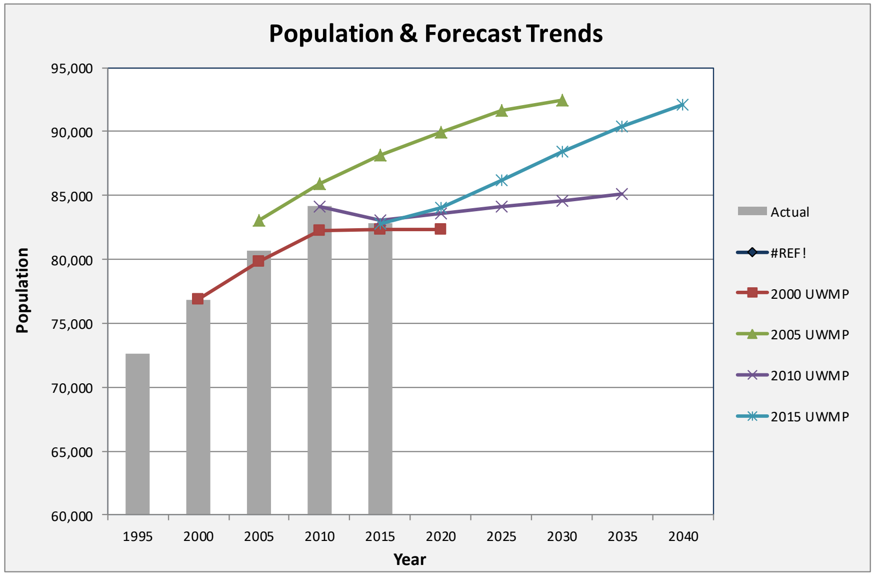
Population
Actual and Forecasted

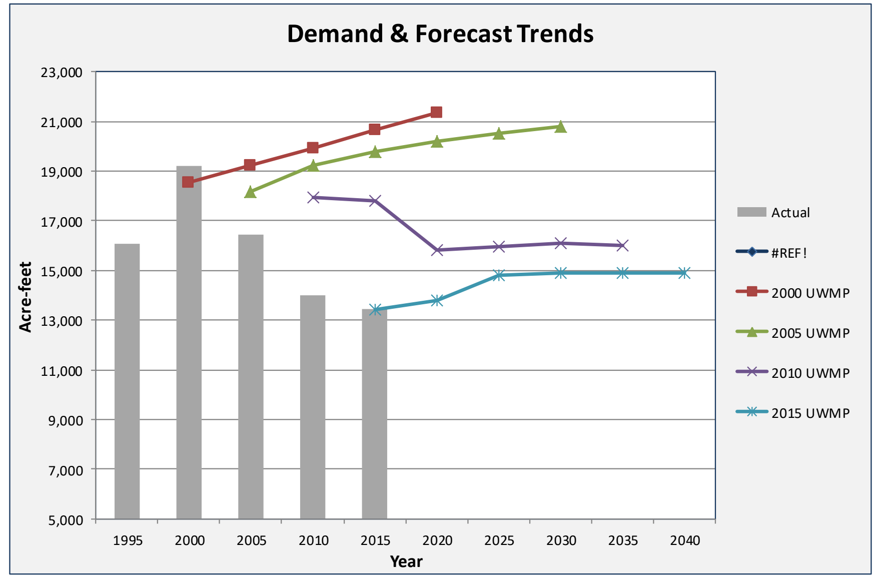
Year	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040
Actual	72,610	76,869	80,670	84,141	82,791					
2000 UWMP		76,869	79,859	82,213	82,365	82,315				
2005 UWMP			83,081	85,885	88,134	89,960	91,697	92,481		
2010 UWMP				84,141	83,100	83,600	84,100	84,600	85,100	
2015 UWMP					82,791	84,021	86,159	88,437	90,419	92,110

Demand
Actual and Forecasted (AF)

Year	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040
Actual	16,050	19,212	16,419	14,019	13,430					
2000 UWMP		18,550	19,245	19,940	20,635	21,330				
2005 UWMP			18,165	19,233	19,760	20,200	20,530	20,798		
2010 UWMP				17,958	17,800	15,820	15,970	16,079	15,984	
2015 UWMP					13,430	13,770	14,782	14,883	14,879	14,900

Buena Park's 2010 UWMP has projections with and without conservation, used figures with conservation





	Predicted Compared to Subsequent Actual Population			Change in 2015 Forecasts Compared to Previous UWMPs			
2000 UWMP	96.1%	97.7%	99.5%	2.1%			
2005 UWMP		102.1%	106.5%	-6.6%	-6.0%	-4.4%	
2010 UWMP			100.4%	0.5%	2.4%	4.5%	6.3%

	Predicted Compared to Subsequent Actual Demand			Change in 2015 Demand Forecasts Compared to Previous UWMPs			
2000 UWMP	105.9%	111.0%	153.6%	-35.4%			
2005 UWMP		107.1%	147.1%	-31.8%	-28.0%	-28.4%	
2010 UWMP			132.5%	-13.0%	-7.4%	-7.4%	-6.9%

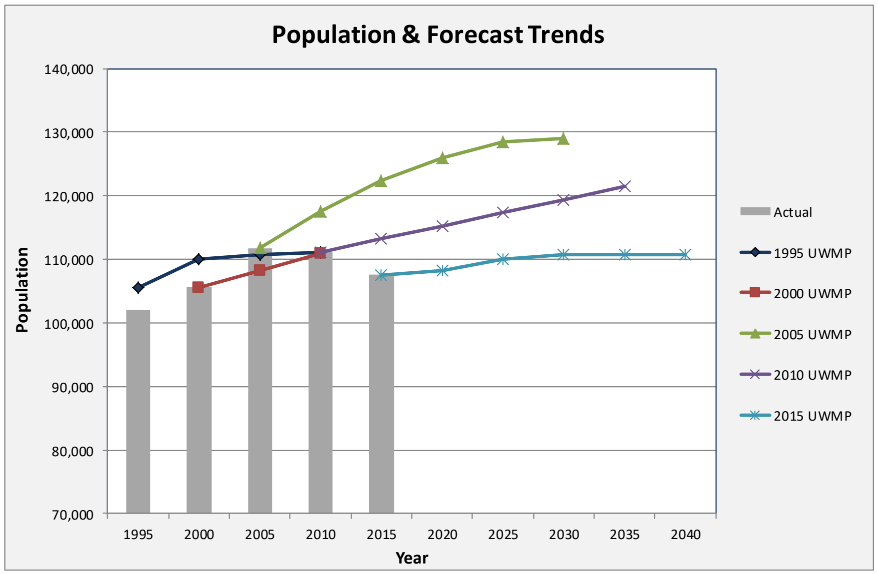
A 1995 UWMP was not available for Buena Park.

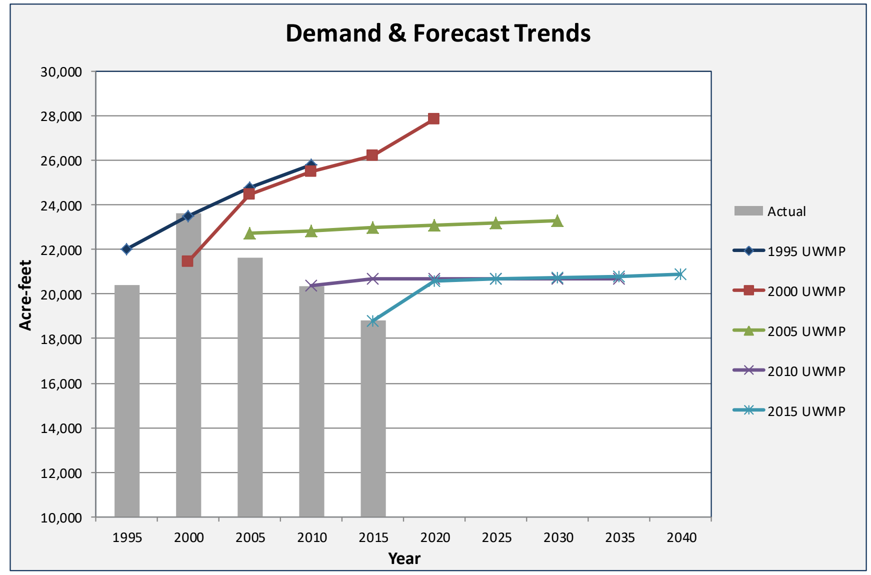
The 2015 UWMP describes the Buena Park service area as “a predominately single and multi-family residential community” and stated “housing is becoming denser and new residential units are multi-storied” and “the City is almost completely built-out" (p 2-2)

Mesa

Population Actual and Forecasted										
Year	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Actual	102,095	105,608	111,737	111,166	107,588					
1995 UWMP	105,600	110,100	110,700	111,100						
2000 UWMP		105,608	108,300	110,994						
2005 UWMP			111,737	117,492	122,301	125,952	128,483	129,098		
2010 UWMP				111,166	113,218	115,270	117,322	119,374	121,426	
2015 UWMP					107,588	108,186	109,971	110,805	110,774	110,675

Demand Actual and Forecasted (AF)										
Year	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Actual	20,406	23,610	21,620	20,370	18,802					
1995 UWMP	22,000	23,500	24,800	25,800						
2000 UWMP		21,478	24,471	25,489	26,213	27,851				
2005 UWMP			22,724	22,862	22,966	23,081	23,195	23,297		
2010 UWMP				20,370	20,685	20,685	20,685	20,685	20,685	
2015 UWMP					18,802	20,610	20,676	20,742	20,809	20,874





	Predicted Compared to Subsequent Actual Population				Change in 2015 Forecasts Compared to Previous UWMPs			
1995 UWMP	104.3%	NA	99.9%					
2000 UWMP		96.9%	99.8%					
2005 UWMP			105.7%	113.7%	-14.1%	-14.4%	-14.2%	
2010 UWMP				105.2%	-6.1%	-6.3%	-7.2%	-8.8%

	Predicted Compared to Subsequent Actual Demand				Change in 2015 Demand Forecasts Compared to Previous UWMPs			
1995 UWMP	109.4%	109.1%	126.7%					
2000 UWMP		107.7%	125.1%	139.4%	-26.0%			
2005 UWMP			112.2%	122.1%	-10.7%	-10.9%	-11.0%	
2010 UWMP				110.0%	-0.4%	0.0%	0.3%	0.6%

The 2015 UWMP indicate Mesa's service area is a "predominately residential single and multifamily community" (p. 2-2)

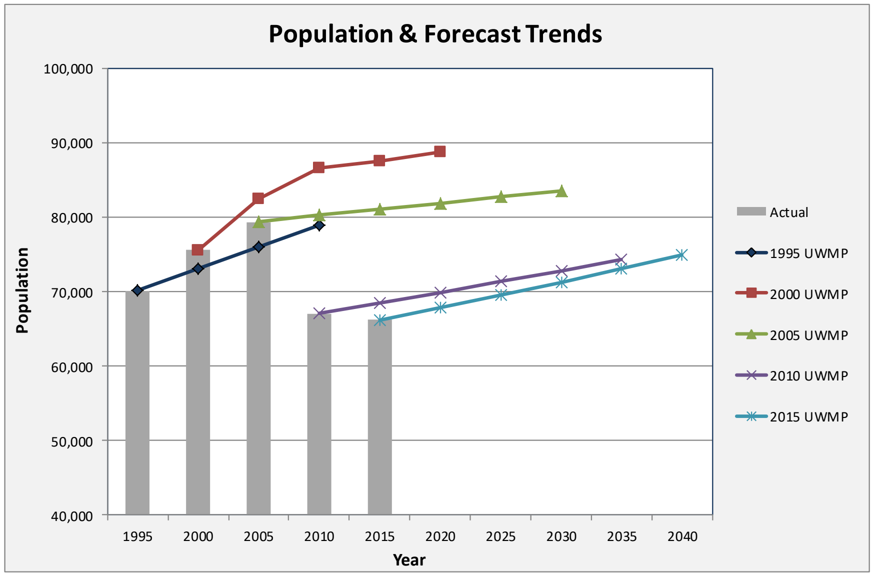
Newport Beach

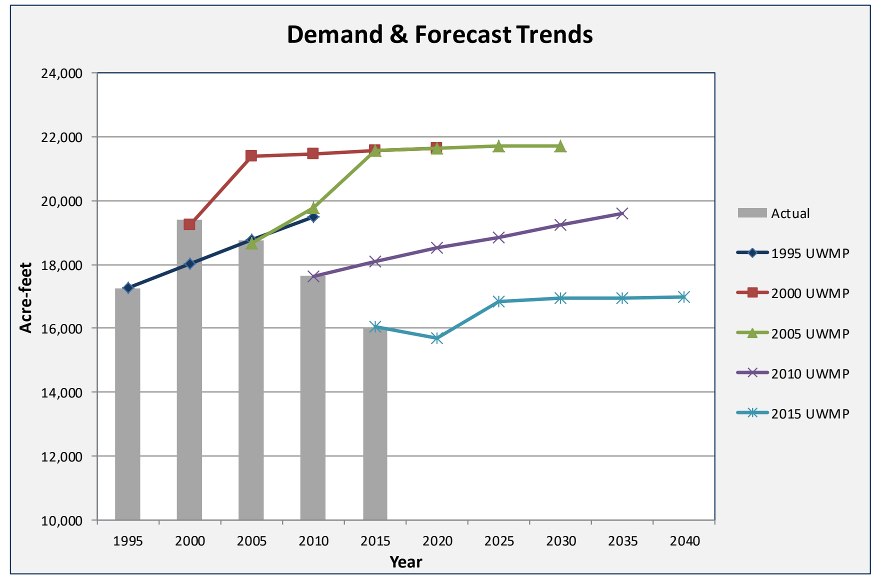
Population — Actual and Forecasted

Year	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040
Actual	70,098	75,600	79,320	67,030	66,219					
1995 UWMP	70,098	73,023	75,948	78,880						
2000 UWMP		75,600	82,409	86,579	87,457	88,676				
2005 UWMP			79,320	80,250	81,052	81,863	82,681	83,508		
2010 UWMP				67,030	68,478	69,926	71,375	72,823	74,271	
2015 UWMP					66,219	67,874	69,571	71,311	73,093	74,921

Demand — Actual and Forecasted (AF)

Year	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040
Actual	17,254	19,402	18,756	17,635	16,033					
1995 UWMP	17,254	18,004	18,754	19,504						
2000 UWMP		19,235	21,400	21,475	21,550	21,625				
2005 UWMP			18,648	19,791	21,555	21,640	21,716	21,716		
2010 UWMP				17,635	18,101	18,504	18,859	19,223	19,582	
2015 UWMP					16,033	15,685	16,838	16,953	16,944	16,973





	Predicted Compared to Subsequent Actual Population				Change in 2015 Forecasts Compared to Previous UWMPs			
1995 UWMP	96.6%	NA	117.7%					
2000 UWMP		103.9%	129.2%	132.1%	-23.5%			
2005 UWMP			119.7%	122.4%	-17.1%	-15.9%	-14.6%	
2010 UWMP				103.4%	-2.9%	-2.5%	-2.1%	-1.6%

	Predicted Compared to Subsequent Actual Demand				Change in 2015 Demand Forecasts Compared to Previous UWMPs			
1995 UWMP	93.6%	100.6%	110.6%	0.0%				
2000 UWMP		114.8%	121.8%	134.4%	-27.5%			
2005 UWMP			112.2%	134.4%	-27.5%	-22.5%	-21.9%	
2010 UWMP				112.9%	-15.2%	-10.7%	-11.8%	-13.5%

The 2015 UWMP states Newport Beach is a "predominately residential single and multi-family community located" and "housing is becoming denser and new residential units are multi-storied. Additional growth within the City will be limited development areas are at their ultimate build-out density. There is one large proposed development of the 401-acre Newport Banning Ranch that would bring residential and commercial units into the City’s Coastal Zone in a previously undeveloped area. The project has been revised several times since 2010 but has not received approval at this time." (p 2-2)

Tustin

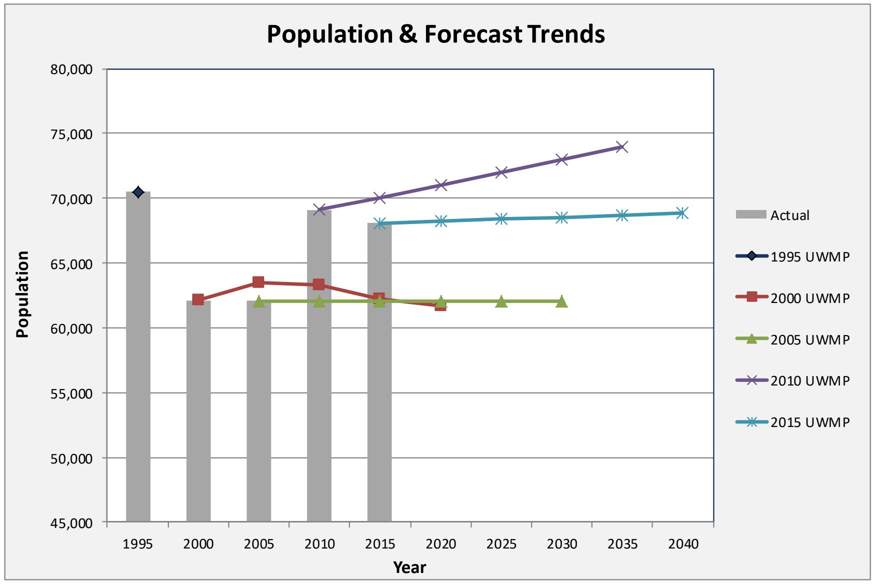
Population
Actual and Forecasted

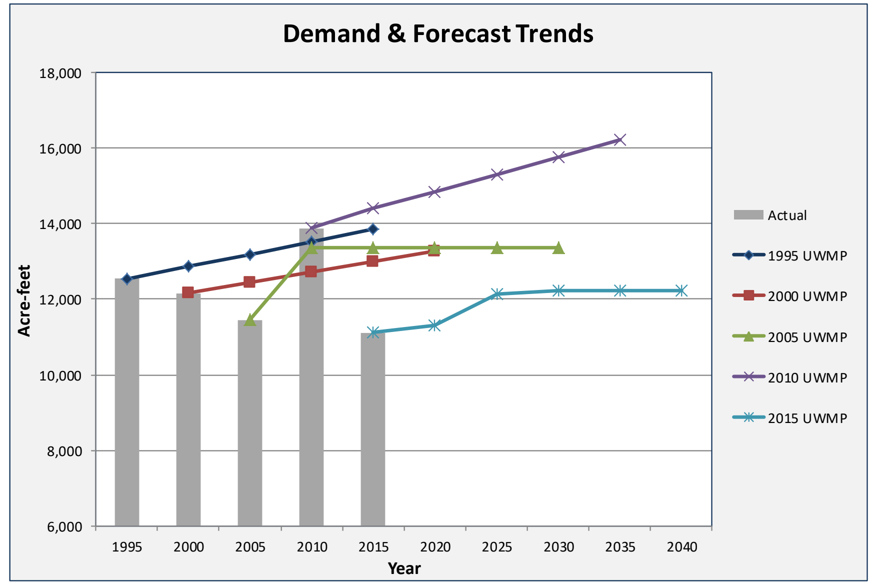
Year	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040
Actual	70,500	62,131	62,100	69,100	68,088					
1995 UWMP	70,500									
2000 UWMP		62,131	63,471	63,354	62,259	61,739				
2005 UWMP			62,100	62,100	62,100	62,100	62,100	62,100		
2010 UWMP				69,100	69,999	70,987	71,976	72,964	73,953	
2015 UWMP					68,088	68,238	68,388	68,538	68,669	68,840

Demand
Actual and Forecasted (AF)

Year	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040
Actual	12,547	12,166	11,449	13,884	11,113					
1995 UWMP	12,547	12,860	13,180	13,510	13,850					
2000 UWMP		12,166	12,429	12,705	12,989	13,282				
2005 UWMP			11,449	13,370	13,370	13,370	13,370	13,370		
2010 UWMP				13,884	14,418	14,851	15,296	15,755	16,227	
2015 UWMP					11,113	11,310	12,141	12,224	12,221	12,238

2000 UWMP figures include conservation





	Predicted Compared to Subsequent Actual Population				Change in 2015 Forecasts Compared to Previous UWMPs			
1995 UWMP	100.2%	NA						
2000 UWMP		102.2%	91.7%	88.9%	15.0%			
2005 UWMP			89.9%	91.2%	9.9%	10.1%	10.4%	
2010 UWMP				102.8%	-3.9%	-5.0%	-6.1%	-7.1%

	Predicted Compared to Subsequent Actual Demand				Change in 2015 Demand Forecasts Compared to Previous UWMPs			
1995 UWMP	105.7%	115.1%	97.3%	124.6%				
2000 UWMP		108.6%	91.5%	116.9%	-14.8%			
2005 UWMP			96.3%	120.3%	-15.4%	-9.2%	-8.6%	
2010 UWMP				129.7%	-23.8%	-20.6%	-22.4%	-24.7%

The 2015 UWMP describes the Tustin service area as "a predominately single and multi-family residential community" and states "the City's water service area is essentially built-out" and "housing is becoming denser and new residential units are multi-storied" (p 2-2)

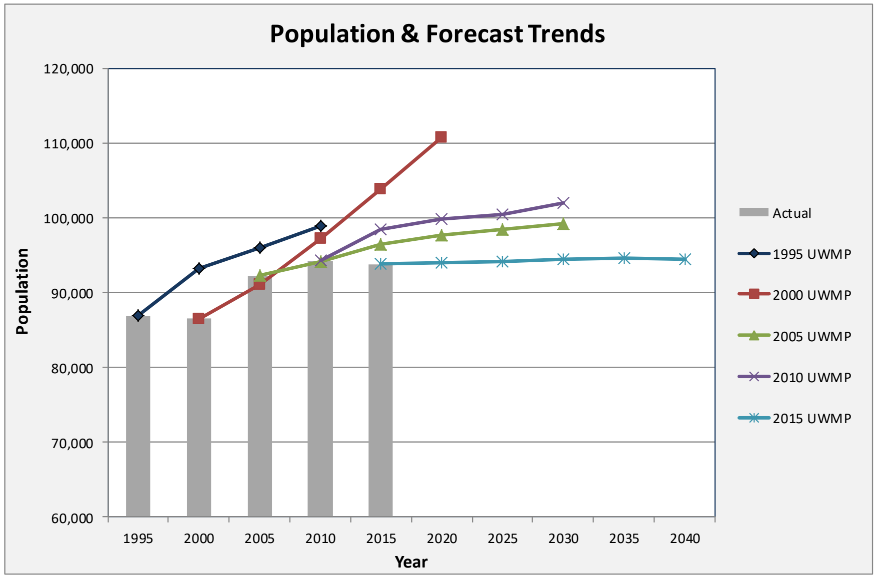
Westminster

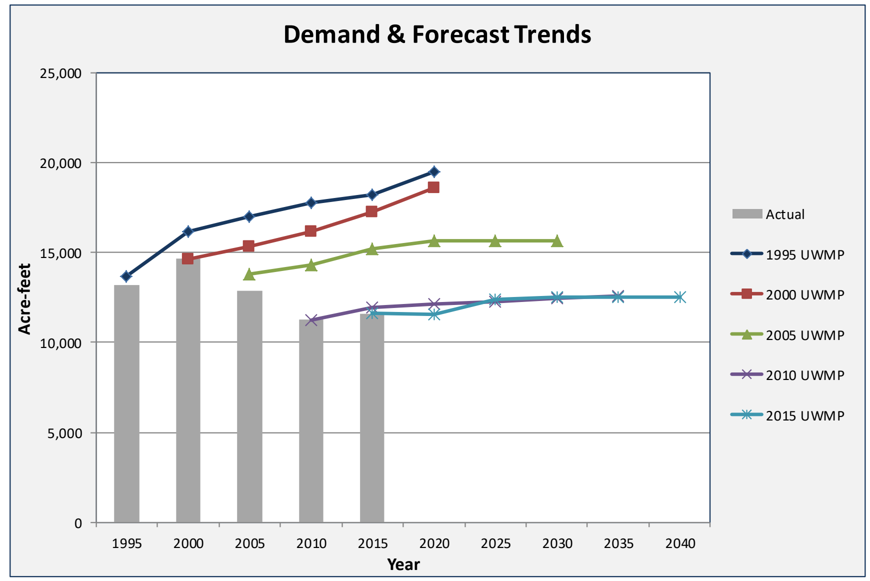
Population
Actual and Forecasted

Year	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040
Actual	86,889	86,495	92,270	94,294	93,785					
1995 UWMP	86,889	93,212	96,062	98,912						
2000 UWMP		86,495	91,117	97,244	103,782	110,775				
2005 UWMP			92,270	94,226	96,409	97,717	98,458	99,291		
2010 UWMP				94,294	98,384	99,793	100,496	102,018		
2015 UWMP					93,785	94,009	94,118	94,398	94,624	94,531

Demand
Actual and Forecasted (AF)

Year	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040
Actual	13,176	14,668	12,882	11,271	11,622					
1995 UWMP	13,679	16,200	17,000	17,800	18,250	19,500				
2000 UWMP		14,668	15,343	16,203	17,280	18,613				
2005 UWMP			13,810	14,290	15,223	15,666	15,664	15,663		
2010 UWMP				11,271	11,976	12,126	12,278	12,443	12,589	
2015 UWMP					11,622	11,577	12,427	12,512	12,509	12,527





	Predicted Compared to Subsequent Actual Population				Change in 2015 Forecasts Compared to Previous UWMPs		
1995 UWMP	107.8%	NA	104.9%	0.0%			
2000 UWMP		98.8%	103.1%	110.7%	-15.1%		
2005 UWMP			99.9%	102.8%	-3.8%	-4.4%	-4.9%
2010 UWMP				104.9%	-5.8%	-6.3%	-7.5%

	Predicted Compared to Subsequent Actual Demand				Change in 2015 Demand Forecasts Compared to Previous UWMPs			
1995 UWMP	110.4%	123.1%	157.9%	157.0%				
2000 UWMP		111.1%	143.8%	148.7%	-37.8%			
2005 UWMP			126.8%	131.0%	-26.1%	-20.7%	-20.1%	
2010 UWMP				103.0%	-4.5%	1.2%	0.6%	-0.6%

The 2015 UWMP describes the Westminster service area as "a predominately single and multi-family residential community" and states "the City is almost completely built-out" and "housing is becoming denser and new residential units are multi-storied." (p 2-2)"

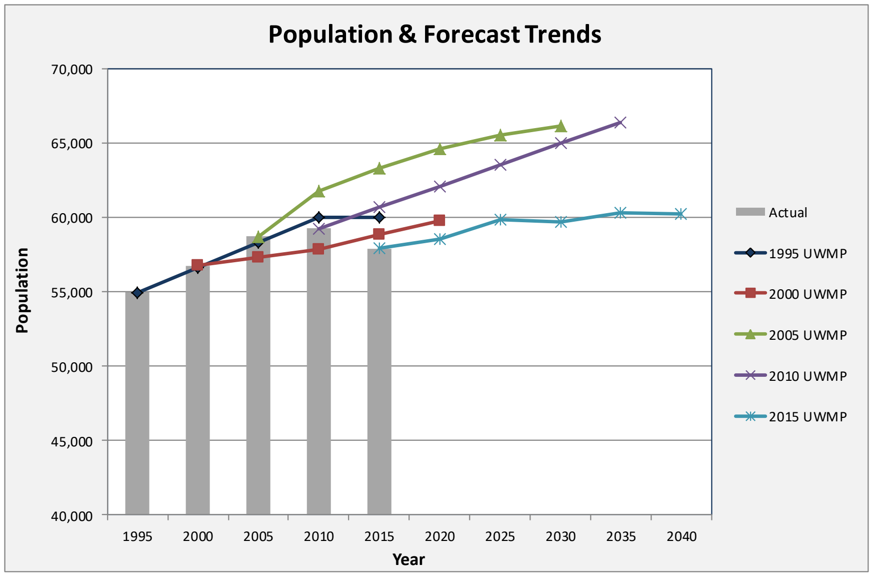
Fountain Valley

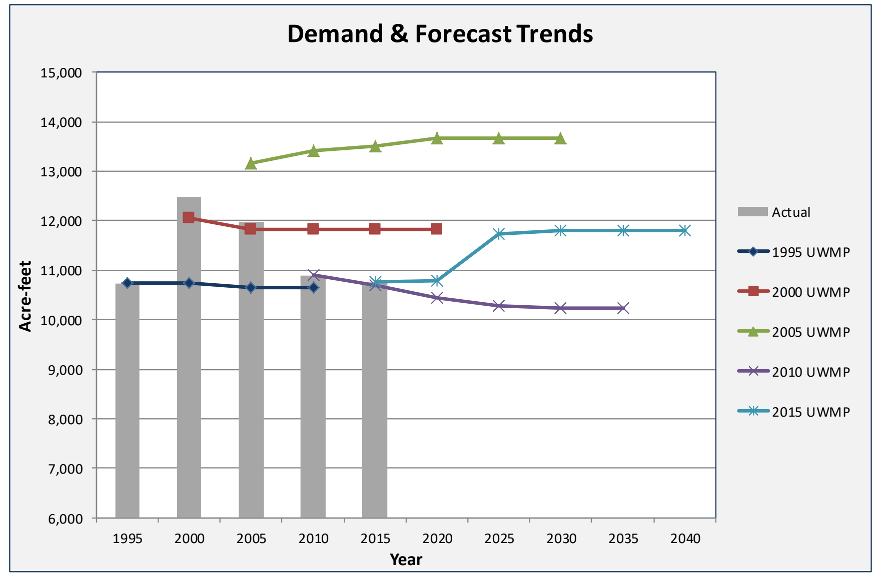
Population
Actual and Forecasted

Year	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040
Actual	54,932	56,753	58,692	59,227	57,908					
1995 UWMP	54,932	56,577	58,272	60,017	60,017					
2000 UWMP		56,753	57,269	57,811	58,836	59,735				
2005 UWMP			58,692	61,758	63,318	64,567	65,490	66,107		
2010 UWMP				59,227	60,658	62,088	63,519	64,949	66,380	
2015 UWMP					57,908	58,569	59,802	59,678	60,272	60,210

Demand
Actual and Forecasted (AF)

Year	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040
Actual	10,730	12,485	11,962	10,900	10,755					
1995 UWMP	10,730	10,750	10,650	10,650						
2000 UWMP		12,048	11,819	11,819	11,819	11,819				
2005 UWMP			13,160	13,410	13,510	13,660	13,660	13,660		
2010 UWMP				10,900	10,695	10,440	10,280	10,240	10,230	
2015 UWMP					10,755	10,778	11,741	11,800	11,800	11,800





Predicted Compared to Subsequent Actual Population / **Change in 2015 Forecasts Compared to Previous UWMPs**

1995 UWMP	99.7%	NA	101.3%	103.6%				
2000 UWMP		97.6%	97.6%	101.6%	-2.0%			
2005 UWMP			104.3%	109.3%	-9.3%	-8.7%	-9.7%	
2010 UWMP				104.7%	-5.7%	-5.9%	-8.1%	-9.2%

Predicted Compared to Subsequent Actual Demand / **Change in 2015 Demand Forecasts Compared to Previous UWMPs**

1995 UWMP	89.2%	80.9%	97.7%	0.0%				
2000 UWMP		89.8%	108.4%	109.9%	-8.8%			
2005 UWMP			123.0%	125.6%	-21.1%	-14.0%	-13.6%	
2010 UWMP				99.4%	3.2%	14.2%	15.2%	15.3%

The 2015 UWMP describes the service area as "a predominately single and multi-family residential community" and states "the City is almost completely built-out" and "housing is becoming denser and new residential units are multi-storied" (p 2-2)

Seal Beach

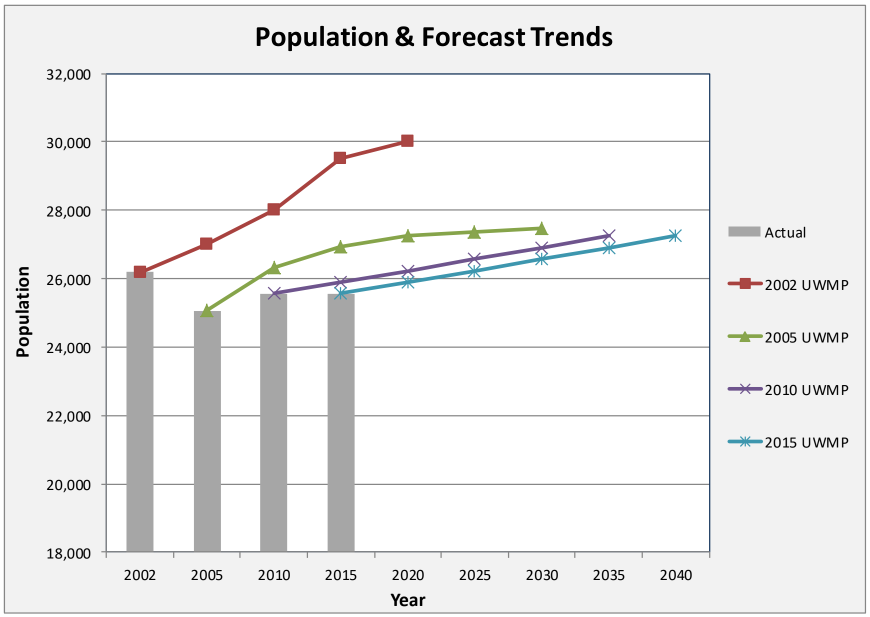
Population
Actual and Forecasted

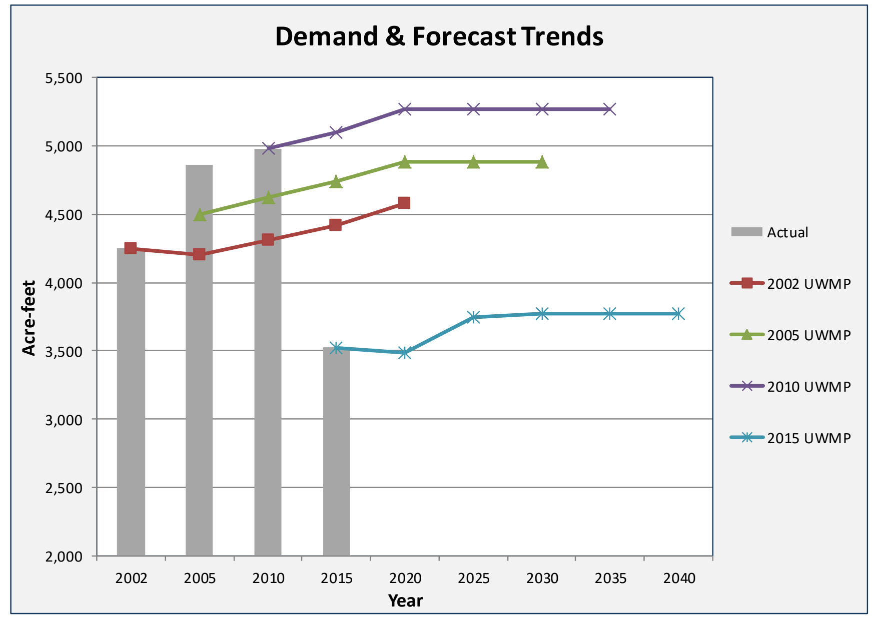
Year	2002	2005	2010	2015	2020	2025	2030	2035	2040
Actual	26,200	25,058	25,561	25,561					
2002 UWMP	26,200	27,000	28,000	29,500	30,000				
2005 UWMP		25,058	26,335	26,922	27,245	27,350	27,471		
2010 UWMP			25,561	25,895	26,223	26,570	26,906	27,242	
2015 UWMP				25,561	25,897	26,223	26,570	26,906	27,242

Demand
Actual and Forecasted (AF)

Year	2002	2005	2010	2015	2020	2025	2030	2035	2040
Actual	4,249	4,860	4,979	3,521					
2002 UWMP	4,249	4,200	4,310	4,420	4,580				
2005 UWMP		4,500	4,622	4,737	4,880	4,880	4,880		
2010 UWMP			4,979	5,098	5,270	5,270	5,270	5,270	
2015 UWMP				3,521	3,488	3,744	3,770	3,769	3,774

For 2005 and 2015 UWMPs losses not indicated, unkown if included in figures above





	Predicted Compared to Subsequent Actual Population			Change in 2015 Forecasts Compared to Previous UWMPs			
2000 UWMP	107.8%	109.5%	115.4%	-13.7%			
2005 UWMP		103.0%	105.3%	-4.9%	-4.1%	-3.3%	
2010 UWMP			101.3%	-1.2%	-1.3%	-1.2%	-1.2%

	Predicted Compared to Subsequent Actual Demand			Change in 2015 Demand Forecasts Compared to Previous UWMPs			
2000 UWMP	93.3%	86.6%	125.5%	-23.8%			
2005 UWMP		92.8%	134.5%	-28.5%	-23.3%	-22.7%	
2010 UWMP			144.8%	-33.8%	-29.0%	-28.5%	-28.5%

A 1995 UWMP was not available for Seal Beach. The 2015 UWMP indicate Seal Beach is a “"a predominately single and multi-family residential community" and states, "The City is almost completely built-out” and "housing is becoming denser and new residential units are multi-storied. A single new development within the City is moving forward on the last available piece of ocean front property. On September 9, 2015 the California Coastal Commission (CCC) approved the Ocean Place development for 28 single family residences and four overnight accommodations." (p 2-2)

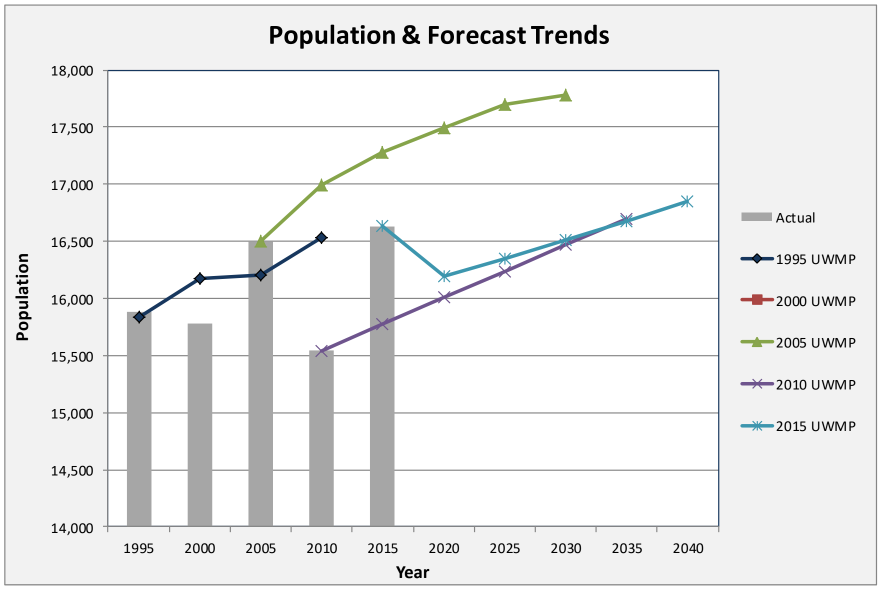
La Palma

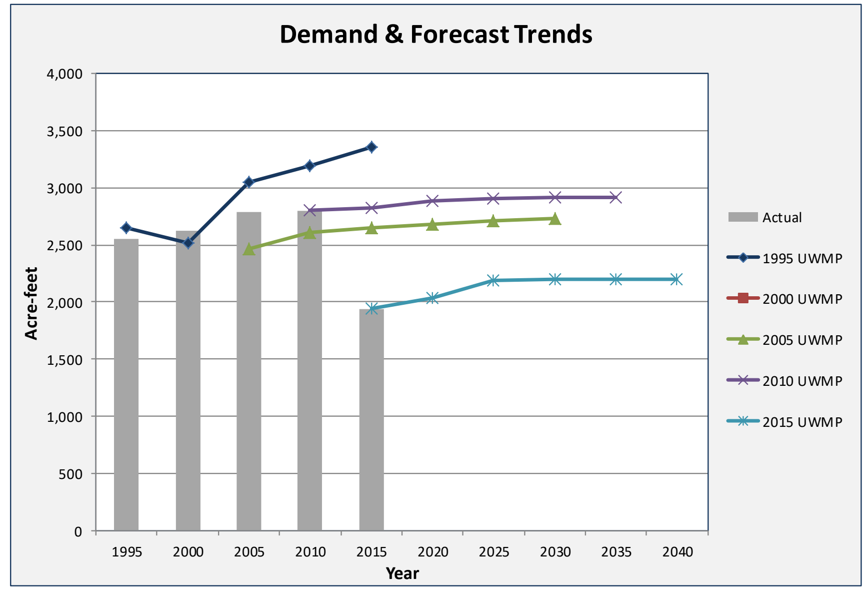
Population — Actual and Forecasted

Year	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040
Actual	15,885	15,778	16,499	15,544	16,630					
1995 UWMP	15,840	16,177	16,207	16,535						
2000 UWMP										
2005 UWMP			16,499	16,998	17,279	17,496	17,701	17,785		
2010 UWMP				15,544	15,775	16,006	16,237	16,468	16,699	
2015 UWMP					16,630	16,190	16,352	16,516	16,681	16,848

Demand — Actual and Forecasted (AF)

Year	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040
Actual	2,557	2,627	2,792	2,803	1,940					
1995 UWMP	2,645	2,518	3,044	3,196	3,356					
2000 UWMP										
2005 UWMP			2,468	2,607	2,650	2,684	2,715	2,728		
2010 UWMP				2,803	2,821	2,884	2,903	2,917	2,917	
2015 UWMP					1,940	2,036	2,186	2,201	2,200	2,204





Population: Predicted Compared to Subsequent Actual Population / Change in 2015 Forecasts Compared to Previous UWMPs

	2000	2005	2010	2020	2025	2030	2035
1995 UWMP	NA	106.4%					
2000 UWMP		NA					
2005 UWMP		109.4%	103.9%	-7.5%	-7.6%	-7.1%	
2010 UWMP			94.9%	1.1%	0.7%	0.3%	-0.1%

Demand: Predicted Compared to Subsequent Actual Demand / Change in 2015 Demand Forecasts Compared to Previous UWMPs

	2000	2005	2010	2020	2025	2030	2035
1995 UWMP	123.3%	114.0%	173.0%				
2000 UWMP	NA						
2005 UWMP		93.0%	136.6%	-24.1%	-19.5%	-19.3%	
2010 UWMP			145.4%	-29.4%	-24.7%	-24.5%	-24.6%

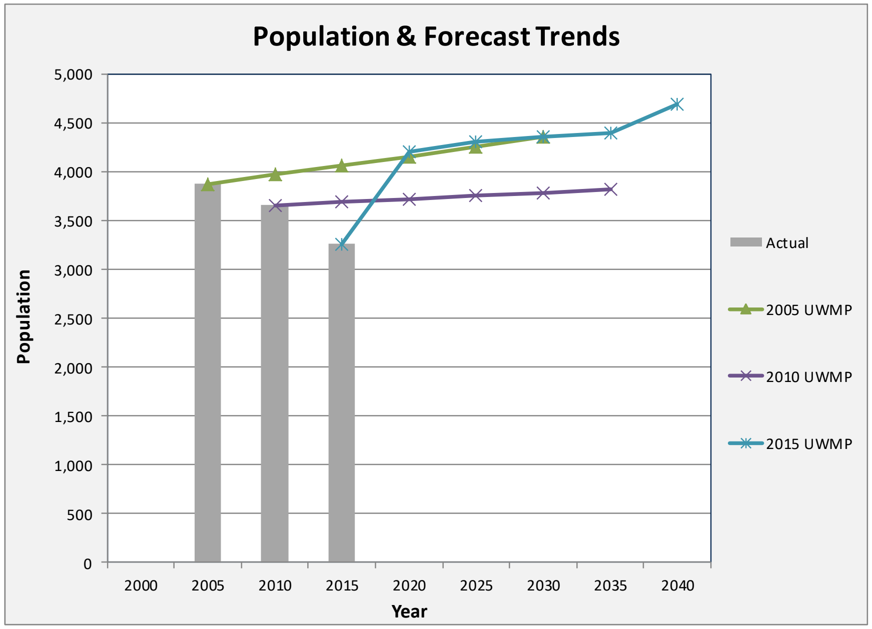
A 2000 UWMP was not available. Actual population and demand figures for 1995 and 2000 are from the 2005 UWMP.

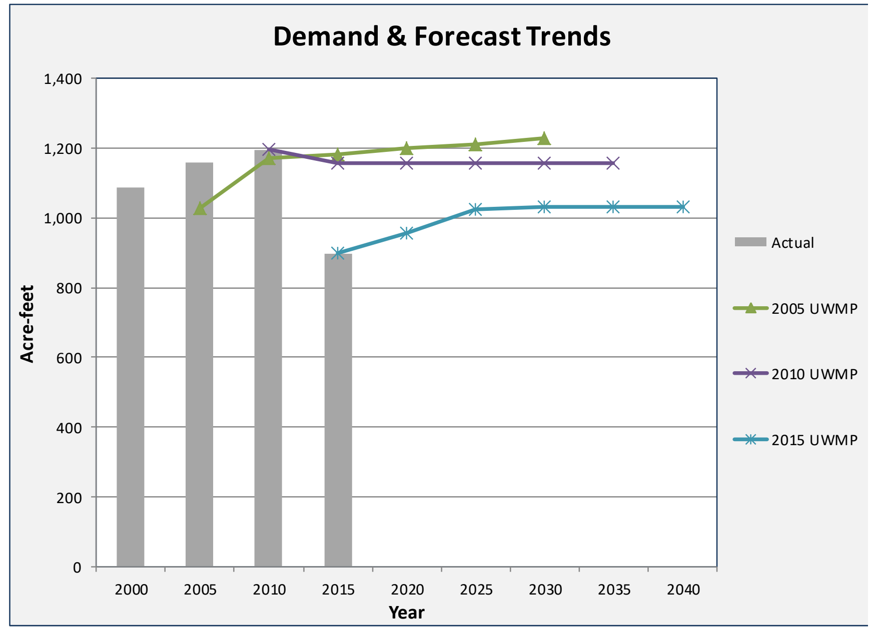
The 2015 UWMP describes the service area as “"predominately single and multi-family residential community" and “the City is almost completely built-out.” (p 2-2)

East OCWD

Population Actual and Forecasted									
Year	**2000**	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Actual		3,872	3,656	3,257					
2005 UWMP		3,872	3,970	4,060	4,150	4,250	4,350		
2010 UWMP			3,656	3,688	3,720	3,752	3,784	3,816	
2015 UWMP				3,257	4,200	4,300	4,350	4,400	4,686

Demand Actual and Forecasted (AF)									
Year	**2000**	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Actual	1,087	1,160	1,196	897					
2005 UWMP		1,026	1,170	1,180	1,200	1,210	1,230		
2010 UWMP			1,196	1,155	1,155	1,155	1,155	1,155	
2015 UWMP				897	955	1,025	1,032	1,032	1,033





	Predicted Compared to Subsequent Actual Population		Change in 2015 Forecasts Compared to Previous UWMPs			
2005 UWMP	108.6%	124.7%	1.2%	1.2%	0.0%	
2010 UWMP		113.2%	12.9%	14.6%	15.0%	15.3%

	Predicted Compared to Subsequent Actual Demand		Change in 2015 Demand Forecasts Compared to Previous UWMPs			
2005 UWMP	97.8%	131.5%	-20.4%	-15.3%	-16.1%	
2010 UWMP		128.8%	-17.3%	-11.3%	-10.6%	-10.6%

UWMPs for 1995 and 2000 were not available.

The year 2000 actual demand is from the 2005 UWMP.

The 2015 UWMP indicates , “the District’s Retail Zone can best be described as a predominately single and multi-family residential” and “the District is almost built-out with few remaining vacant lots community' (p 2-2, 2-3)

Endnotes

[1] Orange County Water District. "Long-Term Financial Plan 2014 Update." p 2-2.
[2] Ibid. p 2-2.
[3] Ibid, p 2-2.
[4] Ibid, p 2-3.
[5] Municipal Water District of Orange County. Orange County Reliability Study "Final Technical Memorandum #1, by CDM Smith." Table 7, p. 14. John Kennedy, OCWD Executive Director of Engineering and Water Resources, confirmed the comparison of demand forecasts is using the same retailer boundaries, including the 70%/30% boundary split for the Irvine Ranch Water District, in a phone communication with Joe Geever, July 26, 2016.
[6] Metropolitan Water District of Southern California. "Potential regional Recycled Water Program." Water Planning & Stewardship Committee, Item 9-1. September 21, 2015. Slide 16.
John Kennedy, OCWD Executive Director of Engineering and Water Resources, in a personal phone communication with Joe Geever confirmed the 65,000 AFY of new indirect potable recycled water expected to become available to OCWD. July 26, 2016.
[7] Metropolitan Water District of Southern California and Sanitation Districts of Los Angeles County. "Regional Recycled Water Supply Program"
[8] Metropolitan Water District of Southern California. Board of Directors, Water Planning and Stewardship Committee, Item 8-3. November 11, 2015. p. 1.
[9] MWDOC. Reliability Study "Draft Technical Memorandum #4, by CDM Smith." Table 3. June 27, 2016. p. 9.
[10] Reliability Study, Technical Memo #1. p. 1.
[11] Ibid. p. 5.
[12] Ibid. p. 7.
[13] Ibid. p. 7.
[14] Ibid. p. 9, 10, 11.
[15] Fryer, James. "An Assessment of Demand Elasticity during Drought." 2013, revised 2016. See phone survey question responses in Section V, and in particular Question 7 starting on page V-11, and Question 15 starting on page V-27.
[16] Reliability Study, Technical Memo #1. p. 6.
[17] Ibid. p. 7.
[18] California State Water Resources Control Board. "suppliercompliance_020216"
http://www.waterboards.ca.gov/water_issues/programs/conservation_portal/conservation_reporting.shtml#monthly_archive
[19] Reliability Study, Technical Memo #1. p. 9.
[20] Fryer, James. "An Assessment of Demand Elasticity during Drought." 2013, revised 2016. p. III-14, F-6.
[21] Ibid
[22] Ibid. See phone survey question responses in Section V, and in particular Question 7 starting on page V-11, and Question 15 starting on page V-27.
[23] Reliability Study, Technical Memo #4, p. 17 and 31.
[24] Reliability Study, Technical Memo #1., p. 7.
[25] Fryer, James. "Demand Elasticity During a Drought - How Long-Term Conservation Programs Can Offset Demand Hardening During Droughts, and How to Integrate This Into Supply Reliability Planning." Conserv99 Proceedings. 1999. p. 2 and 3.
[26] "An Assessment of Demand Elasticity during Drought" p. A-9.
[27] "An Assessment of Demand Elasticity during Drought" p. III-13.
[28] "An Assessment of Demand Elasticity during Drought" See phone survey question responses in Section V, and in particular Question 7 starting on page V-11, and Question 15 starting on page V-27.

[29] Reliability Study, Technical Memo #1, Figure 6, p. 7.
[30] The Semmelweis Reflex is a metaphor for the reflex-like tendency of rejecting new information or evidence without serious consideration because it contradicts with preconceived beliefs and prevailing norms or paradigms at the time. The metaphor refers to the professional experiences of Dr. Ignaz Semmelweis (1818 – 1865) who developed empirical evidence that childbirth patients handled by doctors that carefully washed their hands in a chlorine solution between patients and after an autopsy experienced a dramatically reduced rate of infectious disease. At the cost of many lives, Dr. Semmelweis' evidence was widely rejected by doctors at the time because germ theory was not understood until several decades later so no exact mechanism could be described, other theories of disease prevailed, and many doctors were offended and scoffed at the idea that a gentleman's hands could communicate disease.
See:
https://en.wikipedia.org/wiki/Semmelweis_reflex
https://en.wikipedia.org/wiki/Ignaz_Semmelweis
[31] Fishman, Charles. "How California is Winning the Drought." The New York Times, August 14, 2015.
[32] "An Assessment of Demand Elasticity during Drought" p. IV-4.
[33] Ibid. p. IV-6.
[34] Ibid. p. VI-8, VI-9.
[35] Ibid. p. VI-9.
[36] Ibid, p. VI-5.
[37] Reliability Study, Technical Memo #1, p. 6.
[38] Municipal Water District of Southern California. "2015 Urban Water Management Plan." p. 2-3.
[39] "An Assessment of Demand Elasticity during Drought" p. VI-9.
[40] Reliability Study, Technical Memo #1, p. 4, 5.
[41] "An Assessment of Demand Elasticity during Drought." See Section VIII, "Trends in the Marginal Price of Water," starting on page VIII-1.
[42] Reliability Study, Technical Memo #4, p. 30.
[43] Crouch, Dennis. Law Professor at the University of Missouri School of Law. Co-director of the Center for Intellectual Property and Entrepreneurship. "Tracing the Quote: Everything that can be Invented has been Invented." January 6, 2011Dennis Crouch
http://patentlyo.com/patent/2011/01/tracing-the-quote-everything-that-can-be-invented-has-been-invented.html
[44] "The Friend" Volume 76, 1902, as quoted in Wikipedia, https://en.wikipedia.org/wiki/Charles_Holland_Duell)

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(Poseidon Water, Huntington Beach)

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February 11, 2022

Sent via Electronic Mail
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tom.luster@coastal.ca.gov

California Coastal Commission ("Commission")
Attn: Mr. Tom Luster, Ms. Noaki Schwartz
445 Market Street, Suite 300
San Francisco, CA 94105

Re: Poseidon Resources, LLC; Seawater Desalination Project at Huntington Beach; Application for Coastal Development Permit; Appeal of Coastal Development Permit; 21730 Newland Street, Huntington Beach

Dear Mr. Luster, Ms. Schwartz, Commission Staff, and Honorable Commissioners,

The University of California, Irvine School of Law Environmental Law Clinic submit this letter on behalf of Azul concerning the Commission's review of the coastal development permits ("CDPs") sought by Poseidon Resources, Inc. for the Seawater Desalination Project at Huntington Beach ("Project"). Azul is a grassroots, nonprofit organization that works to address the lack of Latinx involvement in ocean conservation and coastal policy. Since 2011, Azul has led efforts to reduce ocean pollution and center environmental justice in coastal decision-making in California and beyond. Throughout the Commission's consideration of the Project, Azul has steadfastly advocated on behalf of environmental justice communities that would be disproportionately burdened by the negative environmental and financial impacts of the Project if the CDPs are approved.

If approved, the construction, development, and operation of the Project would become a significant burden and hazard to environmental justice ("EJ") communities, sensitive populations, fenceline communities, the unhoused population, educational institutions, and the entire population of North Orange County, in both life and property. The construction risks are many and severe given the long history of toxic uses on the project site and the neighboring industrial sites, as well as due to the inherently dangerous construction efforts that the Project assumes. The operational risks are many and severe, with the greatest risk being the contamination of the entire water supply of North Orange County. Virtually none of these risks have been addressed in the Project application, and those that have were treated as minor, with no mitigation plans or alternatives offered, with false declarations like "even extreme coastal and geotechnical hazard worst-case scenarios are not expected to present a significant risk to the Project's structural stability or to public health and safety."[1] Throughout the voluminous Project application, one conclusion does emerge: the applicants seem wholly unconcerned with the health and safety of the humans that are implicated in this Project; their sole concern is to build the Project at the least cost possible in order to make the highest margin on their for-profit sale of water to ratepayers in North Orange County.

For the above stated reasons, the Commission should deny the Project permit outright. The opportunity to cure the massive environmental justice failings within the application and the disregard for life and property throughout should have been cured prior to the March 17 hearing and cannot be cured in an expedited fashion. The failings are material, fundamental, and dispositive; the duty to cure them was the applicant's and that should directly accrue to a denial of the CDPs, not an allowance for more time. The Project applicant has had the better part of a generation to do this the right way. They have failed. The Commission can affirm that clearly in the rejection of this deeply faulty and incredibly dangerous Project application for CDPs.

Upon review of the application and the documents submitted by the applicant to affirm this Project, the extent of EJ issues and the range of communities affected by the Project would be impossible to cover in perfect detail given the proximity to the hearing and the need to submit this document in advance of the February 18 staff report. As such, we will only flag the major issues in a number of categories as we see them. We would also like to reaffirm the findings and conclusions in the legal opinion letter submitted by Chatten-Brown, Carstens & Minteer LLP on behalf of California Coastal Protection Network et al.

In short, we believe the Project violated numerous provisions of the California Coastal Act ("CCA"), the Huntington Beach Local Coastal Program ("LCP"), the California Environmental Quality Act ("CEQA"), the National Environmental Policy Act ("NEPA"), and the Environmental Justice Laws for the State of California.[2] The applicant provided inadequate and faulty analysis of impacts to affected communities in regards to extreme weather, natural disasters, sea-level rise, industrial disasters, and from the known burdens of construction and operations. In all likelihood, never has a nearly 3000 page permit application been so shallow on the areas that should concern the commission the most: risks to life and property.

We strongly urge the Commission to deny the Project's CDPs.

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[1] Letter to Mr. Tom Luster, California Coastal Commission from Mr. Scott Maloni, Poseidon Water (July 7, 2021) in *Application for Coastal Development Permit*, Poseidon Water at 7 (2021).

[2] California Senate Bill No. 1000 Land use: general plans: safety and environmental justice (2016); California Assembly Bill No. 2616 California Coastal Commission: environmental justice (2016); California Assembly Bill No. 1628 Environmental Justice (2019)

I. The Environmental Justice Communities and Sensitive Populations at Risk from the Project are Many.

a. The Project Service Area Is All of North Orange County, the Zone of Risk for the Project.

Since the Project does not have a buyer for the water it would produce, the desalinated water will be discharged into North Orange County groundwater. Recharging desalinated water through injection wells would massively increase the salt load within the OC water basin, lowering the quality of the water, and increasing problems associated with the pollutant (salt). This implicates all EJ communities and sensitive populations, both directly adjacent and further afield of the proposed project site (see addendum) given that the entire region's residents are taxpayers, and California state revenue, generated from taxes, will be granted to the Project, and all ratepayers, since the water will go to the entire North OC groundwater supply—anyone in the region will have their water rates affected by the Project—and finally, because every resident relies on that singular source of water, any toxic implications from the Project that negatively affect the water supply will affect all residents. Wealthy communities will be able to afford additional water filtration at the home; low-income communities will not, especially when the water costs will also rise significantly. The scope of the EJ analysis should therefore include all residents and areas of North Orange County that qualify as EJ communities or sensitive populations.

b. EJ Communities throughout North OC Are in the Zone of Risk.

Many disadvantaged communities exist in North OC such that the Project implicates significant environmental justice concerns. "Disadvantaged communities" was defined in SB 1000 as an area identified by CalEPA pursuant to Health and Safety Code § 39711 or "an area that is a low-income area that is disproportionately affected by environmental pollution and other hazards that can lead to negative health effects, exposure, or environmental degradation."[3] The Commission's EJ policy is broader and encompasses not only the definitions of "disadvantaged communities" under SB 1000, but also references "marginalized" and "underserved" communities, such that "low-income communities and communities of color that are disproportionately burdened by or less able to prevent, respond, and recover from adverse environmental impacts" are also protected.[4]

The addendum to this document includes the many EJ communities and sensitive populations that exist in the zone of risk with maps depicting the type of burdens they currently

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[3] *Supra* note 1; Disadvantaged communities are defined by CalEPA as those within the highest 25% of census tracts for CalEnviroScreen (CES), those census tracts scoring in the top 5% of the Pollution Burden indicator but without an overall CES score due to data unreliability or unavailability, all census tracts identified as disadvantaged but not scoring in the highest 25% of census tracts in CES, and all areas within federally recognized tribal boundaries (*Preliminary Designation of Disadvantaged Communities Pursuant to Senate Bill 535*, California Environmental Protection Agency at 2 (2021).

[4] *California Coastal Commission Environmental Justice Policy*, California Coastal Commission at 4 (2019). https://documents.coastal.ca.gov/assets/env-justice/CCC_EJ_Policy_FINAL.pdf.

face, burdens that should be analyzed in light of the cumulative impacts that would compound if the Project were to be permitted, allowing for demolition, construction, and operation. The Project applicant has performed virtually none of this analysis, made no effort to mitigate these risks nor genuinely assess alternatives. This failure alone should require a denial of CDPs.

Not only are all EJ communities in North OC within the zone of risk because they are taxpayers and ratepayers, but also because the Project puts at risk the entire water supply of North OC given the inherent risks in developing the Project within a toxic brownfield. The project site itself, and the surrounding parcels are highly toxic lands that the Project requires development in and through. Any time a brownfield is developed, there are risks to the surrounding communities, but particularly in this instance as the Project will be pumping 50 million gallons of water per day into the North OC groundwater supply. If the soil surrounding the pipes, known to be highly toxic from historic uses, were to intrude the pipes, the result would be the toxification of the entire North OC water supply. These downside risks are so vast that the only comparable tragedy would be that of Flint, Michigan, where tens of thousands of residents there were poisoned with lead and other heavy metals.[5]

c. Many Schools Are within the Zone of Risk for the Project.

The two most proximate educational institutions to the project site are Edison High School and Eader Elementary School, together serving around 3000 students ranging from Kindergarten to 12th grade.[6] Edison High School has an award-winning program for students with developmental disabilities which serves high school students age 14-18 as well as adult students age 18-22.[7] More than 100 teachers and staff serve these schools on a daily basis.[8] These schools are within 1 city block of the project site and must be included in any analysis of the risks facing surrounding communities and mitigation plans to reduce those risks. The Project applicant fails to perform any analysis whatsoever in regards to at-risk schools and instead claims that no schools are at risk.

The Edison Community Center and Edison Park are directly across the street from the project site and are one of the largest park areas in North OC. The sites have tennis courts, soccer fields, walking paths, and are used by the aforementioned Special Needs Program. They also include a parking lot that many student at Edison HS use to park and therefore access on

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[5] Flint Water Advisory Task Force, *Flint Water Advisory Task Force Final Report* at 1, 54 (2016). https://www.michigan.gov/documents/snyder/FWATF_FINAL_REPORT_21March2016_517805_7.pdf. (finding that "Flint water customers were needlessly and tragically exposed to toxic levels of lead and other hazards through the mismanagement of their drinking water supply." In its environmental justice analysis, the Task Force considered environmental justice to be "about process and results – fair treatment, equal protection, and meaningful participation in neutral forums that honor human dignity." The Task Force subsequently found that "the facts of the Flint water crisis lead us to the inescapable conclusion that this is a case of environmental injustice.")

[6] Edison High School, *Public School Review*. https://www.publicschoolreview.com/edison-high-school-profile/92646; John H. Eader Elementary School, *Public School Review. https://www.publicschoolreview.com/john-h-eader-elementary-school-profile.*

[7] About SAC, *Edison High School*. https://www.edisonchargers.com/apps/pages/index.jsp?uREC_ID=1557601&type=d&pREC_ID=1685896.

[8] *Supra* note 3.

weekdays. The area already deals with methane emissions and subsidence issues since it was built on a former landfill.[9]

Within the zone of risk, there are over 80 high schools, 70 middle schools, 300 elementary schools that use the North OC groundwater as a source of water.[10] More than 10 YMCA facilities, which often act as hubs of recreation, health, and education for EJ communities, are located within the zone of risk.

d. Many Senior Living Facilities Are within the Zone of Risk for the Project.

A very significant senior living facility, the Huntington Landmark Senior Adult Community, with approximately 2000 senior residents is just one city block away from the Project site, and includes much outdoor space and porches for the residents to enjoy.[11]

The Cabrillo Mobile Homes and the Huntington by the Sea Mobile Estates as well as the RV Park are immediately adjacent to the Project site. The mobile home communities began as senior living, and while private equity firms have since purchased the real estate, they both are still predominantly occupied by long term senior residents. The Cabrillo homes are further at risk due to older facilities that have single-paned windows that are already known to be quite porous and do not block construction noise generated at the Project site.

II. The Project Application Fails on Numerous Procedural Environmental Justice Grounds.

a. The California Coastal Commission Has Extensive Authority under Its EJ Policy to Deny the CDPs.

The Commission's EJ Policy, Coastal Act Section 30604(h), states, "When acting on a coastal development permit, the issuing agency, or the Commission on appeal, may consider environmental justice, or the equitable distribution of environmental benefits throughout the state."

The EJ Policy further articulates environmental justice concepts: "The term 'environmental justice' is currently understood to include both substantive and procedural rights, meaning that in addition to the equitable distribution of environmental benefits, underserved communities also deserve equitable access to the process where significant environmental and land use decisions are made."

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[9] *Edison Park Waste Delineation*, Geosyntec Consultants (2021). https://www.huntingtonbeachca.gov/files/users/info_systems/Edison-Geotechnical-Report.pdf.

[10] *See OCWD service area*, Orange County Water District. https://www.ocwd.com/media/4436/district-service-area_cities.jpg; *Orange County Schools and Districts*, https://www.arcgis.com/apps/webappviewer/index.html?id=c81a8f6f6b544b7f87b96ae3d7ffd27c.

[11] Huntington Landmark, https://www.huntingtonlandmark.com/

b. The Project Applicant Has Not Met Its Procedural Obligations for Meaningful Public Participation.

The Project has been in the works for over twenty years, what is considered an entire generation of human life. Yet the applicant has never engaged any EJ community or sensitive population in meaningful public participation. This lack of engagement is evidenced by the complete lack of support from any of those groups for the Project and also by the applicant's failure to even acknowledge any of these communities might be harmed by the Project. At no point has the applicant voluntarily translated the document record or their submissions into the three most predominant languages spoken in North OC other than English, namely, Spanish, Vietnamese, and Korean.[12] Their nearly 3000 page application is virtually impossible for a lay community with English as a second language to parse, comprehend, and provide comment or feedback on. Project applicant has failed in every regard to engage the community in the process.

Despite two decades of planning, the Project applicant has not engaged in any listening session or official conversation with the EJ communities in the zone of risk. For example, in the context of Tribal consultation concerning impact on tribal cultural resources, "[o]utreach letters were mailed to 13 Tribal members identified by the NAHC . . . No responses were received" (Final Supplemental EIR - ORC 1980.1 Lease Amendment at 4-110). This is not sufficient outreach or engagement to satisfy Tribal consultation requirements in 2022. In its Tribal Consultation Policy, the Commission considers "consultation" to mean "the meaningful and timely process or seeking, discussing, and considering carefully the views of Tribes" and that "consultation" "should not be viewed as a 'one-time, one-meeting activity,' but rather an interactive process."[13] The Project outreach does not appear consistent with "meaningful engagement" as understood in the 2019 Commission EJ Policy, which "acknowledges the need to communicate consistently, clearly, and appropriately with environmental justice groups and underserved communities" and recognized the importance of "mak[ing] additional efforts to inform these communities."[14]

Given the risks to EJ communities, and in fact, to every North OC resident, outlined in this letter and in the Azul briefing book, the Project CDPs must be denied.

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[12] There are federal and state laws that govern the translation of documents for government funded projects and programs. Federally, Executive Order 13166 interprets and enforces Title VI of the Civil Rights Act to require that recipients of Federal financial assistance "must take reasonable steps to ensure meaningful access to their programs and activities by LEP persons." (Executive Order 13166, reprinted at 65 Fed. Reg. 50121 (Aug. 16, 2001)). At the California state level, the California Civil Rights Act requires, inter alia, that recipients of state financial assistance shall provide equal access to benefits without regard to the person's race, color, national origin, or ethnic group identification (Cal. Gov't. Code § 11135(a)). Also, California's Bilingual Services Act requires local agencies that serve a substantial number of non-English-speaking people to provide certain information and render certain services in a language other than English (California Assembly Bill No. 305 (2011)).

[13] *California Coastal Commission Tribal Consultation Policy*, California Coastal Commission at 4, fn4 (2018). https://documents.coastal.ca.gov/assets/env-justice/tribal-consultation/CCC%20Tribal%20Consultation%20Policy%20Adopted%208.8.2018.pdf.

[14] California Coastal Commission Environmental Justice Policy, California Coastal Commission at 6 (2019). https://documents.coastal.ca.gov/assets/env-justice/CCC_EJ_Policy_FINAL.pdf.

III. The Project Application Fails on Numerous Substantive Environmental Justice Grounds.

a. Like the Carlsbad Plant, the Project Will Increase Water Costs to Ratepayers and Small Businesses.

The Project applicant has frequently refrained from promising any real cost savings for local ratepayers despite numerous state and federal subsidies. The applicant has employed a "wait and see" strategy to determining costs, claiming that it is too difficult to determine the exact costs pre-operations. But their own analog is in San Diego, in the form of the Carlsbad Desalination Plant that has increased the local costs of water to such an extent that it is now some of the costliest in the country.[15] Project applicant has given no indication or evidence to show that this Project would yield a different result. Indeed, to the contrary, a recent analysis by researchers at UCLA concluded that "the Poseidon agreement will likely make water for disadvantaged households in Orange County moderately to severely less affordable."[16] Specifically, the authors found that "no reasonable set of [Municipal Water District of Orange County] cost increases would make Poseidon agreement water competitive with imported water within the next decade."[17] Increased water costs are like a regressive tax, hitting lowest income residents the hardest. At the same time, the area has seen small businesses suffer greatly during the pandemic, and it is these small business, dependent on affordable water, whether in the food, clothes, cut flower, or the many industries implicated, that would be hit the hardest by drastic increases in water costs. Small businesses are also more likely to be owned by residents of color. Put simply, the Project will directly harm EJ communities due to the inevitable increase in the cost of water that would result.

b. The Greenhouse Gas Emissions (GHGs) Resulting from the Construction and Operations of the Project Are Borne Most by EJ Communities.

The Project will not be run by clean, green, alternative energies, despite the California state mandates that all new industrial projects should be[18], and instead will run on energy generated at the next door AES gas plant. The GHGs emitted in the course of operations will make the water that is produced nothing short of "dirty water."[19] It is clear that EJ communities

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[15] *San Diego County Water Authority Board Meeting Documents September 26, 2019, San Diego County Water Authority* at 45 *(2019). (https://www.sdcwa.org/sites/default/files/2016-12/Board/2019_Agendas/2019_09_26FormalBoardPacketSEC_0.pdf#page=41. (reporting that in 2018/2019 water from the Carlsbad Desalination Plant had an average unit cost $2,685 per acre-foot).*

[16] *Analyzing Southern California Supply Investments from a Human Right to Water Perspective: The Proposed Poseidon Ocean Water Desalination Plant in Orange County*, UCLA Luskin Center for Innovation at 2 (2019) https://innovation.luskin.ucla.edu/wp-content/uploads/2019/04/Analyzing_Southern_CA_Supply_Investments_from_a_Human_Right_to_Water_Perspective.pdf.

[17] *Id.* at 21.

[18] CA PRC § 30253 - energy use minimization requirements

[19] But the "dirty water" moniker is not only apt for the production strategy of the Project; the water is also dirty to drink, in that it would contain elevated levels of salt, boron, mercury, and other heavy metals naturally occurring in ocean water, as well as pollutants found there from a century of toxic industrial practices. The water is dirty for a

already bear the greatest burden in regards to GHG caused climate change and that reality will undoubtedly continue into the future.[20] This Project will add to that burden for its 50 year lifespan, only contributing to the global climate catastrophe, and exacerbating problems borne disproportionately by EJ communities in terms of flooding, the heat island effect, erosion, food deserts, etc.

The Yorke Report within the application admits that GHGs "primarily carbon dioxide (CO2), methane (CH4), and nitrous (N2O) oxide, collectively reported as carbon dioxide equivalents (CO2e) – are directly emitted from stationary source combustion of natural gas in equipment such as water heaters, boilers, process heaters, and furnaces."[21] It also goes on to list the other GHGs emissions that will result from the project, from "equipment burning gasoline" and other fuels, yet neither the report nor the Project application connects these emissions with the EJ communities they will affect the most; the application also fails to mitigate these risks or address alternative options, like producing electricity needed to run the facility with alternative energy.

c. Plastic Waste Resulting from Project Operations Will Harm EJ Communities the Most.

Over thirty years of research into environmental justice has shown unequivocally that landfills and waste management facilities are most often sited in or near EJ communities.[22] That is no different in North OC (see addendum).

The Project will employ 16,000 plastic membranes as part of its operations, requiring routine replacement. Those membranes are not recycled material, or recyclable, meaning they will enter the waste stream, which will impact EJ communities most. As the membranes degrade,

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third reason: it will be dirty to swim in. The elevated toxins will be dumped back into the ocean, unmitigated, every day of the year for 50 years, potentially creating dead zones in the ocean and harming swimmers there of all types, human and animal. In total, the Project will not yield 50 million gallons of clean, potable water every day, but 50 million gallons of toxified water that must be blended with potable water for drinkability, is produced with dirty energy, and makes the ocean dirtier.

[20] *Toxic Tides: Sea Level Rise, Hazardous Sites, and Environmental Justice in California*, Toxic Tides, https://sites.google.com/berkeley.edu/toxictides. (finding that in California "disadvantaged communities are over 5 times more likely to live within 1km of one or more [hazardous] facilities at risk of flooding in 2050, and over 6 times in 2100" and concluding that "climate resilience strategies must address the disproportionate impacts of SLR and associated flooding threats faced by environmental justice communities."); *More than 400 toxic sites in California are at risk of flooding from sea level rise*, Los Angeles Times (Nov. 30, 2021) https://www.latimes.com/environment/story/2021-11-30/toxic-tides-sea-level-rise (quoting UCLA environmental health scientist that "'We know from past flood events that wealthy communities are not the ones that suffer the greatest impacts,' Cushing said, pointing to recent disasters in New Orleans and Houston. 'The vulnerabilities of environmental justice communities to sea level rise have not been front and center in the conversation in a way that it should be.'")

[21] *Final Report – CEQA Support – Air Quality and Greenhouse Gas Analysis for Construction of the Proposed Pura Substation in Huntington Beach, CA*, Yorke Engineering, LLC at 6-7 (2019).

[22] *See* Robert Bullard, et. al., *Toxic Wastes and Race at Twenty: 1987-2007: Grassroots Struggles to Dismantle Environmental Racism in the United States*, Church of Christ Justice and Witness Ministries (2007) https://www.ejnet.org/ej/twart.pdf.

they will produce micro-plastics that will end up in the surrounding ecology (water, flora, fauna) and in the drinking water supply for all North OC. Microplastics are a known toxin in drinking water. Wealthier residents have water filtration systems that can reduce or eliminate microplastics from entering their drinking water. Low-income communities often lack these types of filtration systems.

d. Pesticides and Fertilizers Used in Floral Wall to Block View to Operations Will Harm Local Residents, Species, and Groundwater.

The Project plans to erect a "floral wall" in order to block the view of the facility as it operates. No plans are given for using organic fertilizers, soils, or indigenous plants. Instead, the wall will likely be industrial in nature, created through spray-on plant material, using toxic fertilizers and pesticides to ensure growth. These toxins become airborne and waterborne, affecting local populations, flora, and fauna. Given proximity to Environmentally Sensitive Habitat Areas, this is particularly troubling. Given the proximity to the Cabrillo Mobile Home community, which has single-paned windows, they are directly at risk from this type of activity, as are all pedestrians passing by the facility to access the ocean.

e. EJ Communities Are Affected Most by Increased Industrial Activity.

As noted above, particulates from development and exhaust from trucks and machines during construction have the greatest negative effects on nearby vulnerable communities. For instance, the Project plans include 150 round-trip truck trips *per day* during construction, all on the already impacted Beach Blvd which is a critical roadway for locals. These trucks will be loaded with concrete, steel, toxic materials and soils, and anything else required for demolition and construction, traveling right by low-income mobile home communities with mostly elderly residents, but also traveling many miles to reach final destinations, implicating many EJ communities along the way.

f. The Project Site Itself Is a Toxic Brownfield.

One of the most striking omissions from the Project application is that the Project site itself is a highly toxic brownfield and that much of the soil the plan requires to be dug up is almost certainly riddled with toxic materials. The long industrial history of the adjacent sites, and the site itself, dating back to the 1930s, and the history of that area of Huntington Beach being one of nearly unlimited oil derricks, means that the soils that the Project will require to excavate, and plan to, are almost certainly highly toxic. This creates heightened risks for the nearby community, any community downwind from the construction, and most negatively, from the water system the Project plans to use: if that toxicity were to enter the Project water pipes, either through leaks or corrosion, those toxins would be pumped into the water of the entire North Orange County or pumped into the ocean with the brine output. Again, the Project applicant acts as if these risks are minimal, require little to no mitigation or alternatives assessment, and are well worth the effort.

But these claims also include a material omission in that the Project application does not include information about the EPTC - Huntington Beach site that is a RCRA Hazardous Waste site, directly on the Project property.[23] Much of the Project demolition and construction will require hauling toxic soil off-site, to a landfill likely located near EJ communities, or must be remediated in situ, creating a toxic scenario for local communities. What cannot happen is simply repurposing the toxic soil without a remedial plan and a mitigation plan. That exposes the community to significant dangers. There is a very high likelihood that the area of the facility that the Project plans to build a berm on is actually toxic land. The current plans (Application Attachment 7 Berm Earthwork) include drainage, grading, elevating pads, and removal of exterior berms: all of these could qualify as brownfields remediation. Any development on site will kick toxic particulates into the air that locals breathe. The entire project site should be remediated *before* development, which poses its own risks associated with hazardous cleanups. For the Project to essentially pretend that little remediation is required poses even greater hazards.

The current Project plan calls for the demolition of decommissioned fuel tanks and a facility containing lead and asbestos and some form of remediation of surrounding soils, but the Project does not go into detail about any mitigation plans for neighboring communities. Trucking the soil offsite creates diesel emissions and potential leakage from trucks in transit, which will impact the communities along the truck route. Despite promising at least 150 round-trip truck trips per day for the entire duration of the demolition and construction, the Project application goes on to conclude that "the number of trips generated by the project on a long-term basis was considered negligible and impacts in this regard are not anticipated to be significant." How convenient. Likely none of the authors of the application live along the truck path, but the communities that do will clearly be impacted by this plan. It is precisely these types of inaccurate conclusions that are drawn throughout the application.

The Project will require toxic substances to function throughout operation, as the application admits, and will generate toxic substances throughout the operations, including GHGs from major electricity use. The toxins do not just disappear in the wind, but go into peoples' lungs and fall onto their land and eventually end up in soils and the water supply. The toxins would be generated 365 days a year for over 50 years of operation, no small burden. The operations will also generate significant and unceasing vibrations that will undoubtedly be felt by adjacent communities and construction and operations will also generate significant noise despite claims that these will be minor and insignificant. Even the now completely stale 2010 FSEIR found that "construction activities such as excavation, grading, and backfilling associated with project implementation are anticipated to generate erosive conditions that may include sediment-laden storm runoff or dust." Given that the revised Project plan includes significantly more excavation, grading, and backfilling, these risks have only risen, despite the applicants claim that they do not. Essentially, every single increase in negative effects that the Project identifies since the 2010 FSEIR is written off by the applicant as negligible. These erroneous conclusions do not

[23] https://www.envirostor.dtsc.ca.gov/public/eerp_profile_report?global_id=3002048

make the impacts go away: the affected communities will feel them and deserve proper mitigation plans and alternative options.

g. The Project Presents Major Risks to EJ Communities Due to Extreme Weather and Natural Disasters.

At this point in the 21st Century, it is without question that all coastal zones will face major risks from extreme weather, natural disasters, and sea level rise. But, the Project claims without fail, that none of these are risks for their coastal dependent plan. Each page notes that challenges will be faced in general, but just not at the Project site, mainly because now, unlike the plan analyzed by the 2010 FSEIR, the Project site will be lifted by demolishing the external berm currently on site and using that soil to lift the site fourteen feet above the previous plan. Just a few feet of lift and all the world's disasters just disappear. If only it were that simple.

First, the idea that this Project, so dependent on the coast, so close to it, and surrounded by protected wetlands, would not be built to Critical Infrastructure standards, is a danger to everyone in North Orange County. Once connected to the water supply, and fueled by the AES Plant, the site would become a massive risk in the case of a tsunami, major flooding[24], earthquake, and the inevitable sea level rise. The Project plan admits frequently that the surrounding neighborhoods would be flooded, inundated, or liquified, but somehow the Project site itself remains untouched and intact. An eight foot high chain link fence the plan has added must also have untold powers. But what happens when the hundreds of mobile homes immediately adjacent to the Project site are lifted by flood waters or a tsunami is that they become waterborne projectiles, likely besting that few extra feet the Project site would be sitting on, and causing immense destruction, damaging powerlines and gas pipelines, slamming into hazardous materials storage, or battering the main Project facilities. If any of those waterborne projectiles were to crack the water pipes flooding North Orange County's groundwater supply, then suddenly that water supply becomes brackish and undrinkable, compounding the emergency. Not only would the entire region be dealing with the aftermath of an extreme event, but residents would have no potable water to drink. Nowhere in the Project plan does the applicant contend with these very real issues, develop mitigation strategies, communication plans, evacuation plans, or develop alternatives. Instead, the Project application just admits that these communities would be in real trouble, but not the Project. These failures create massive risks to life and property, so significant that the CDPs must be denied on these grounds alone.

Further, despite acknowledging major flood risks that would inundate the site over time due to climate change induced sea level rise, no plans are given to deconstruct or decommission the Project site before it becomes unused and unusable. The failure to provide a real end-of-life

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[24] It is worth nothing that EJ communities are at particular risk when it comes to climate change-exacerbated flooding events. In particular, low-income communities have suffered from less investment in flood adaptation or infrastructure and generally recover less quickly from disasters (*See New flood maps show US damage rising 26% in the next 30 years due to climate change along, and the inequity is stark*, The Conversation (2022) https://theconversation.com/new-flood-maps-show-us-damage-rising-26-in-next-30-years-due-to-climate-change-alone-and-the-inequity-is-stark-175958).

analysis for the facilities also show a lack of care for the surrounding environment and the generations in the future that will have to deal with this monstrosity of a facility.

In 2018, the Commission unanimously adopted the 2018 California Ocean Protection Council update to the report "State of California Sea-Level Rise Guidance."[25] The Commission report declares that "[t]he Coastal Commission will be using and recommends that local governments and applicants use best available science, currently identified as the projections provided in the 2018 OPC Sea-Level Rise Guidance . . ., in all relevant local coastal planning and coastal development permitting decisions."[26] The applicant did not perform this analysis.

The report identifies three scenarios depending on the type of project and the level of risk associated with development type: low risk aversion scenario, medium-high risk aversion scenario, and extreme risk aversion.[27] Low risk aversion is appropriate for projects with "limited consequences or have a higher ability to adapt, such as sections of unpaved coastal trail, public accessways, and other small or temporary structures that are easily removable and would not have high costs if damaged."[28] Medium-high risk aversion is appropriate for "projects with greater consequences such as residential and commercial structures."[29] Extreme risk aversion (H++) "should be used for projects with little to no adaptive capacity that would be irreversibly destroyed or significantly costly to repair, and/or would have considerable public health, public safety, or environmental impacts should that level of sea rise occur." In the Coastal Commission's jurisdiction, this could include new wastewater treatment plants, power stations, highways, or other critical infrastructure."[30] The Project application argues that, "[g]iven the proposed development is a commercial structure that poses very low risk to public health, safety, natural resources and critical infrastructure, the 'medium-high' risk aversion scenario is the most scientifically defensible for the Project."[31] In its SLR analysis, then, the applicant improperly relied on low-risk aversion and medium-high risk aversion SLR projections. Instead, the applicant should have used the extreme risk aversion (H++) SLR projections.

The Commission recommends taking a precautionary approach for most development and adopting a medium-high risk aversion scenario, for projects "with little to no adaptive capacity, that would be irreversibly destroyed or significantly costly to repair, and/or would have considerable public health, public safety, or environmental impacts, the analysis should consider 'extreme risk aversion' scenario."[32] Even without flooding, the Project, as discussed throughout this letter, poses "considerable public health, public safety, or environmental impacts" and these

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[25] *California Coastal Commission Sea Level Rise Policy Guidance: Interpretive Guidelines for Addressing Sea Level Rise in Local Coastal Programs and Development Permits*, California Coastal Commission at 1 (2019). https://documents.coastal.ca.gov/assets/slr/guidance/2018/0_Full_2018AdoptedSLRGuidanceUpdate.pdf.
[26] *Id*. at 49.
[27] *Id.* at 102.
[28] *Id.*
[29] *Id.*
[30] *Id.*
[31] *Huntington Beach Desalination Project Sea Level Rise Hazard Analysis and Adaptation Plan, Moffatt and Nichol at 15 (2020).*
[32] *Supra note 31 at 102.*

impacts would only worsen in the event of flooding. Further, as a desalination facility, the project is much more akin to the Commission's examples of extreme risk aversion scenarios of wastewater treatment plants and power stations than to the medium-high risk examples of residential and commercial structures. Because of the nature and risks of the Project, applicant should have used an extreme risk aversion (H++) scenario.

Applicant estimates the project's design life at 50 years and analyzed sea level projections from 2070-2100.[33] Under the appropriate extreme risk aversion scenario, SLR in 2070 is 5.2 feet and in 2100 is 10.2 feet.[34] Given the existing site elevation ranges from 4 to 14 feet (NAVD88), it appears that portions of the Project site are at risk of flooding under 2070 and 2100 extreme risk aversion scenario (H++) projections.[35] Critically, the product water storage tank, despite applicant saying it is "designed to withstand coastal hazard events without damage and would not be sensitive to shallow flooding of short duration," will be raised to only 10 feet.[36] Even under medium-high risk aversion SLR projections of 3.5 in 2070 and 6.9 in 2100, some areas of the project site would still be at risk of flooding.

Applicant suggests that the H++ scenario is not widely supported in the scientific community and therefore should not factor into the design or decision-making process for the proposed project.[37] However, the Commission's adoption of the 2018 OPC update makes clear that the Commission currently identifies the 2018 OPC Sea-Level Rise guidance as the best available science and declares that the Commission will use the guidance in all relevant permitting decisions.[38] Applicant should abide by Commission's recognition of the best available science which indicates the Project should be evaluated with the H++ scenario of 5.2 feet SLR in 2070 and 10.2 feet SLR in 2100.

Applicant reports that "CoSMoS 3.0 results indicate the Project site would not be exposed to flooding during a 100-year coastal storm event for any sea level rise projection of less than 5 feet. Therefore, flooding from an extreme coastal storm event is not a concern for the life of the project."[39] However, applicant reached this conclusion using improper SLR projections. Considering the nature and risks of the desalination project, applicant should have used the appropriate extreme high risk aversion (H++) SLR projections of 5.2 feet in 2070 and 10.2 feet in 2100. Using proper SLR projections, CoSMoS 3.0 results instead indicate that the Project is indeed at risk of flooding during a 100-year coastal storm event during the life of the project.

Applicant reports that the Project "includes plans to adapt to H++ sea level rise scenarios if they materialize" but provides no indication of the plans in the Project documents. Because the applicant applied the improper SLR projections, and the proper SLR projections show areas of

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[33] *Supra note 25.*
[34] *Supra note 313 at 103.*
[35] *See supra note 25 at 11.*
[36] See id. at 8.
[37] *See id. at 14.*
[38] *Supra note 313 at 49.*
[39] *Id. at 22.*

the Project site are susceptible to SLR related flooding, the applicant's analysis is inadequate and inappropriate and consequently, their CDPs should be denied.

IV. The Project Application Fails on CEQA Grounds.

a. The Project Applications Fails on Substantive CEQA Grounds.

The Project CEQA analysis is deeply flawed. Despite 12 years having passed since the HB City 2010 SEIR being filed, and literally dozens of material changes to the Project plan, virtually nothing has changed in the analysis. This is in the face of new data showing how much more severe extreme weather, natural disasters, and sea-level rise will be to coastal zones, and that the Project now includes a massive artificial reef, uncovered by any analysis, and numerous alterations to the 2010 plan. These failures alone should require the CDPs to be denied.

Given the extent of the failures on this front, this document could not possibly cover all of them, and they could be the subject of litigation in the future where the details can be explicated and analyzed in great detail. But this document will list just a few of the obvious failings in the application.

Dudek, the firm hired to claim the Project plan is still in compliance with CEQA, uses conclusory language throughout their report, saying significant changes are "slight" or "minor."[40] The repeated downplaying of risks to their best-case scenarios shows bias in the analysis. Consulting firms should not craft a report to confirm their client's conclusions, but sadly, this does happen. Deep, clinical analysis is lacking throughout the document. As an example, instead of a renewed and real analysis of different elements of the Project plan that have changed, Dudek will simply point to the 2010 FSEIR as proof that the changes are not a problem.[41] This violates the spirit and letter of CEQA's requirements. Despite the many real risks the Project must contend with, the report actually states that "the proposed project is not expected to present significant health hazards."[42] How one could come to this conclusion is incomprehensible.

The 2012 City of Huntington Beach Dept of Planning and Building Memo, at a total of two pages, was the most cursory analysis imaginable and should not act as any sort of affirmation of quality or content. The 2017 California State Lands Commission certified SEIR and the 2021 addendum by Santa Ana Regional Water Quality Control Board, certified by City of Huntington Beach, do not rectify any of the significant issues noted here, but were more akin to a rubber stamp of the same, now very stale and out-of-scope FSEIR from 2010. In other

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[40] *Memorandum: CEQA Equivalence Review and Updated Cumulative Analysis for CDP Application*, Dudek at 2 (July 8, 2021) (reporting that the updated plan "includes a slight reconfiguration of the layout on the project site, removal of external berms, and retention of the majority of the soil from the berms on site" and "minor refinements to the 66-kV sub-transmission lines connection to the electrical substation and FO cable routes.")

[41] *Id.* at 3 (concluding that "these project refinements and updated related projects cumulative analysis do not result in any new significant environmental impacts, or substantially increase the severity of previously identified impacts as compared to the 2010 FSEIR. Therefore, not additional CEQA documents . . . would be required.")

[42] *Id.* at 36.

words, no real effort to update the 2010 plan has occurred, leaving dozens of substantive changes without any CEQA review whatsoever. As such, the CDPs must be denied.

1. The Substantive Changes to the Project Plan Since the 2010 FSEIR Are Many.

The proposed landside refinements involve the addition of an emergency generator, revisions to the original grading plan and layout, and revisions to the electrical substation component of the Project. The new substation will be surrounded by an eight foot chain-link fence, as if that would prevent waterborne projectiles from causing an explosion or from flooding to inundate it, or from toxicity to pass beyond it. Thousands of feet of new FO Cable, conduit, and structures are included, requiring new trenching and new overhead poles. The removal and replacement of hardware to accommodate upgraded substations would require installing underground duct banks and more trenching.

Other than the major artificial reef the Project plan proposes, the most significant change in the plan is an updated grading plan proposing the removal of the exterior berms on the project site. The majority of soils from the removal of the berm will be retained on site and used to raise the elevation of the site from the 2010 design elevation of between 14 and 16 feet. The report characterizes this as a "slight reconfiguration" of the site layout.[43]

Regarding toxic emissions, the 2010 FSEIR determined that there would be a significant and unavoidable construction impact from localized particulate matter emissions (PM10 and PM2.5) because these emissions would exceed the South Coast Air Quality Management District (SCAQMD) localized significance thresholds. The 2010 FSEIR also found that even with incorporation of mitigation measures the maximum daily construction emissions of oxides of nitrogen (NOx) for the Project and primary pipeline alignment would be 182.15 pounds per day, which would exceed the SCAQMD maximum daily construction emission threshold for NOx. As such, short-term construction impacts were determined to be a significant and unavoidable impact, yet no mitigation or alternatives analysis has since been provided. These impacts should have been included in a cumulative impacts analysis given the already heightened air monitor readings from the Ascon site, the Magnolia Tank Farm site, and AES Energy site.

The Project plan admits that initial site grading would take approximately 4 months, with 5,200 total construction worker and haul trips, and 60 one-way truck trips per day resulting in 10 - 21 days of additional grading, yet no mitigation or alternatives analysis was provided. These impacts should have been included in a cumulative impacts analysis.

The Project plan includes new generators, a stationary source that emits TACs; TACs associated with generators include diesel particulate matter, yet no mitigation or alternatives analysis was provided. These impacts should also have been included in a cumulative impacts analysis. The operation of generators would require delivery of diesel to refill the tanks. The

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[43] *Id. at 2.*

report goes on to say that "during project construction, GHG emissions would be emitted from employee vehicles, construction vehicles (e.g., crew trucks, line trucks, and water trucks) and off-road equipment (e.g., bulldozers, graders, and backhoes)" and that "during operation, GHG emissions would be generated from annual maintenance trips," yet no mitigation or alternatives analysis was provided.[44] These impacts should have been included in a cumulative impacts analysis.

In one of the most disconcerting and dangerous admissions in the report, it states that "several plugged and abandoned oil wells are located within proximity to the project site" but that "if possible, development over these wells would be avoided."[45] The potential for explosions and fire from the underground toxic materials in these former wells is very real, yet no mitigation or alternatives analysis was provided. These impacts should also have been included in a cumulative impacts analysis.

The Project plan admits that lead and asbestos are in facilities to be demolished on site, yet no mitigation or alternatives analysis was provided.[46] These impacts should also have been included in a cumulative impacts analysis.

The Project plan admits on-site storage of hazardous chemicals, requiring registration with EPA, yet no mitigation or alternatives analysis was provided.[47] These impacts should also have been included in a cumulative impacts analysis.

These many failures should accrue to the denial of Project CDPs.

2. The Cumulative Impacts Analysis in the Project Application Are Inadequate.

Cumulative Impacts from the toxic sites that surround the Project site are never adequately analyzed and are always assessed in the best light possible, rather than genuinely considered for the real risks they present to the community and the environment. The AES Huntington Beach natural gas plant essentially shares the site with the Project; the Ascon toxic landfill site, one of the more toxic in the state, is immediately adjacent; the former Magnolia Tank Farm is also adjacent and despite recent remedial efforts is likely still toxic to a meaningful extent; the EPTC - HB site is literally on the Project Site, yet goes without mention anywhere in the nearly 3000 page Project application and is known to have RCRA hazardous wastes on site; a former landfill is under the Edison Community Center; and the toxins that have leached to most of the surrounding land given the quantity of toxins contained on these sites and the duration of historic uses (some starting in the 1930s), combined with the many former oil wells that are not

[44] See id. at 32.
[45] See id. at 36.
[46] See id.
[47] See id.

mapped due to how long ago they were capped, all create one massive set of cumulative impacts inevitably facing the affected communities before, during, and after operation of the Project.

Regarding aesthetics, the Project plan claims: "During construction, the project would not substantially degrade the existing visual character of the site or its surroundings, as all impacts would be limited in scope and duration. Substantial sources of light and glare would not be produced by construction activities. Most construction would occur during the day, and any night lighting would be limited and focused directly on the construction area, minimizing light spill into surrounding areas."[48] Except in reality, construction will go from 7am to 8pm 6 days a week; the AES Energy site frequently used massive construction lights well into the night according to neighbors, and still has a demolition scheduled for the decommissioned AES facility on site, yet no mitigation or alternatives analysis was provided. These impacts should also have been included in a cumulative impacts analysis.

Re air quality claim, the Project plan barely acknowledges the significant toxicity at the Ascon state superfund and brownfield sites that are part of the construction plans: "The pollutants generated from construction of these cumulative projects could result in an impact on ambient air quality that would overlap with those of the proposed refinements since the construction work occurs in close proximity and is expected to be at relatively the same time."[49] No mitigation or alternatives analysis was provided. These impacts should also have been included in a cumulative impacts analysis.

Regarding significant additional grading on site, implausibly: "The grading refinements would not result in additional daily grading activity and therefore would not exceed the daily on-site emissions as analyzed in 2010 FSEIR. Daily grading activities would be limited to what was analyzed in the 2010 FSEIR because there are spatial limitations for the number of workers and the amount of equipment that can operate on site at once. Therefore, the grading refinements would result in daily emissions that are consistent with the 2010 FSEIR."[50] Yet the application goes on to also say, regarding energy use: "Additional energy in the form of petroleum would be required to accommodate 21 additional days of grading activities and substation refinements."[51] So, despite a major increase in number of workers, truck trips, movement of soil, and days at work, the application claims no change from the 2010 plan. This simply defies logic. No mitigation or alternatives analysis was provided. These impacts should also have been included in a cumulative impacts analysis.

Regarding on site emissions of carbon monoxide: "The new refinements construction emissions would be below the 2012 CEQA Consistency Determination construction emissions, with the exception of CO emissions . . . However, the new refinement's CO emissions would not be substantially more than the 2012 refinement CO emissions and the new refinement's

[48] See id. at 14.
[49] See id. at 49.
[50] See id. at 20.
[51] Id. at 35.

emissions would be below the SCAQMD emission thresholds."[52] No mitigation or alternatives analysis was provided. These impacts should also have been included in a cumulative impacts analysis.

Regarding hazardous materials stored on site: "The accidental spill or use of hazardous materials in excess quantities could be a potential hazard to the public or the environment."[53] The report then goes on to say that the "development and implementation of a Hazardous Material Spill Prevention and Response Plan for vessels associated with the construction of the proposed refinements is recommended."[54] This Hazardous Material Spill Prevention and Response Plan is currently undeveloped and unpublished. No mitigation or alternatives analysis was provided. These impacts should also have been included in a cumulative impacts analysis.

Regarding noise from construction: "High groundborne noise levels and other miscellaneous noise levels can be created by the operation of heavy-duty trucks, backhoes, bulldozers, excavators, front-end loaders, compactors, graders, and other heavy-duty construction equipment."[55] Yet the application goes on to implausibly claim, even though all this construction noise would be 6 days a week from 7am to 8pm for 12-24 months of construction, that it is "temporary, intermittent."[56] No mitigation or alternatives analysis was provided. These impacts should also have been included in a cumulative impacts analysis.

Regarding recreation at the proximate areas, the application claims: "it is not anticipated that the construction or operation of the modified project would result in a direct or indirect impact associated with parks and recreation facilities" despite the many aforementioned toxins likely blowing around the area, at schools, waterways, soccer fields, beach volley ball courts, and the community center and park.[57] No mitigation or alternatives analysis was provided. These impacts should also have been included in a cumulative impacts analysis.

Regarding truck traffic, the application claims there will be "no impact" despite 150 round-trip truck trips per day down small Beach Blvd. that neighbors the Cabrillo Mobile Homes that already vibrate when any truck passes. These trucks will be full of concrete, steel, toxic waste, and other heavy materials. Instead, the report considered the number of truck trips generated to be "negligible and impacts in this regard are not anticipated to be significant."[58] This conclusion, however, followed a recognition that the "deficient intersections" along Beach Boulevard "may be temporarily impacted by short-term demolition, remediation, and construction traffic."[59] No mitigation or alternatives analysis was provided beyond cursory

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[52] Id. at 23.
[53] Id. at 51.
[54] Id. at 52.
[55] Id. at 52-53.
[56] See id. at 53.
[57] See id. at 53.
[58] See id. at 45.
[59] See id.

recognition of potential preparation a "Traffic Management Plan," of which no real details were given.[60] These impacts should also have been included in a cumulative impacts analysis.

Due to the numerous failures regarding cumulative impacts analysis, the CDPs should be denied.

b. The Project Application Fails on Procedural CEQA Grounds.

As established in *In re Natural Resources Defense Council v. City of Los Angeles* (2002) 103 Cal.App.4th 268, 271, a CEQA review must be fully open to the public and must disclose the fullest information regarding environmental consequences before the project begins. In the Project application, information has been withheld, avoided, omitted, or directly misrepresented through the process despite nearly 3000 pages to articulate the plans and risks. Neither the application nor any document submitted by applicant has been provided in the three most commonly used languages in the area other than English (Spanish, Vietnamese, Korean), obviating any chance for the public to understand the project and determine its validity and safety; no interpreters have been provided at previous hearings where applicant provided testimony, nor translations of the record.

At every turn, applicant has failed to engage EJ communities, fenceline communities, Tribal communities, local schools, elderly living facilities and sensitive populations in the process. Applicant also failed to provide the fullest information regarding environmental consequences, often acting as if this major industrial Project had no consequences at all. The Project application fails to discuss the effects to the neighboring communities in terms of toxic soil remediation, in the event of extreme weather or natural disasters, if there is a major malfunction or failure during construction or operations, or in regards to toxic substances and hazardous materials. No communication or evacuation plans for the community have been developed or disseminated whatsoever.

Perniciously, applicant openly admits on a number of occasions that their full plans have not been developed and will only be revealed *after* the CDPs are granted. This fails under CEQA. On other occasions, applicant fails to provide critical information or plans on many material aspects of the Project as if the decision on whether to grant or deny the CDPs is not dependent on having them. These critical plans have never been adequately reviewed by any relevant California agency. On both procedural and substantive CEQA grounds, the CDPs should be denied.

V. The Project Violates the California Coastal Act.

California Coastal Act Section 13096 of the Commission's administrative regulations requires Commission approval of coastal development permit applications to be supported by a

[60] See id.

finding showing the application, as modified by any conditions of approval, to be consistent with any applicable requirements of CEQA. As stated above, they do not.

Section 21080.5(d)(2)(A) of CEQA prohibits approval of a proposed development if there are feasible alternatives or feasible mitigation measures available that would substantially lessen any significant impacts that the activity may have on the environment. The Commission's regulatory program for reviewing and granting CDPs has been certified by the Resources Secretary to be the functional equivalent of CEQA (14 CCR § 15251(c)). The Commission is therefore a responsible agency for the purposes of CEQA. A failure to satisfy CEQA is a failure of the Coastal Act.

Beyond the CEQA failures, the Project would also violate the Coastal Act in terms of its mandate to protect equitable coastal access. Access to one of the most popular areas of the Huntington Beach coastal zone would be severely limited during construction and possibly during operations. Given the fact that the Project would be a major industrial facility emitting toxins and GHGs 24 hours a day, 365 days a year, the public that does spend time near these pollutive industrial activities exposes themselves to health risks, the site reduces the scenic natural beauty and potentially the public's ability or interest in recreational activities nearby. Descriptions of an unreviewed sea/sound wall abutting Magnolia Marsh could create further access issues and could accelerate beach erosion.

Ocean acidification that could result from the toxic brine dumped at the rate of 50 million gallons per day year round could make swimming near the output toxic and undesirable, creating a further access issue. Applicant has not stated any plans to monitor water quality of ocean water where the brine would be dumped meaning the area could become unsafe for swimming, bathing, fishing, and water sports. The Huntington State Beach Junior Lifeguards train near the Project output, putting them at risk; the area is a main hub of use, with several public restrooms, an RV park, restaurants, parking, a bike path, beach volley ball courts etc. All of this equates to high traffic in an area that, if the Project is built as described, puts the public at heightened risk.

During construction and operations, walking past or parking near the Project creates significant health risks due to particulate matter, diesel emissions, toxins, and GHGs. The Project provides no mitigation plan for purposes of safe and equitable access. Many EJ communities visit the beach as low-cost recreation, but they may reconsider if people start getting sick from the pollution in the air or water. The area is a magnet for communities all over OC and beyond who will be drawn to the beach access through this area made toxic by the Project. The manmade reef in the Project plan could significantly damage access and ability to surf in and around that reef. Development of this reef could damage the DDT barrels buried underwater, causing massive risks.[61]

[61] https://www.livescience.com/ddt-dump-catalina-island.html

The many potential violations of the Coastal Act should result in the denial of all Project CDPs.

VI. The Project Application Fails on NEPA Grounds.

The Project application does not mention its federal obligations under the National Environmental Protection Act (NEPA) which are triggered when any federal funds are allocated to a project. Applicant applied for and was approved for a $585 million Water Infrastructure Finance and Innovation Act (WIFIA) loan, which would qualify as that very trigger, as well as any other federal funds the Project may have been authorized.[62] It would be inappropriate to grant CDPs to a project that already requires a NEPA Environmental Assessment or Environmental Impact Statement and has not completed that review or any obligations under NEPA. A NEPA analysis is not the same as a CEQA analysis and cannot be deemed as such. Other federal permits under the Clean Water Act may also be required and should already have been applied for. None of these federal obligations have been mentioned in the Project application. Willingness to accept federal funds, but not abide by federal law, puts the Commission in a precarious position and should result in the denial of Project CDPs.

VII. The Project Would Violate the Human Right to Water.

AB 685 established the human right to access clean, safe, and affordable water as a policy priority for California.[63] To promote that priority, agencies should "[g]ive preference to policies that advance AB 685 and refrain from taking actions that adversely impact the human right to water (HRW)…."[64] Importantly, the statute lays out a process for relevant agencies to engage in in order to advance the state's policy goals—agencies must consider the human right to water in their decision making. To meet its obligation to "consider" the human right to water impacts of permitting the Project, the Commission should (1) note any impacts of its action on the human right to water, (2) give preference to decisions that advance the human right to water policy, and (3) refrain from making decisions that run contrary to the human right to water policy.[65] The continued rise of water rates due to operation of Poseidon's facility would undoubtedly affect disadvantaged communities who have less of an income buffer to absorb water costs, forcing them to spend money allocated for other essential goods and services on

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[62] *U.S. EPA to Provide $585 million for Climate-Resilient Huntington Beach Seawater Desalination Plant*, Poseidon Water (2019). https://www.poseidonwater.com/news-and-events/us-epa-to-provide-585-million-for-climate-resilient-huntington-beach-seawater-desalination-plant (reporting that the US EPA "has selected the proposed Huntington Beach Desalination Project to apply for $585 million in credit assistance under the federal government's Water Infrastructure Finance and Innovation Act.")

[63] Assemb. Bill 685, ASSEM. J. 6817 (2011-2012 Reg. Sess.)

[64] University of California, Berkeley School of Law, International Human Rights Law Clinic, The Human Right to Water Bill in California: An Implementation Framework for State Agencies, 2, 6 (May 2013), https://www.law.berkeley.edu/files/Water_Report_2013_Interactive_FINAL.pdf

[65] *Id.* at 7.

water.[66] In short, the statute requires all relevant agencies to consider all of the criteria in the human right to water statute.

The Project creates significant access to water issues. A comprehensive consideration of accessibility would also include analysis of the likely impacts of climate change, including increasing harmful algal blooms, and on impacts from potential oil spills from nearby infrastructure.[67] And while the Project would theoretically increase the total supply of water, an improvement in accessibility of water alone does not promote the human right to water if that water is not also safe and affordable. This Project cannot be justified when California's HRW statute is applied as required.

Privatizing water degrades the Human Right to Water. Using public funds to develop a major privatized source of water is antithetical to the common good. The increased costs to taxpayers and ratepayers will be borne most heavily by the lowest income communities and small businesses. The Project would not benefit the Human Right to Water in Orange County. As stated in a recent report from UCLA, "While potential positive HRW benefits from desalinated ocean water can occur in certain contexts, we find that no such benefits can be plausibly realized by the Poseidon agreement in Orange County. Nearly all of the county's households are connected to community water systems which already provide high-quality, reliable water service and thus would not see supply improvement from ocean desalination. . . The only plausible impact of Agreement Water on disadvantaged households in the county will be a decrease in affordability due to higher system rates."[68] Any project that so blatantly violates the HRW should have its CDPs denied.

VIII. The Project Is Unnecessary.

Given increases in efficiency and decoupling of population growth and water use: the Project is entirely unnecessary. "While the Poseidon Desalination Project for OC Basin could provide system reliability benefits, it is not needed for this purpose as there is sufficient local

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[66] See Nina Lakhani, Millions of Americans Can't Afford Water, as Bills Rise 80% in a Decade, CONSUMER REPORTS (July 10, 2020), https://www.consumerreports.org/personal-finance/millions-of-americans-cant-afford-water-as-bills-rise-80-percent-in-a-decade/.

[67] See MacKenzie Elmer, Environment Report: Why Your Water Bill Might Spike, VOICE OF SAN DIEGO (July 27, 2020), https://www.voiceofsandiego.org/topics/science-environment/environment-report-why-your-water-bill-might-spike/; See also Verity Ratcliffe, Attacks on Aramco Plants Expose Risks to Saudi Water Supply (Nov. 18, 2019), https://www.bloomberg.com/news/articles/2019-11-18/attacks-on-aramco-plants-highlight-risk-to-saudi-water-supply.

[68] Analyzing Southern California Supply Investments from a Human Right to Water Perspective: The Proposed Poseidon Ocean Water Desalination Plant in Orange County, UCLA Luskin Center for Innovation at 1 (2019). https://innovation.luskin.ucla.edu/wp-content/uploads/2019/04/Analyzing_Southern_CA_Supply_Investments_from_a_Human_Right_to_Water_Perspective.pdf.

groundwater that can be used if [Metropolitan Water District of Southern California] water was interrupted for 60 days or more."[69]

There is no buyer for the Project water, despite countless attempts by applicant to sell it, and North OC does not need 50 mgd of desalinated water given the state of their groundwater and recent improvements to efficiency and conservation. When a project is unnecessary, but will substantially alter a coastal zone, the CDPs should be denied.

IX. Better Alternatives Are Available.

While this document does not exhaustively address the many alternatives that would far better serve the community of North OC and pose far less environmental and environmental justice risks, there are some obvious alternatives that must be considered far superior to the current Project. As such, the CDPs should be denied. The applicant had decades to deeply consider and choose any number of alternatives to this fossil fuel burning toxic desalination plant. Instead, they pushed their plan forward, regardless of the human and environmental issues it faced.

First, the Project must obtain all relevant permits for remedial action on toxic soils, mitigation measures, hazardous materials handling, and any other significant aspects of demolition, construction, or operations, before any action can begin. This would necessitate a plan for decommissioning the Project site and maintaining a bond or escrow for eventual decommissioning of the plant and adaptation to sea level rise or other impacts of climate change. The Project plan should include vastly more mitigation measures to contend with the known hazards it would create and the many cumulative impacts that would result. The thinness of mitigation measures throughout the Project application alone should require a rejection of the CDPs.

Second, a smaller plant for emergency use only would make far more sense for the community. It could be switched on in times of major need, could be fueled entirely by alternative, green energies, would have a far smaller footprint, produce less emissions, and cause far less risk to surrounding communities and beyond. It would act as an excellent insurance policy in case of long-lasting droughts and would, because of its smaller size, limit the aesthetic, noise, vibrational, and particulate matter burdens faced by the surrounding communities. The risks from extreme weather, natural disasters, and sea-level rise would also be limited.

Third, the plant could be established as a public utility, like other water facilities in the state, rather than as a private enterprise owned by a multi-billion-dollar corporate conglomerate that will seek to increase margins and profits on every ounce of water produced, as every for-profit company is driven to do. Any public water resource, like ocean water, should be managed only by public utilities.

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[69] 2018 Orange County Water Reliability Study, CDM Smith, Inc. at 5-9 (2019).https://www.mwdoc.com/wp-content/uploads/2019/02/2018-FINAL-OC-Study-Report_Final-Report_02-01-2019-with-appendices.pdf.

Fourth, the plant could be designed with best available technologies, as determined in 2022, not 2010 as the current Project plan does. Tremendous upgrades in desalination technologies have come about in the last decade and even more in terms of water recycling, efficiency, and conservation, so much so that even the best available technology for desalination would be unnecessary versus these other options. Instead, the Project is attempting to sell twenty year old technology to California's taxpayers as if it is cutting-edge technology, and then locking those same residents in as ratepayers to overpay for that water for the next three generations. Further, applicant must agree to purchase clean, renewable energy produced as close as possible to the service area to offset emissions, and may not count the purchasing of carbon offset credits towards satisfying this condition. The Project plan in terms of intake and output, energy production, and efficiency are antiquated and no longer qualify as best available technology; real alternatives to these deficiencies exist.

Fifth, cost caps for ratepayers should be applied for the entire duration of the operations, locking in affordable water that the for-profit owner cannot alter, creating certainty for ratepayers and small businesses dependent on low-cost water, and avoiding price gouging that has occurred in San Diego due to the Carlsbad Desalination Plant created by the same for-profit company as this Project. The Project must maintain a fund sufficient to subsidize water for low-income households throughout the service area of any wholesale purchaser. Applicant must maintain a fund sufficient to subsidize public, residential, and commercial water-smart landscaping efforts in furtherance of AB 1668, AB 2371, and Senate Bill 606, including the goal of averaging 50 gallons per person per day by 2030 instead of Orange County's current average of approximately 142 gallons per person per day.[70] Applicant must agree to a money-back guarantee for agreed upon rates of output and delivery of water to water purchasing agencies. Furthermore, applicant must agree to finance its facility without subsidies that could be used for affordable housing.

Lastly, applicant must maintain a fund to subsidize extensive and ongoing testing of water quality, specifically boron, chlorine, and PFAS levels in the aquifer and distribution systems. Applicant must establish a system to detect oil spills in the intake area. In the case of a facility shutdown due to an oil spill, applicant must cover all costs of decontamination and repair to its facility and the distribution system.

The applicant's failure to adequately and honestly assess these viable alternatives should result in a denial of Project CDPs.

X. Conclusion.

Analysis of environmental justice concerns using quantitative and qualitative information, as well as applicant's many failures of consultation with stakeholders and individuals from communities of concern in the Project area and the zone of risk, should result in

[70] See Memorandum from Larry Dick and Bob McVicker, Dirs., Mun. Water Dist. of Orange Cnty. to Member Agencies – Mun. Water Dist. of Orange Cnty Divs. Two & Three, (Oct. 13, 2020), available at https://ggcity.org/sites/default/files/OCT%2020%20Water%20Supply%20Report-%20LD%20BM%20Garden%20Grove.pdf.

an outright denial of the Project CDPs. The Project, as described in the application, would disproportionately burden communities of concern, create massive risks to life and property for residents of North OC, and ultimately, is entirely unnecessary. For all the aforementioned reasons, the CDPs should be denied. Any further delay of that decision will harm EJ communities who have spent tremendous time and energy in speaking out about the dangers of this Project – every weakness and failure outlined in this document and others should simply accrue to an outright denial of CDPs, not an extension or delay of the decision. Project applicant has had ample opportunity to do the right thing and solve these obvious problems. They have chosen not to. For the sake of every community of concern within the zone of risk, we ask the Commission not to extend this decades long process any further: deny the Project CDPs.

Sincerely,

____

Andrea Leon-Grossmann
Director, Climate Action
Azul
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__/s/___________________________

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Attachment:

1) Maps and Graphics Showing the Many Communities of Concern in the Zone of Risk for the Project.

Addendum:
Environmental Justice Communities and Sensitive Populations in the Zone of Risk for the Project

Baseline Demographics:
"Environmental justice communities in North Orange County primarily reside in Anaheim, Santa Ana, and Garden Grove with other smaller communities spread throughout surrounding cities. The per capita income in these three cities is about $15,000 lower than the county average with about 15% of the population living in poverty. Santa Ana boasts the highest rate of a language other than English spoken at home at 80% with the other two cities averaging around 65%. The percent of the population with a Bachelor or higher in the area is about 18% which is less than half of the average of the county at 40%."

Based on census.gov

Anaheim:

- Non-white: 44%
- Hispanic: 54%
- Owner-occupied housing rate: 45%
- Language other than English spoken at home: 61%
- Bachelor’s or higher: 25%
- Per capita income: 28,465
- Persons in poverty: 15%

Santa Ana:

- Non-white: 60%
- Hispanic: 77%
- Owner-occupied housing rate: 46%
- Language other than English spoken at home: 80%
- Bachelor’s or higher: 15%
- Per capita income: 20,867
- Persons in poverty: 15%

Garden Grove:

- Non-white: 60%
- Hispanic: 36%
- Owner-occupied housing rate: 53%
- Language other than English spoken at home: 67%
- Bachelor’s or higher: 22%

- Per capita income: 25,804
- Persons in poverty: 14%

Orange County Average:

- Non-white: 29%
- Hispanic: 34%
- Owner-occupied housing rate: 57%
- Language other than English spoken at home: 46%
- Bachelor's or higher: 40%
- Per capita income: 41,514
- Persons in poverty: 9%

Oakview, Huntington Beach:
2,118 households w/ average of 3.9 per household

- Hispanic: 66% (more than triple that of HB 20%)
- Owner-occupied housing rate: 38.5%
- Language other than English spoken at home: 52%
- Bachelor's or higher: 20% (half that of HB @ 42.6%)
- Per capita income: 20,505 (2/5ths of the amount of HB @ 48,774)
- Persons in poverty: 23.4% (almost triple that of HB @ 8%)

EJ Neighborhoods w/in Santa Ana (Based on 2020 Santa Ana City Data)

Artesia Pilar

- Non-white: 65%
- Hispanic: 93%
- Owner-occupied housing rate: 51%
- Bachelor's or higher: 6%
- Per capita income: 15,580

Cedar Evergreen Co-Op

- Non-white: 66%
- Hispanic: 93%
- Owner-occupied housing rate: 29%
- Bachelor's or higher: 6.5%
- Per capita income: 10,788

Centennial Park

- Non-white: 53%
- Hispanic: 89%
- Owner-occupied housing rate: 61%
- Bachelor's or higher: 7.6%
- Per capita income: 14,669

Central City

- Non-white: 56%
- Hispanic: 93%
- Owner-occupied housing rate: 65%
- Bachelor's or higher: 4.4%
- Per capita income: 14,720

Cornerstone Village

- Non-white: 57%
- Hispanic: 95%
- Owner-occupied housing rate: 7%
- Bachelor's or higher: 1.2%
- Per capita income: 8,813

Delhi

- Non-white: 53%
- Hispanic: 91%
- Owner-occupied housing rate: 44%
- Bachelor's or higher: 10.3%
- Per capita income: 18,221

Downtown

- Non-white: 48%
- Hispanic: 75%
- Owner-occupied housing rate: 10%
- Bachelor's or higher: 10%
- Per capita income: 13,719

Flower Park

- Non-white: 39%
- Hispanic: 76%
- Owner-occupied housing rate: 16%
- Bachelor's or higher: 6.3%
- Per capita income: 7,347

French Court

- Non-white: 53%
- Hispanic: 94%
- Owner-occupied housing rate: 7%
- Bachelor's or higher: 4.3%
- Per capita income: 11,442

French Park

- Non-white: 42%
- Hispanic: 87%
- Owner-occupied housing rate: 24%
- Bachelor's or higher: 17.2%
- Per capita income: 16,597

Henninger Park

- Non-white: 49%
- Hispanic: 94%
- Owner-occupied housing rate: 22%
- Bachelor's or higher: 6.5%
- Per capita income: 13,161

Lacy

- Non-white: 46%
- Hispanic: 91%
- Owner-occupied housing rate: 20%
- Bachelor's or higher: 10.8%
- Per capita income: 14,206

Logan

- Non-white: 44%
- Hispanic: 87%
- Owner-occupied housing rate: 22%
- Bachelor's or higher: 17.6%
- Per capita income: 16,873

Lyon St

- Non-white: 54%
- Hispanic: 95%
- Owner-occupied housing rate: 18%
- Bachelor's or higher: 6.3%
- Per capita income: 12,978

Madison Park

- Non-white: 56%
- Hispanic: 94%
- Owner-occupied housing rate: 58%
- Bachelor's or higher: 8%
- Per capita income: 17,014

Memorial Park

- Non-white: 53%
- Hispanic: 93%
- Owner-occupied housing rate: 68%
- Bachelor's or higher: 6.2%
- Per capita income: 16,431

Pacific Park

- Non-white: 55%
- Hispanic: 94%
- Owner-occupied housing rate: 32%
- Bachelor's or higher: 4.6%
- Per capita income: 10,990

Pico Lowell

- Non-white: 54%
- Hispanic: 97%
- Owner-occupied housing rate: 31%
- Bachelor's or higher: 4.8%
- Per capita income: 13,253

Riverview West

- Non-white: 69%
- Hispanic: 52%
- Owner-occupied housing rate: 54%
- Bachelor's or higher: 13.3%
- Per capita income: 18,014

Sandpointe

- Non-white: 52%
- Hispanic: 47%
- Owner-occupied housing rate: 52%
- Bachelor's or higher: 23.1%
- Per capita income: 31,969

Willard

- Non-white: 47%
- Hispanic: 91%
- Owner-occupied housing rate: 12%
- Bachelor's or higher: 5.1%
- Per capita income: 13,499

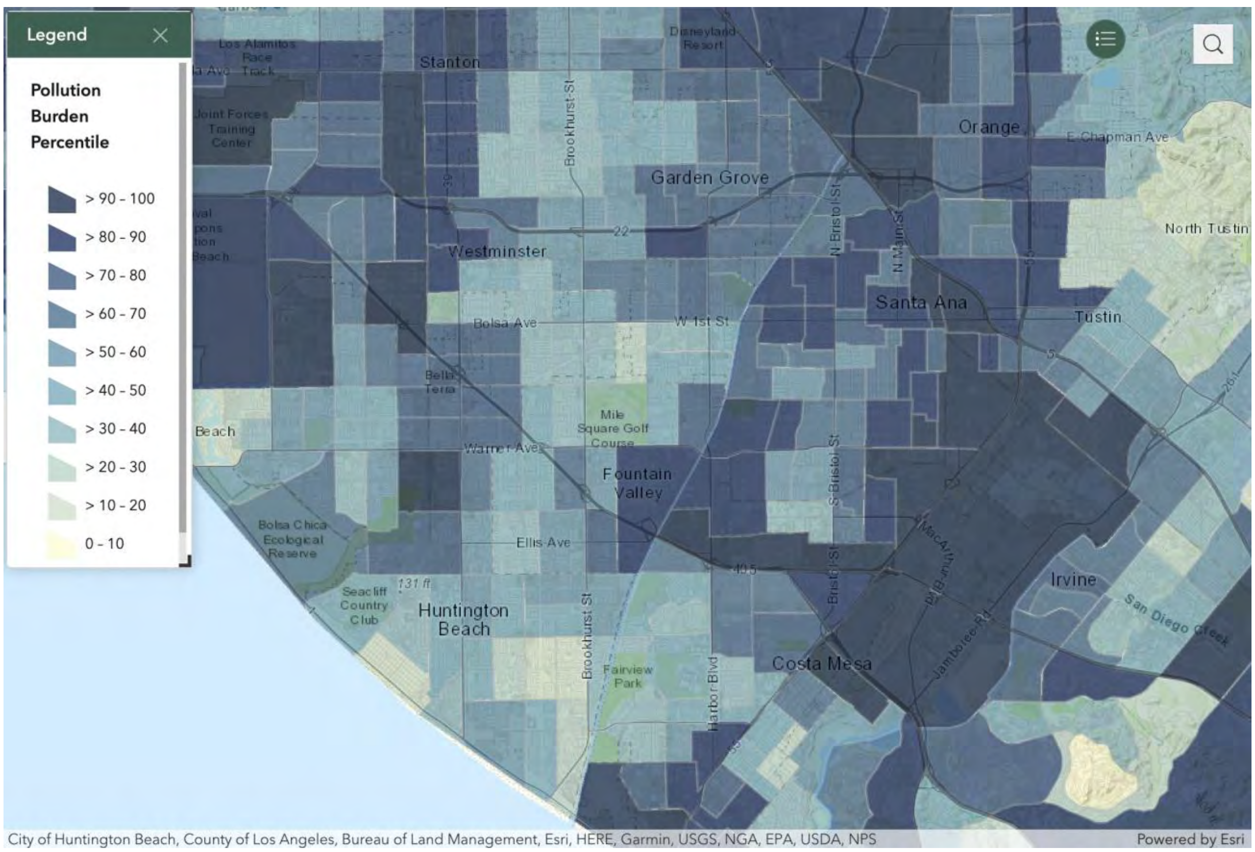
Overall Pollution Burden

Overall CalEnviroScreen scores are calculated from the scores for two groups of indicators: Pollution Burden and Population Characteristics.

This map shows the combined Pollution Burden scores, which is made up of indicators from the Exposures and Environmental Effects components of the CalEnviroScreen model. Pollution Burden represents the potential exposures to pollutants and the adverse environmental conditions caused by pollution.

To explore this map, zoom to a location or type an address in the search bar. Click on a census tract to learn more about the indicator data. The indicator maps can be viewed by clicking on the indicators to the left.

A report with detailed description of indicators and methodology and downloadable results is available at the CalEnviroScreen 4.0 website .

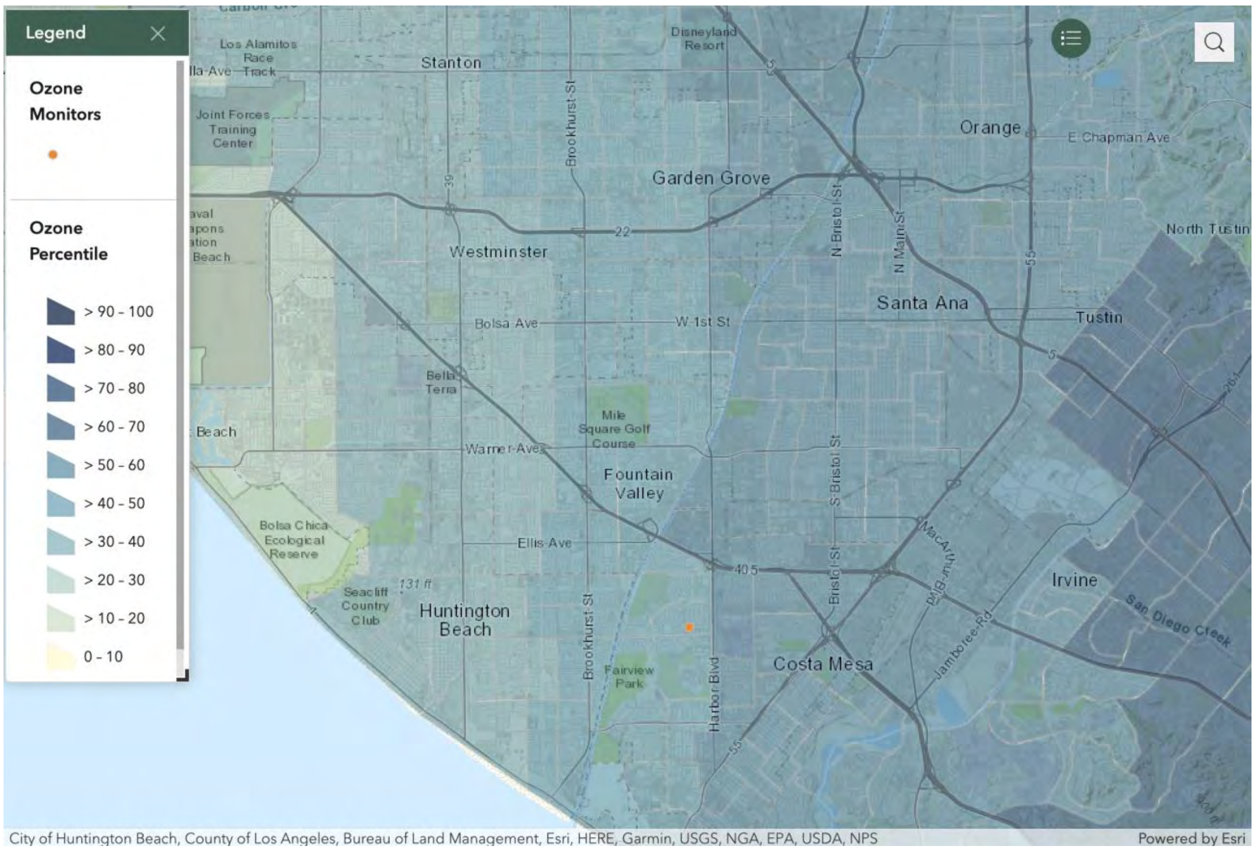


Ozone

Ozone is the main ingredient of smog. At ground level, ozone is formed when pollutants chemically react in the presence of sunlight. The main sources of ozone are trucks, cars, planes, trains, factories, farms, construction, and dry cleaners.

Ozone can irritate the lungs, cause inflammation, and make chronic illnesses worse, even at low levels of exposure. Children and the elderly are sensitive to the effects of ozone. Ozone levels are highest in the afternoon and on hot days. People who spend a lot of time outdoors may also be affected by ozone.

More information can be found in the [Ozone chapter] in the CalEnviroScreen 4.0 report.



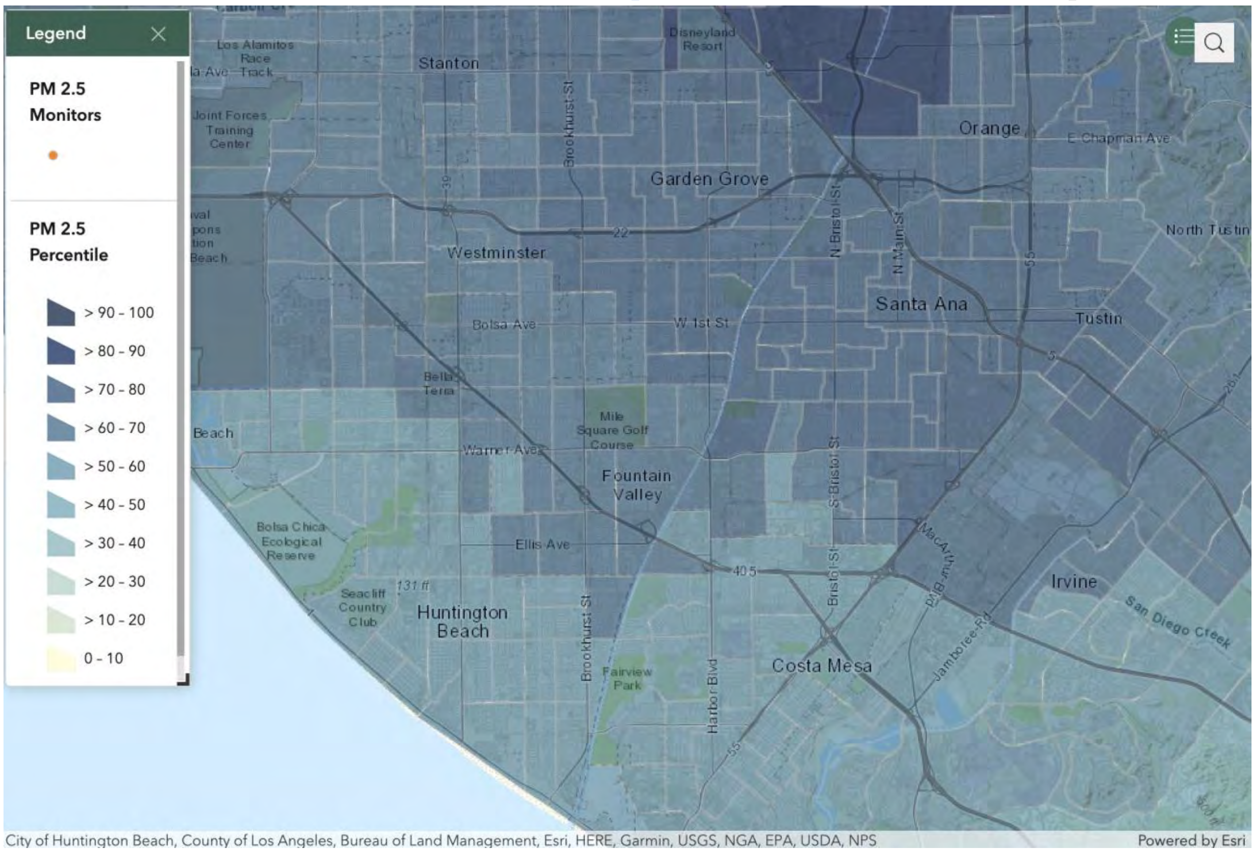
PM 2.5

Particulate matter or PM2.5 is very small airborne particle pollution, less than 2.5 micrometers, which is less than the thickness of a human hair. PM2.5 is a mixture of particles that can include organic chemicals, dust, soot and metals.

These particles can come from cars and trucks, factories, wood burning, and other activities. They can travel deep into the lungs because they are so small and cause various health problems including heart and lung disease.

Children, the elderly, and people suffering from heart or lung disease, asthma, or chronic illness are most sensitive to the effects of PM2.5 exposure.

More information can be found in the PM2.5 chapter in the CalEnviroScreen 4.0 report.

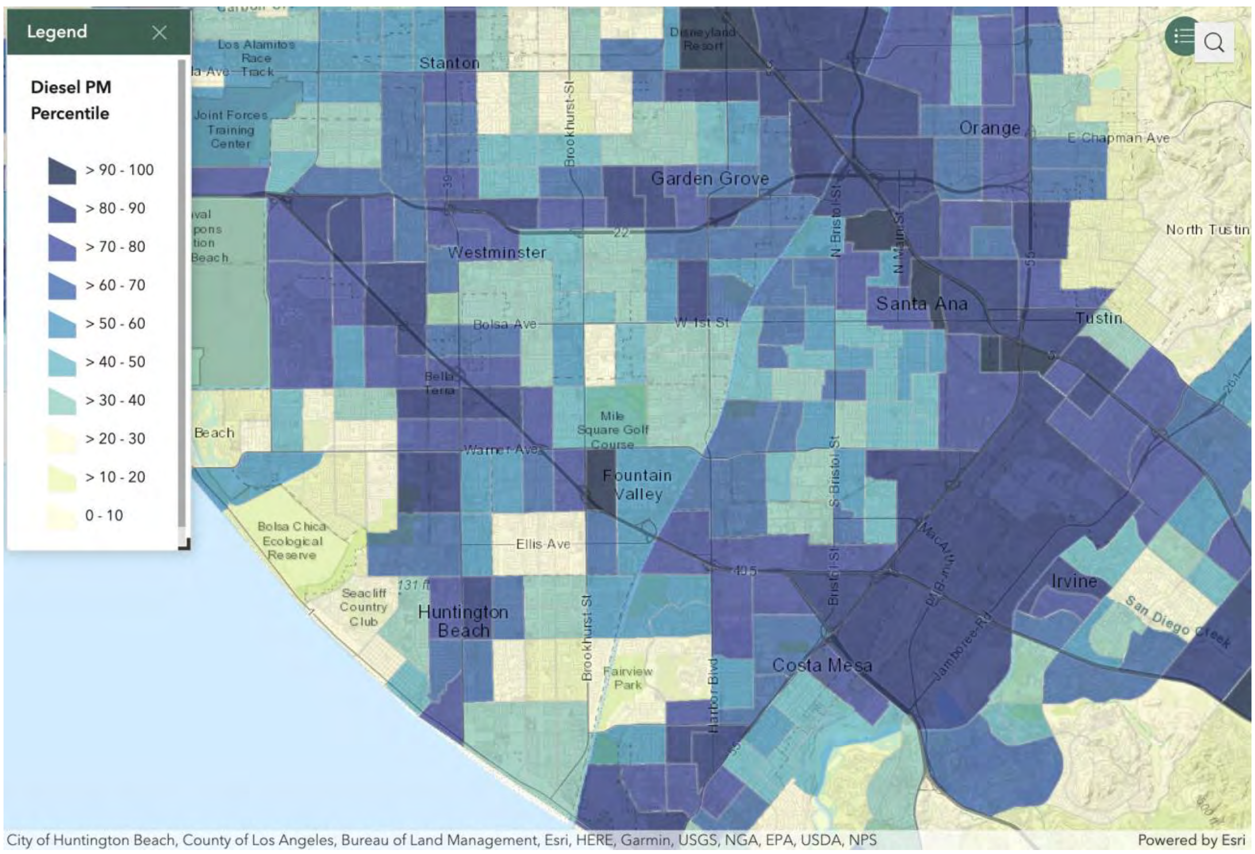


Diesel Particulate Matter

Exhaust from trucks, buses, trains, ships and other equipment with diesel engines contains a mixture of gases and solid particles. These solid particles are known as diesel particulate matter (diesel PM). Diesel PM contains hundreds of different chemicals. Many of these are harmful to health. The highest levels of diesel PM are near ports, rail yards and freeways.

The particles in diesel PM can reach deep into the lung, where they can contribute to health problems including eye, throat and nose irritation, heart and lung disease, and lung cancer. Children and the elderly are most sensitive to the effects of diesel PM.

More information can be found in the [Diesel PM chapter] in the CalEnviroScreen 4.0 report.

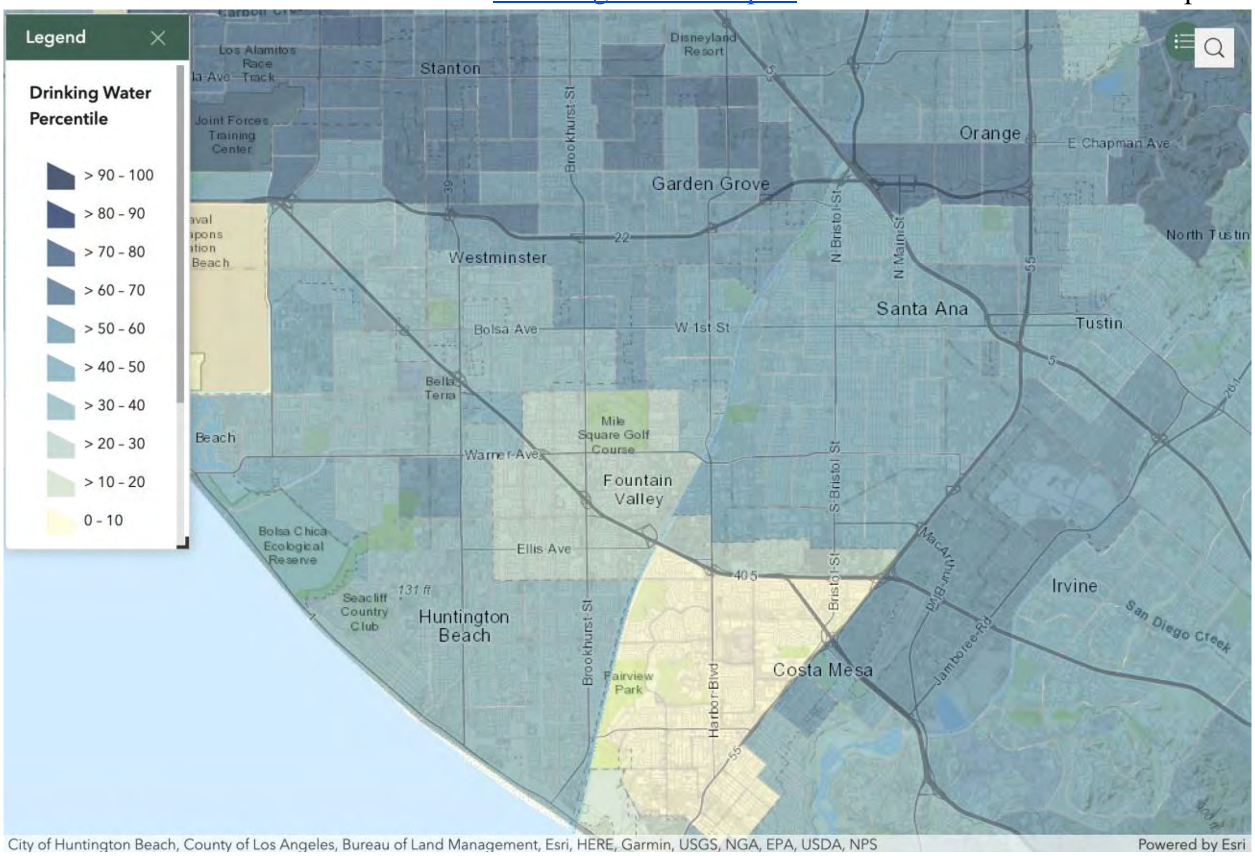


Drinking-Water Contaminants

Most drinking water in California meets health standards. However, drinking water sometimes becomes contaminated with chemicals or bacteria above the standards. Both natural and human sources can contaminate drinking water. Natural sources include rocks, soil, wildlife and fires. Human sources include factories, sewage, and runoff from farms.

One common contaminant, arsenic, occurs naturally in some rocks and soil and is often found in groundwater in California. It can cause cancer. Nitrate from fertilizer or manure can leach into groundwater and contaminate wells. Nitrate can cause a blood disorder in infants called blue baby syndrome.

More information can be found in the Drinking Water chapter in the CalEnviroScreen 4.0 report.

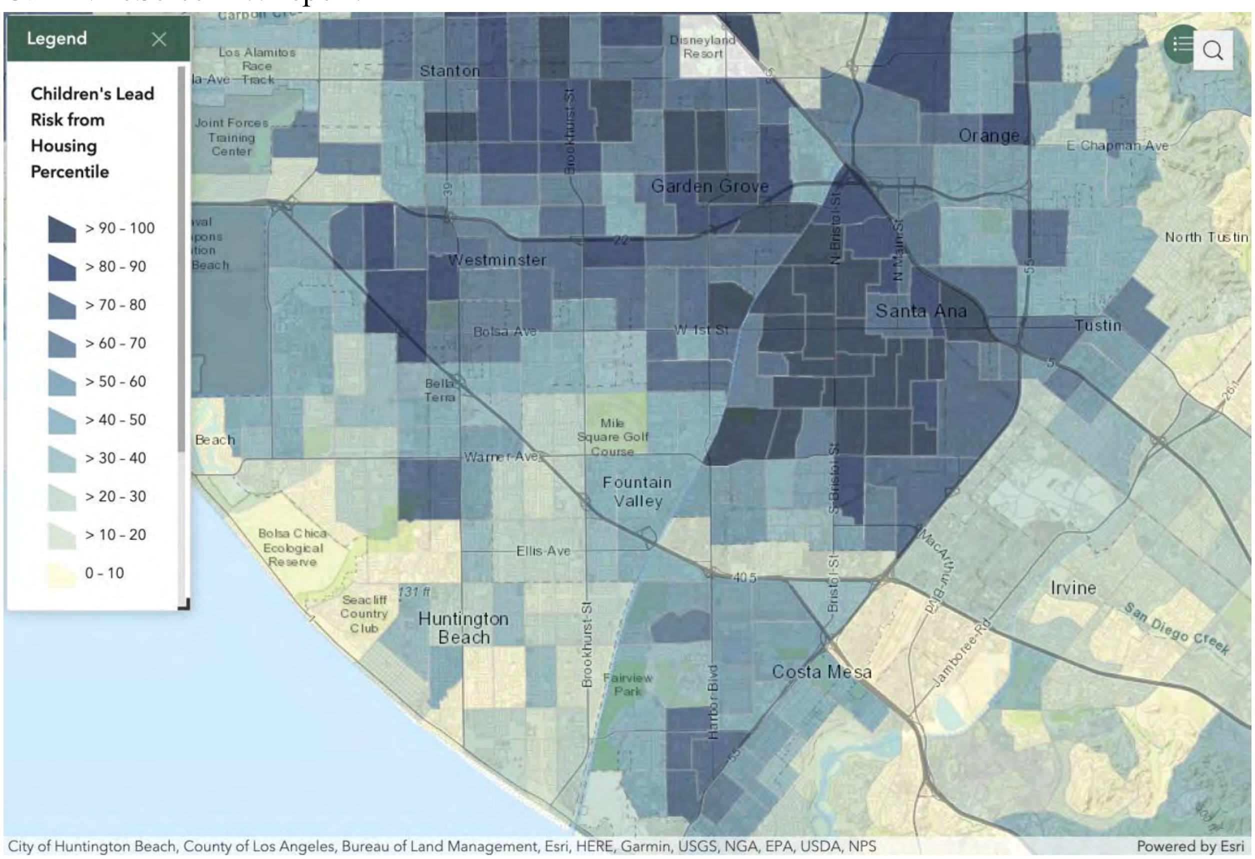


Children's Lead Risk from Housing

Lead is a toxic metal that occurs naturally in the environment. However, the highest levels of lead present in the environment are a result of human activities. Historically, lead has been used in house paint, plumbing, and as a gasoline additive. While lead levels have declined over the past five decades in the United States, it still persists in older housing. Exposure to lead through paint is the most significant source of lead exposure for children.

There are no known safe levels of lead exposure. Young children are especially susceptible to the effects of lead exposure and can suffer adverse health effects, particularly in the brain and nervous system. This increased susceptibility is due to children's unique exposure pathways, developing brains, and differences in the absorption of ingested lead. Children's exposure to lead even at low levels can lead to a higher likelihood of lower IQ and educational performance outcomes, and symptoms of attention deficit hyperactivity disorder (ADHD).

More information can be found in the Children's Lead Risk from Housing chapter in the CalEnviroScreen 4.0 report.

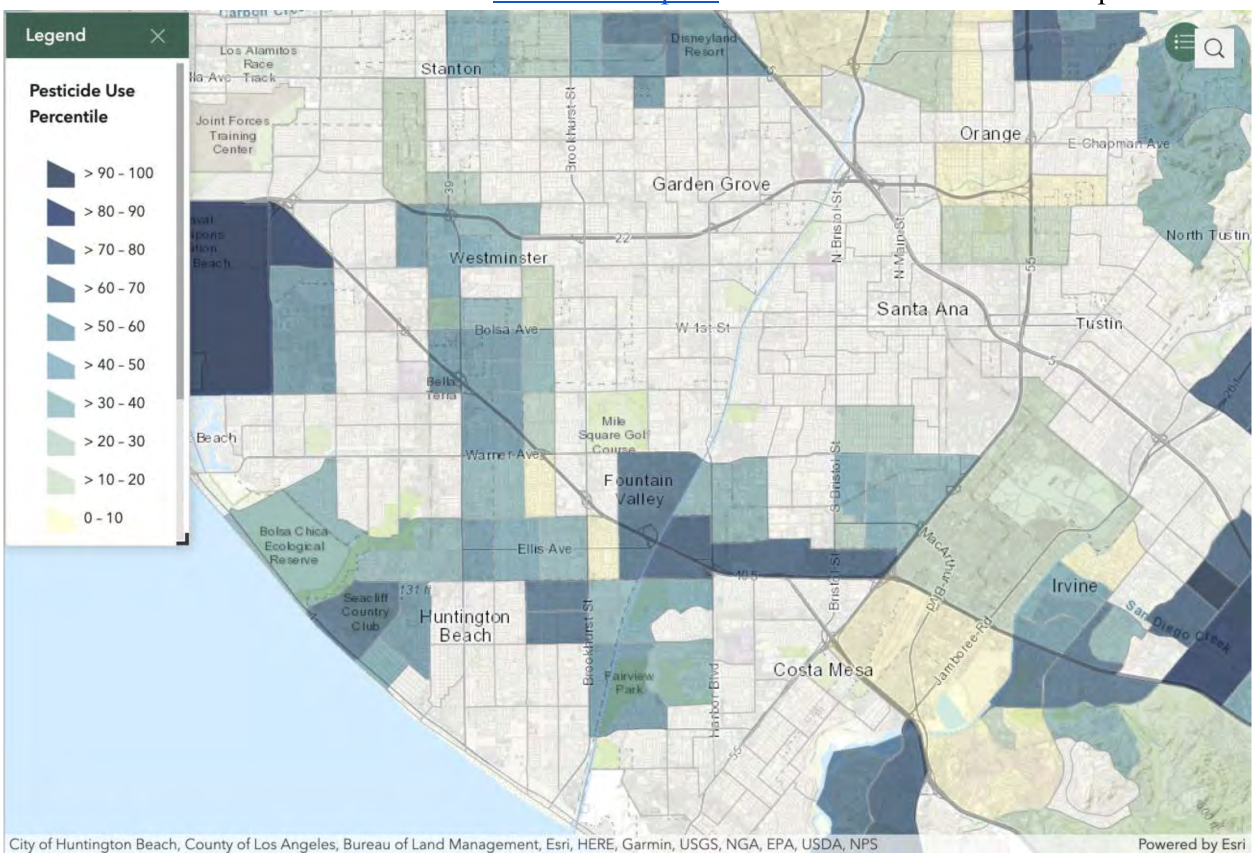


Pesticide Use

Pesticides are chemicals used to control insects, weeds and plant diseases. Over 1,000 pesticides are registered for use in California. They are applied to fields by air, by farm machinery, or by workers on the ground.

Farmworker families and other people who live near fields can be exposed to pesticides, both outdoors and inside homes. Exposure to high levels of some pesticides can cause illness right away or conditions such as birth defects or cancer later in life.

More information can be found in the Pesticide chapter in the CalEnviroScreen 4.0 report.

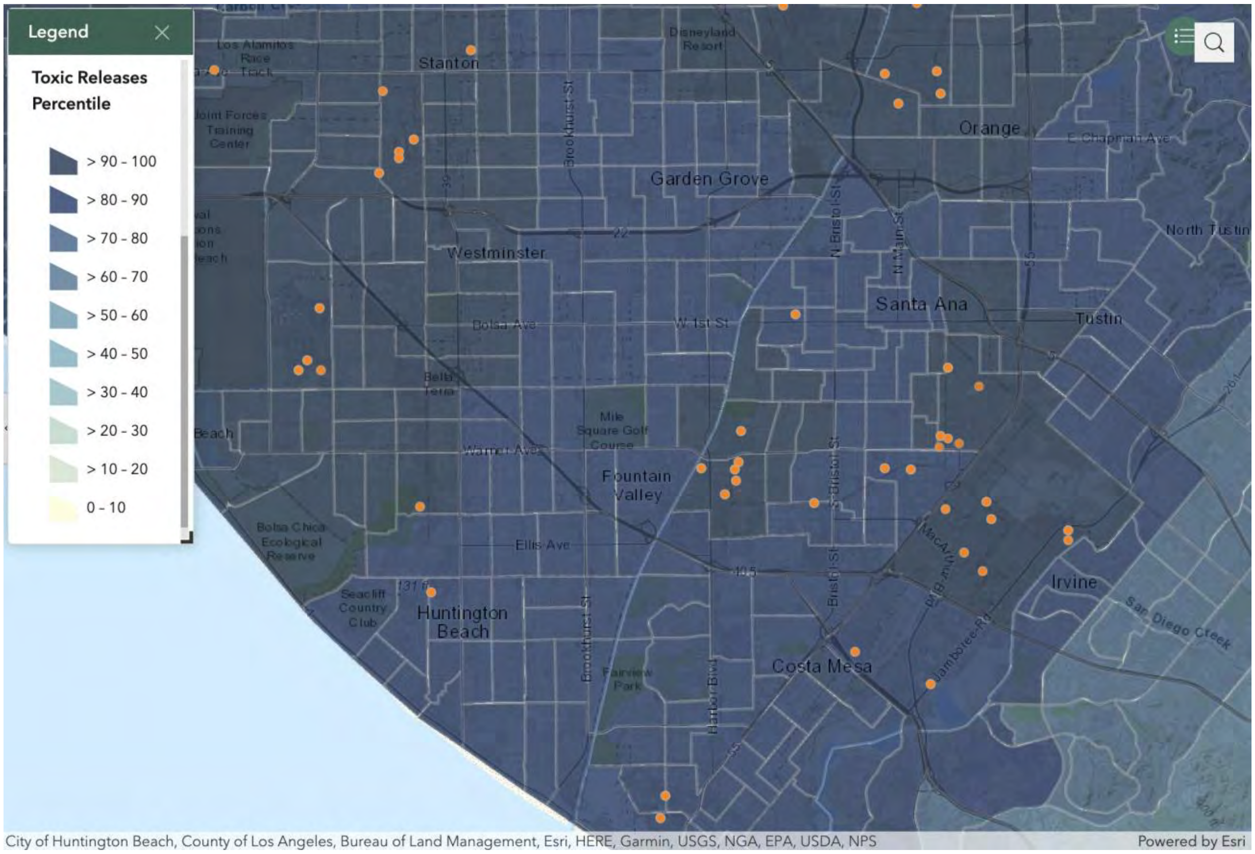


Toxic Releases from Facilities

Facilities that make or use toxic chemicals can release these chemicals into the air. [Information is available](#) on the amount of chemicals released for over 500 chemicals for large facilities in the United States.

These chemicals are sometimes detected in the air of communities nearby. People living near facilities may breathe contaminated air regularly or if contaminants are released during an accident.

More information can be found in the [Toxic Releases chapter](#) in the CalEnviroScreen 4.0 report.

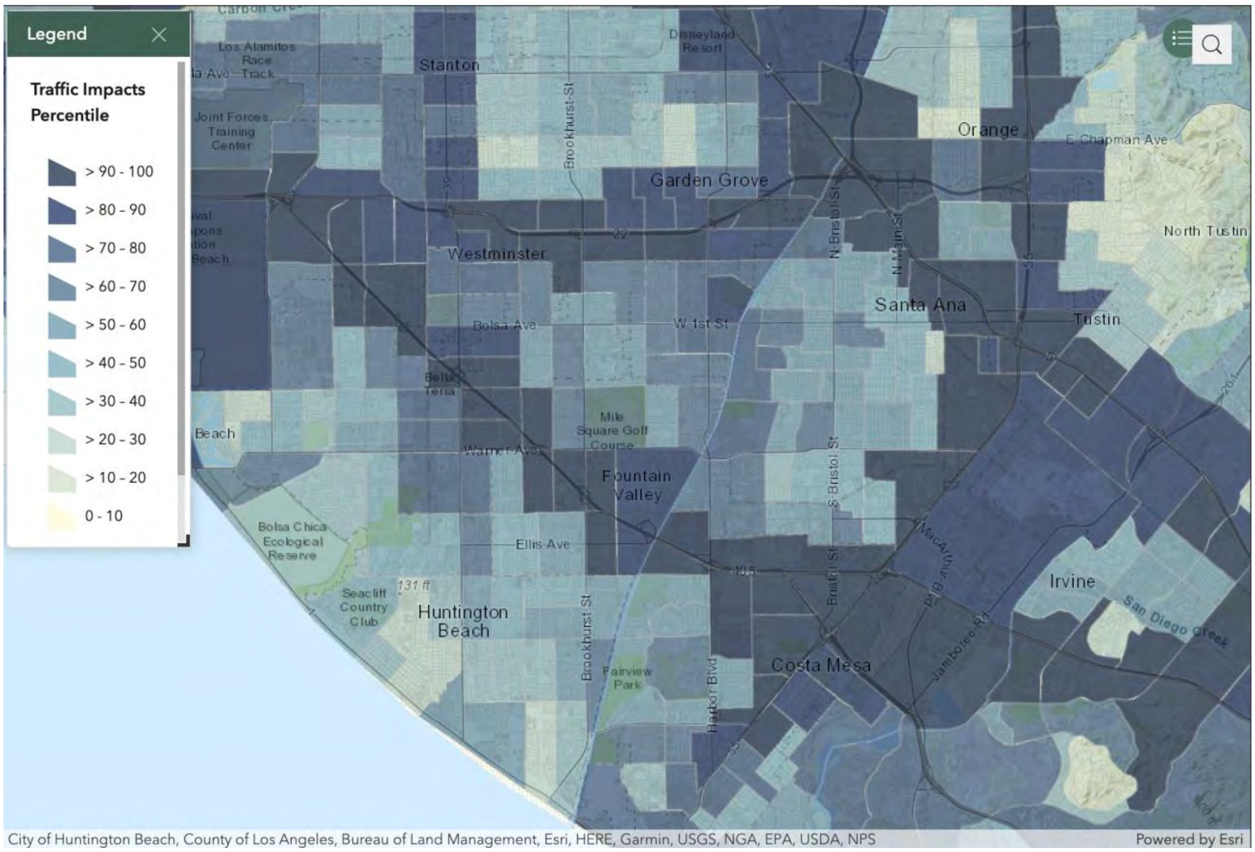


Traffic Impacts

California has the biggest network of freeways in the country. Its cities are known for heavy traffic. Traffic density is a measure of the number of vehicles on the roads in an area.

While California has strict vehicle-emissions standards, exhaust from cars and trucks is the main source of air pollution in much of the state. Major roads and highways can bring air pollutants and noise into nearby neighborhoods. Children who live or go to schools near busy roads have higher rates of asthma than children in areas farther from roads.

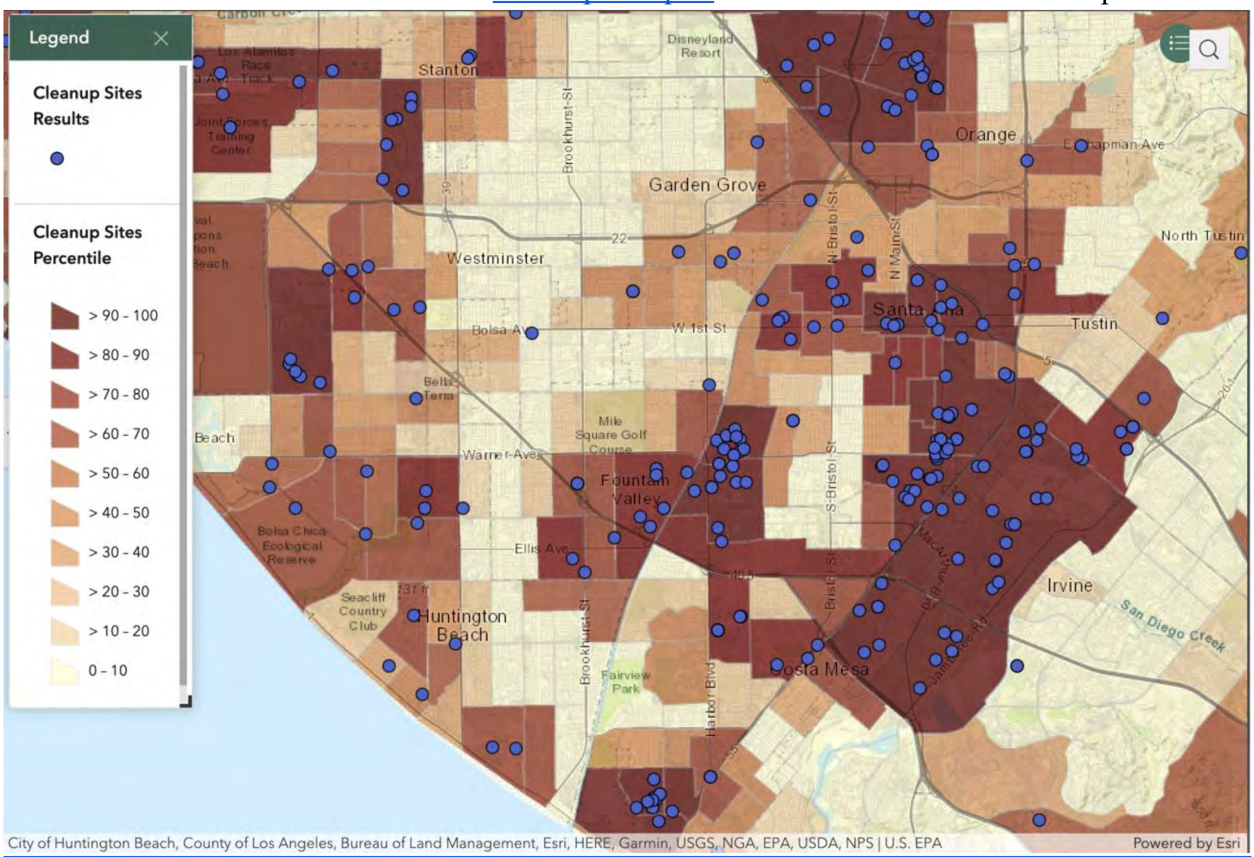
More information can be found in the [Traffic Impacts chapter] in the CalEnviroScreen 4.0 report.



Cleanup Sites

Cleanup sites are places that are contaminated with hazardous chemicals and require clean up by the property owners or government. Chemicals at cleanup sites can move through the air or groundwater. People living near these sites have a greater potential to be exposed to chemicals from the sites than people living further away.
Some studies have shown that neighborhoods with cleanup sites are generally poorer and have more people of color than other neighborhoods. The land may take many years or decades to clean up, reducing possible benefits to the community.

More information can be found in the Cleanups chapter in the CalEnviroScreen 4.0 report.

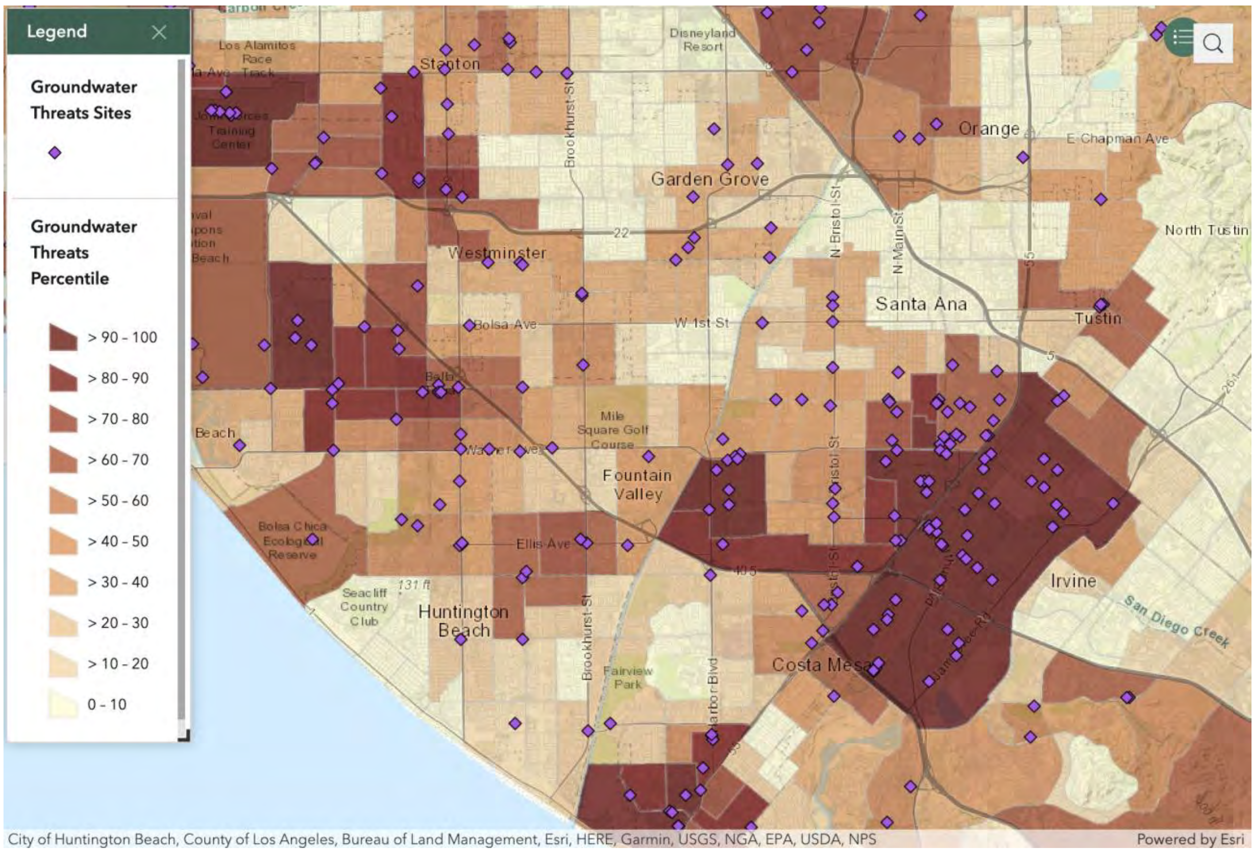


Groundwater Threats

Hazardous chemicals are often stored in containers on land or in underground storage tanks. Leaks from tanks can contaminate soil and groundwater. Common soil and groundwater pollutants include gasoline and diesel fuels at gas stations, as well as solvents, heavy metals and pesticides.

Leaking tanks can affect drinking water and expose people to contaminated soil and air. The land and groundwater may take many years or decades to clean up.

More information can be found in the [Groundwater Threats chapter](#) in the CalEnviroScreen 4.0 report.



Hazardous Waste

Hazardous waste contains chemicals that may be harmful to health. Only certain facilities are allowed to treat, store or dispose of this type of waste. Hazardous waste can range from used automotive oil to highly toxic waste materials produced by factories and businesses. Hazardous waste is transported from businesses that generate waste to permitted facilities for recycling, treatment, storage or disposal.

Studies have found that hazardous waste facilities are often located near poor neighborhoods and communities of color.

Hazardous waste facilities often are cause for concerns about effects on health and the environment in the communities where they operate.

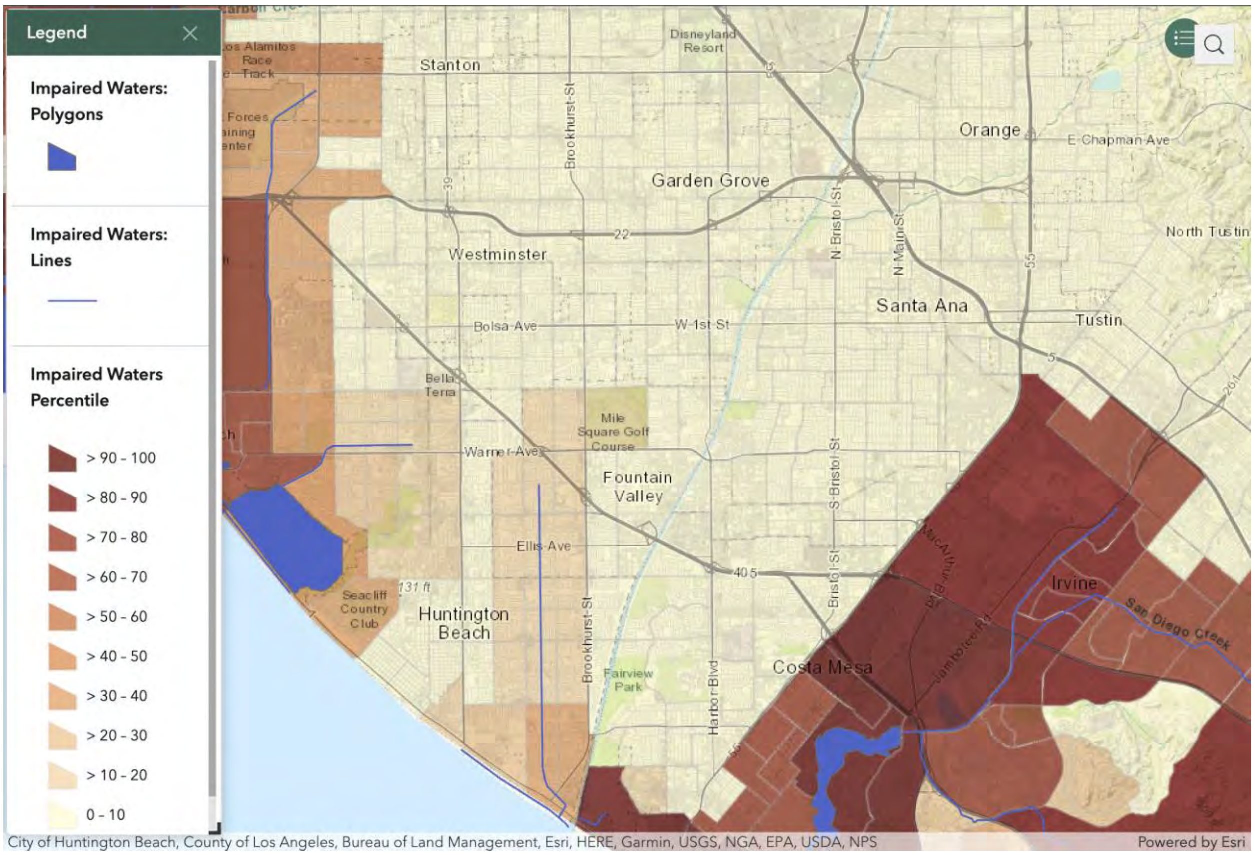
More information can be found in the [Hazardous Waste chapter](#) in the CalEnviroScreen 4.0 report.

Impaired Waters

Water bodies like streams, rivers or lakes are used for recreation and fishing or may provide water for drinking or irrigation. When water bodies are contaminated by pollutants, they are considered impaired. These impairments can harm wildlife habitats and prevent recreational and other uses of the water body.

Certain groups such as tribal or low-income communities may depend on the fish and wildlife in nearby water bodies more than the general public.

More information can be found in the [Impaired Water Bodies chapter] in the CalEnviroScreen 4.0 report.

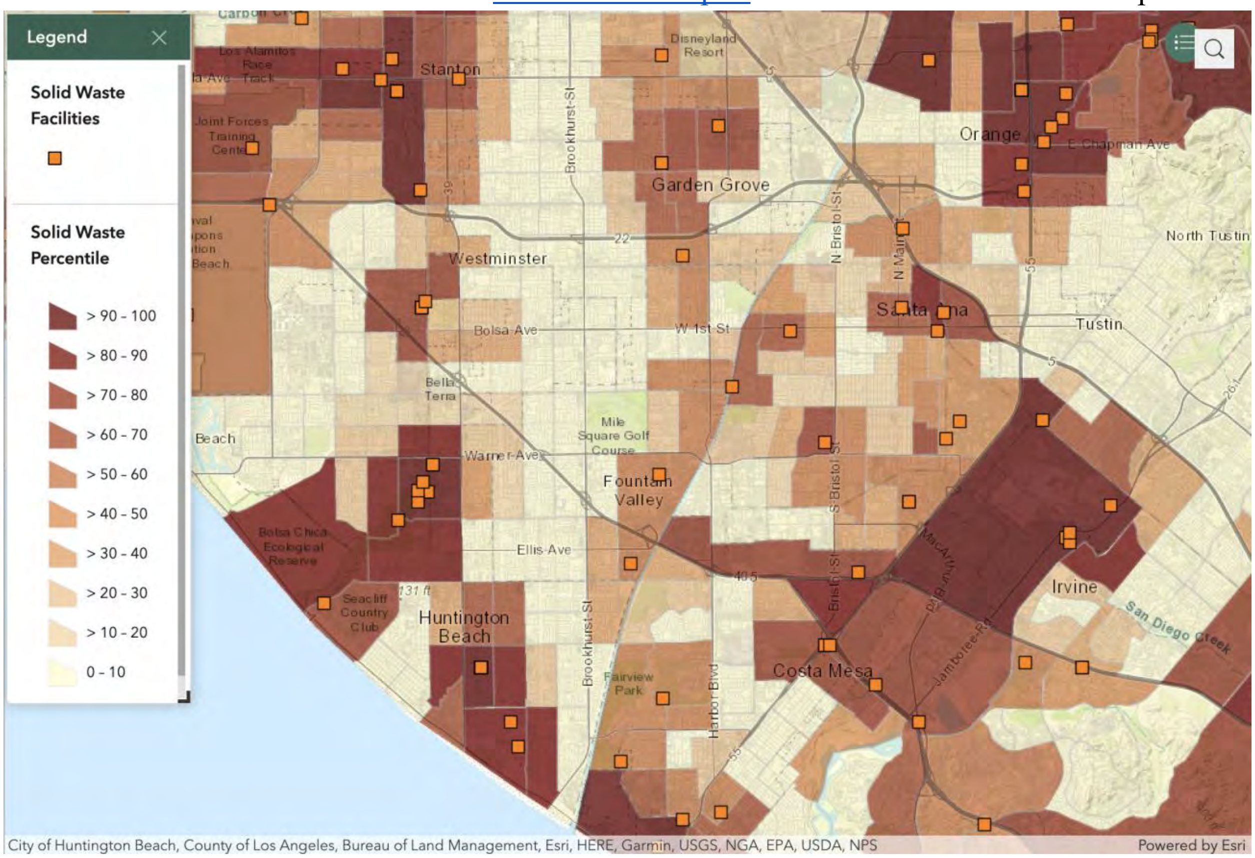


Solid Waste Sites

Solid waste facilities are places where household garbage and similar kinds of waste are collected, processed, or stored. These include landfills and composting or recycling facilities. The waste material may come from homes, factories or businesses. Most of these operations require permits.

Regulated facilities as well as illegal sites that do not comply with the law can harm the environment and potentially expose people to hazardous substances. Solid waste facilities can also raise concern in a community about odors, insect pests, vermin, and truck traffic. The communities near solid waste facilities are usually home to poor and communities of color.

More information can be found in the Solid Waste chapter in the CalEnviroScreen 4.0 report.



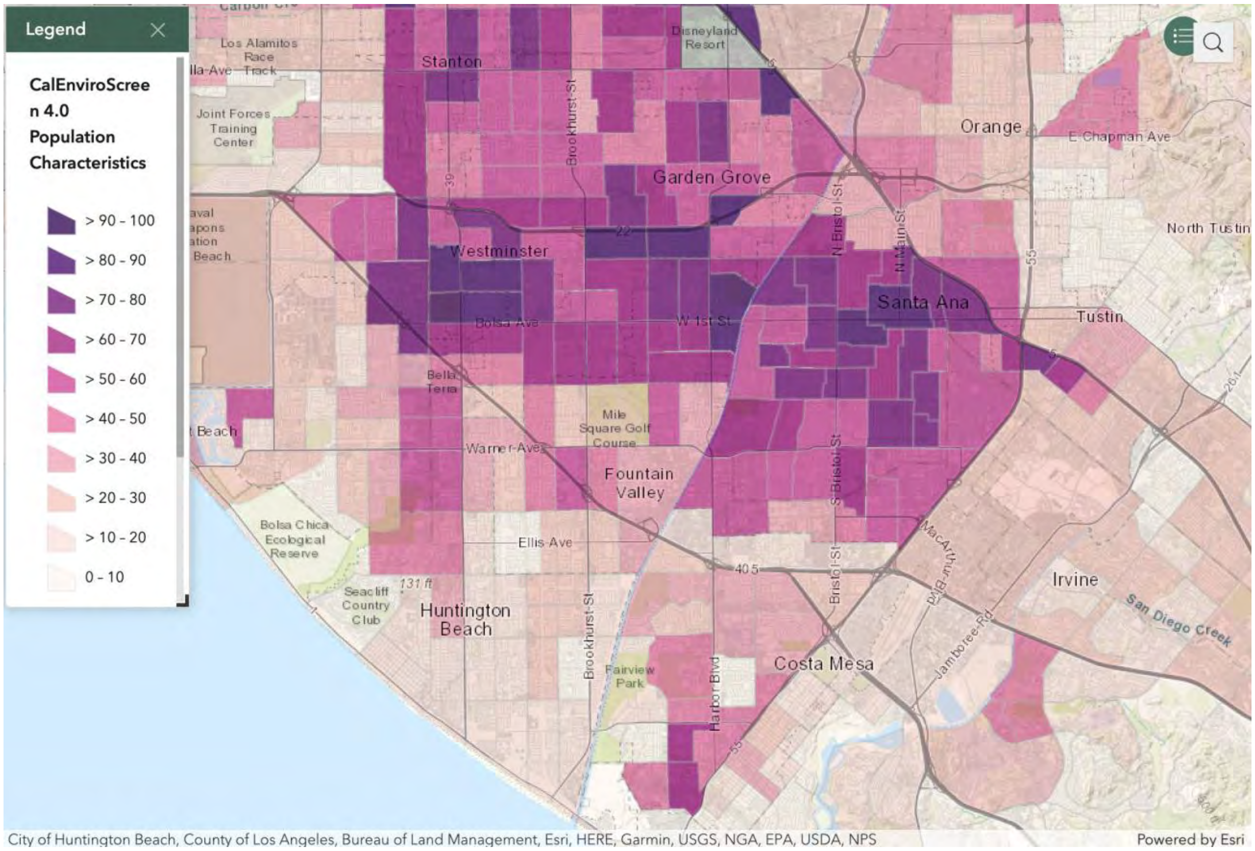
Overall Population Characteristics

Overall CalEnviroScreen scores are calculated from the scores for two groups of indicators: Pollution Burden and Population Characteristics.

This map shows the combined Population Characteristics scores, which is made up of indicators from the Sensitive Populations and Socioeconomic Factors components of the CalEnviroScreen model. Population Characteristics represent physiological traits, health status, or community characteristics that can result in increased vulnerability to pollution.

To explore this map, zoom to a location or type an address in the search bar. Click on a census tract to learn more about the indicator data. All indicator maps can be viewed by clicking on the indicators on the left.

A report with detailed description of indicators and methodology and downloadable results are available at the CalEnviroScreen 4.0 website.

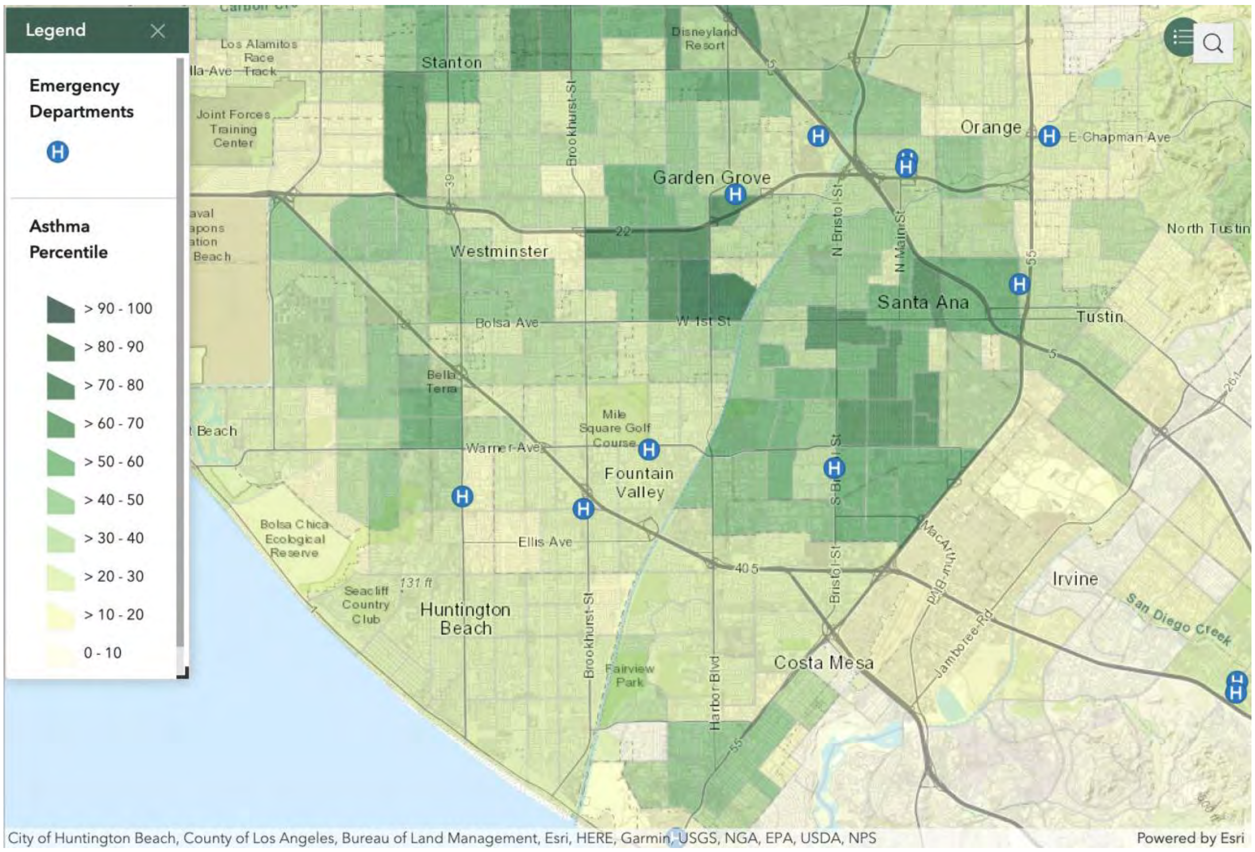


Asthma

Asthma is a disease that affects the lungs and makes it hard to breathe. Symptoms include breathlessness, wheezing, coughing, and chest tightness. The causes of asthma are unknown but both genetic and environmental factors can be involved.

Five million Californians have been diagnosed with asthma at some point in their lives. People with asthma can be especially susceptible to pneumonia, flu and other illnesses. Outdoor air pollution can trigger asthma attacks.

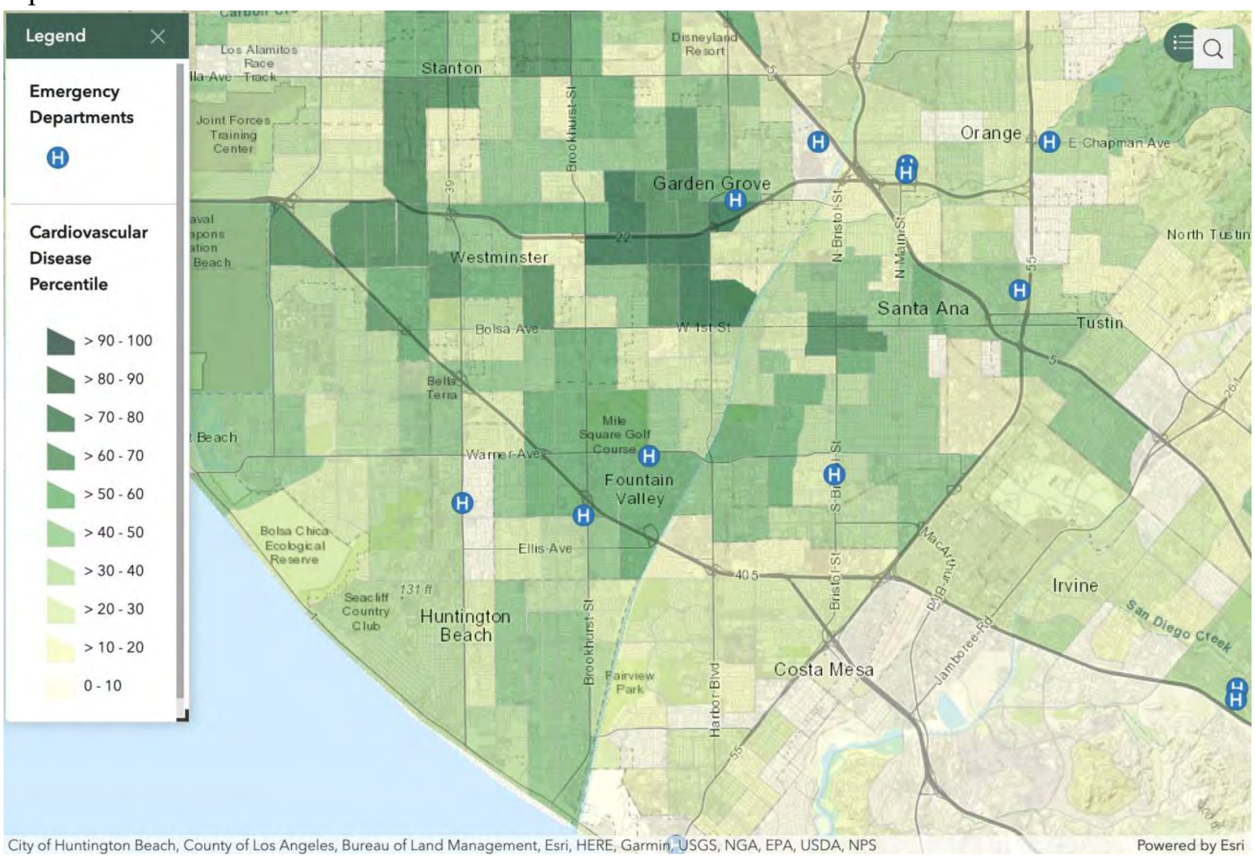
More information can be found in the [Asthma chapter] in the CalEnviroScreen 4.0 report.



Cardiovascular Disease

Cardiovascular disease refers to conditions that involve blocked or narrowed blood vessels of the heart. A heart attack is the most common result of cardiovascular disease. Many people survive and return to normal life after a heart attack, but quality of life may be reduced. There are many risk factors for developing cardiovascular disease including diet, lack of exercise, smoking and exposure to air pollution.
Exposure to outdoor air pollution following a heart attack has been shown to increase the risk of death. In addition to people with a past heart attack, the effects of air pollution may also be greater in the elderly and people with other preexisting health conditions.

More information can be found in the Cardiovascular Disease chapter in the CalEnviroScreen 4.0 report.

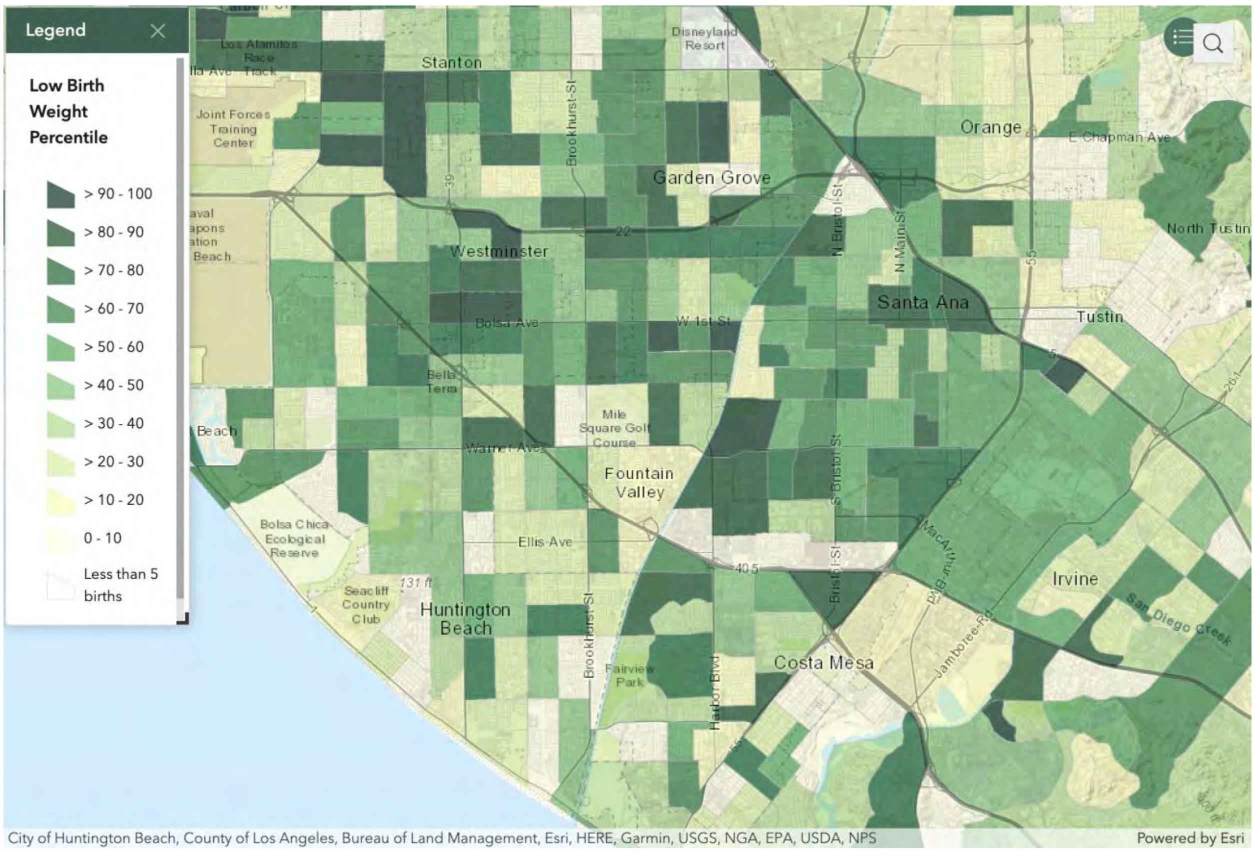


Low Birth Weight

Babies who weigh less than about five and a half pounds (or 2500 grams) at birth are considered low birth weight. Poor nutrition, lack of prenatal care, stress and smoking by the mother are known to increase the risk of having a low birth weight baby. Studies suggest that pollution could also be a factor.

Low birth-weight babies may face a greater risk of developing asthma or other chronic diseases later in life. They are also more likely to die as infants than babies who are not born low weight.

More information can be found in the [Low Birth Weight chapter] in the CalEnviroScreen 4.0 report.

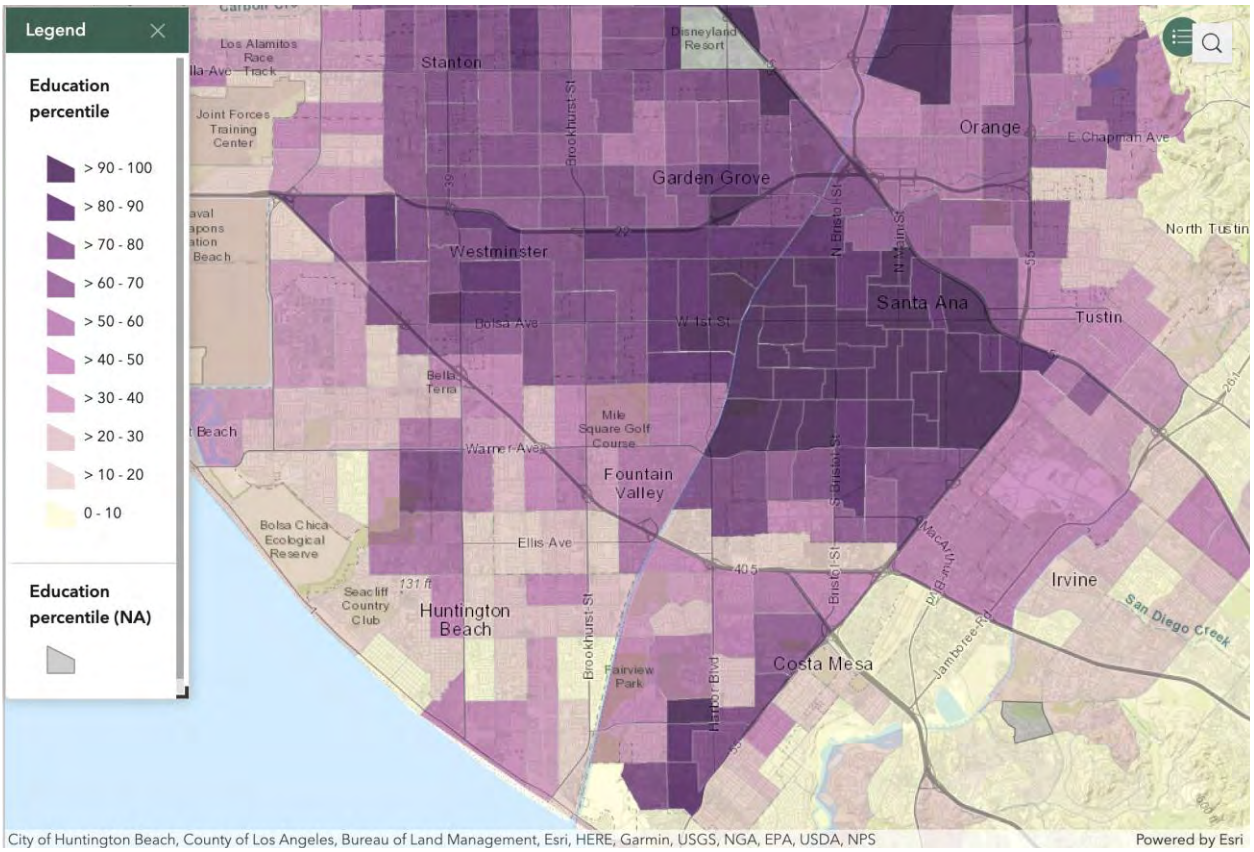


Education

Educational attainment is the highest level of education a person has completed. People with more education usually earn more than people with less education. California has a high percentage of people without high school degrees compared to the rest of the United States, which makes education important to consider.

Many studies have found that the health effects of air pollution are worse among people with low educational attainment.

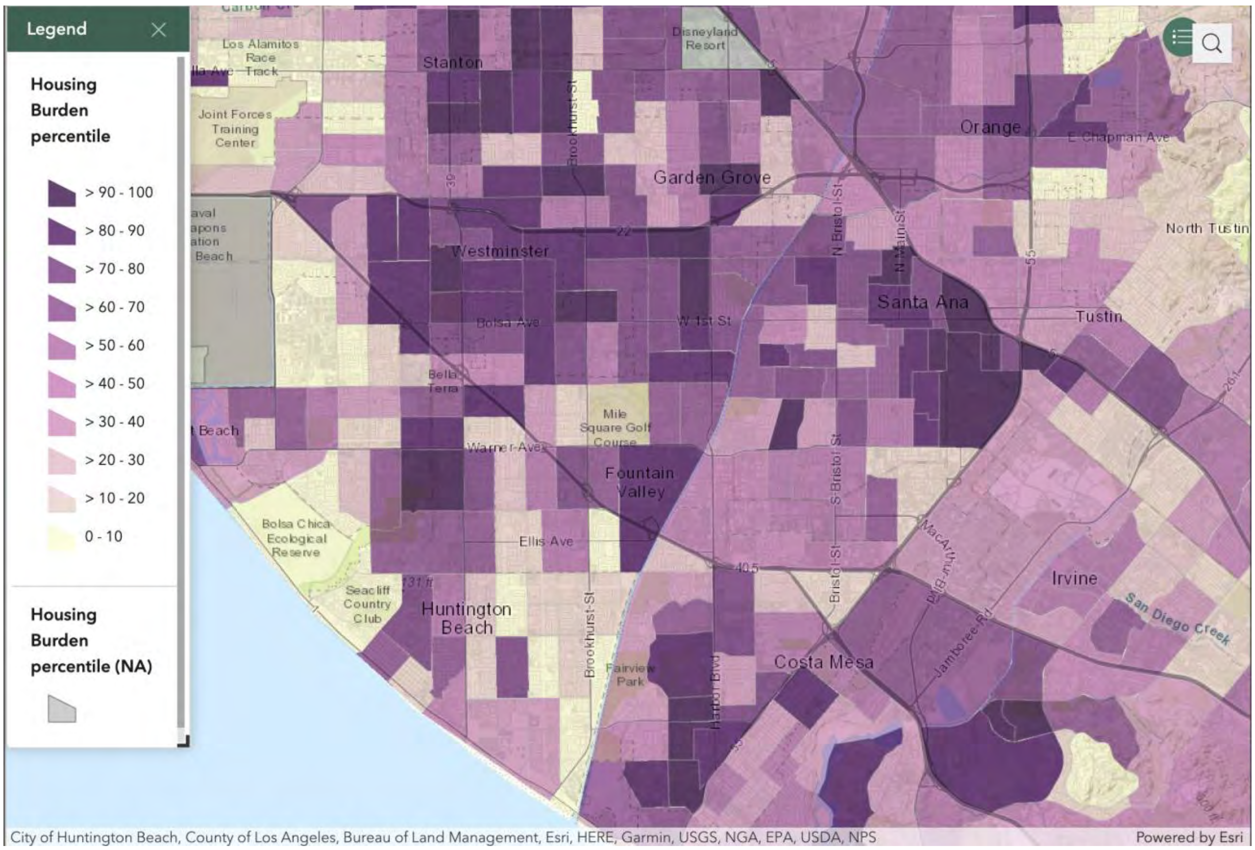
More information can be found in the Educational Attainment chapter in the CalEnviroScreen 4.0 report.



Housing Burden

Housing-burdened low-income households are households that are both low income and highly burdened by housings costs. California has very high housing costs relative to much of the country, which can make it hard for many to afford housing. Households with lower incomes may spend a larger proportion of their income on housing and may suffer from housing-induced poverty.

Housing affordability is an important determinant of health and well-being. Low-income households with high housing costs may suffer adverse health impacts.
More information can be found in the [Housing Burden chapter](#) in the CalEnviroScreen 4.0 report.

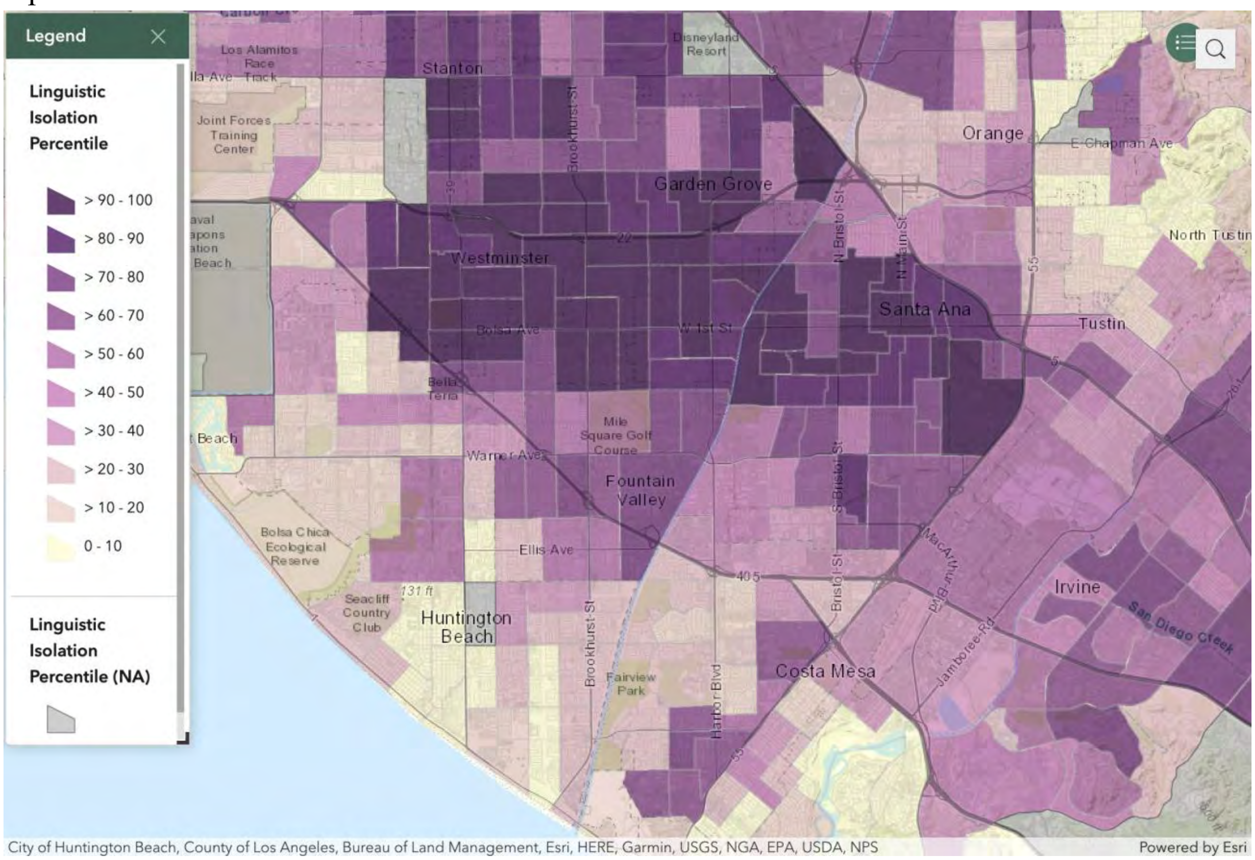


Linguistic Isolation

Linguistic isolation is a term used by the U.S. Census Bureau for limited English-speaking households. More than 40 percent of Californians speak a language other than English at home. About half of those do not speak English well or at all.

Adults who are not able to speak English well often have trouble talking to the people who provide social services and medical care. Linguistically isolated households may also not hear or understand important information when there is an emergency like an accidental chemical release or spill.

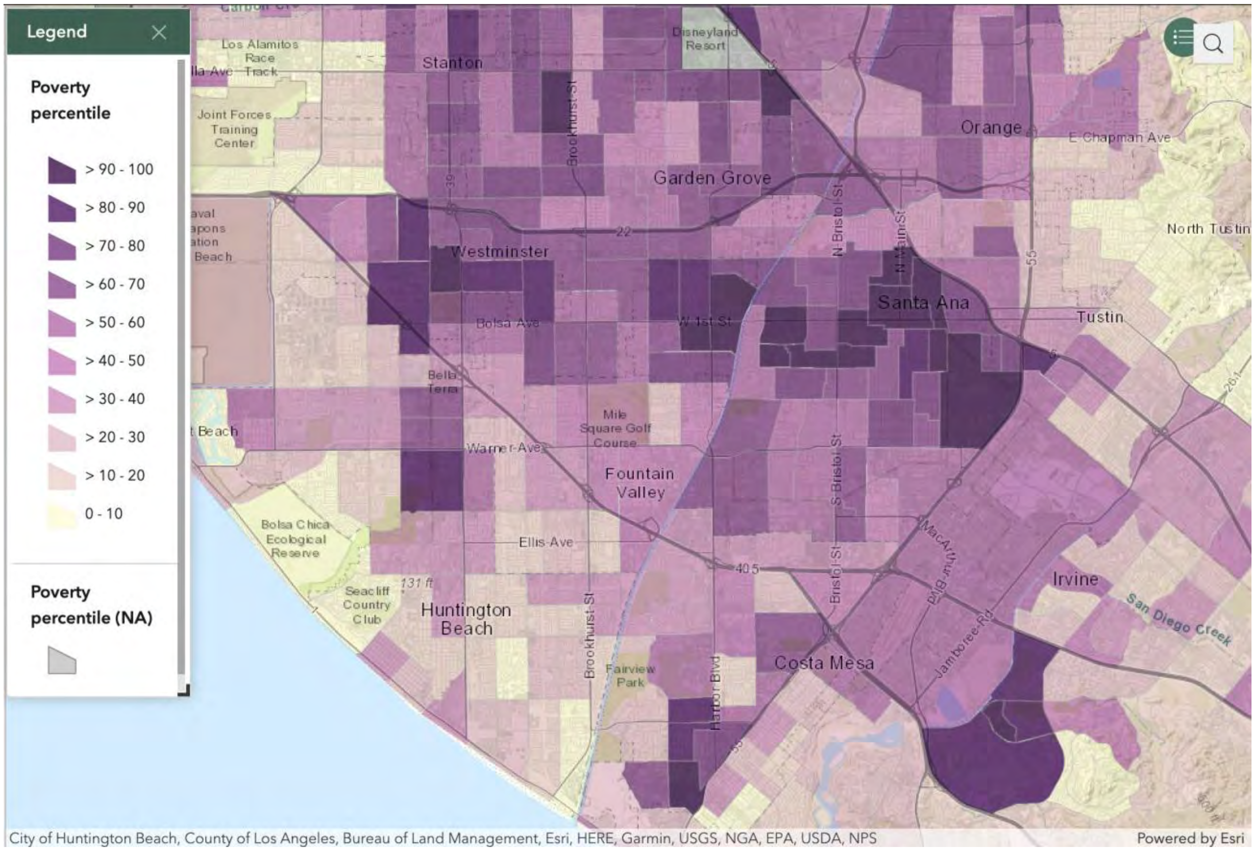
More information can be found in the [Linguistic Isolation chapter](#) in the CalEnviroScreen 4.0 report.



Poverty

The U.S. Census Bureau determines the federal poverty level each year. The poverty level is based on the size of the household and the age of family members. If a person or family's total income before taxes is less than the poverty level, the person or family are considered in poverty. Many studies have found that people living in poverty are more likely than others to become ill from pollution.

More information can be found in the [Poverty chapter](#) in the CalEnviroScreen 4.0 report.

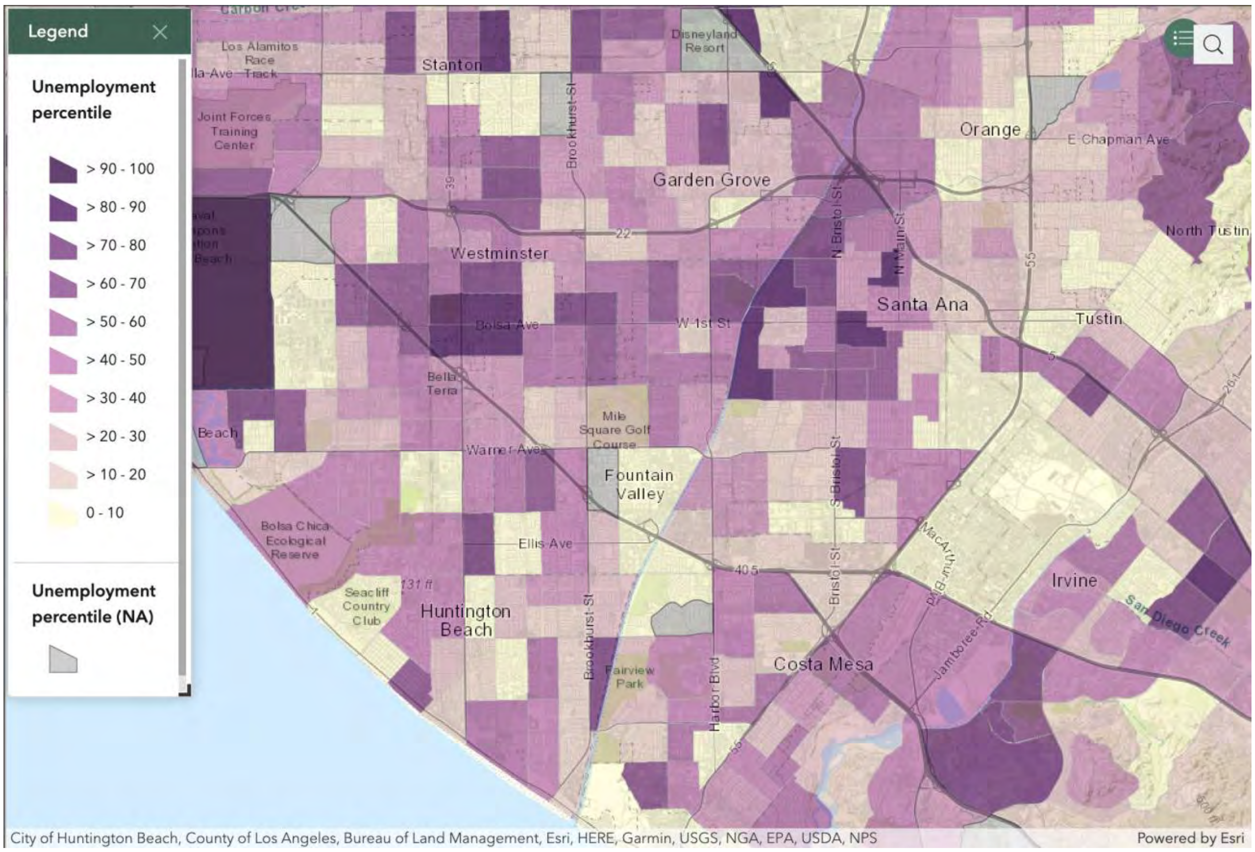


Unemployment

The U.S. Census Bureau counts people who are over 16 years old, out of work and able to work but not working as unemployed. This does not include students, active duty military, retired people or people who have stopped looking for work.

Stress from long-term unemployment can lead to chronic illnesses, such as heart disease, and can shorten a person's life.

More information can be found in the Unemployment chapter in the CalEnviroScreen 4.0 report.

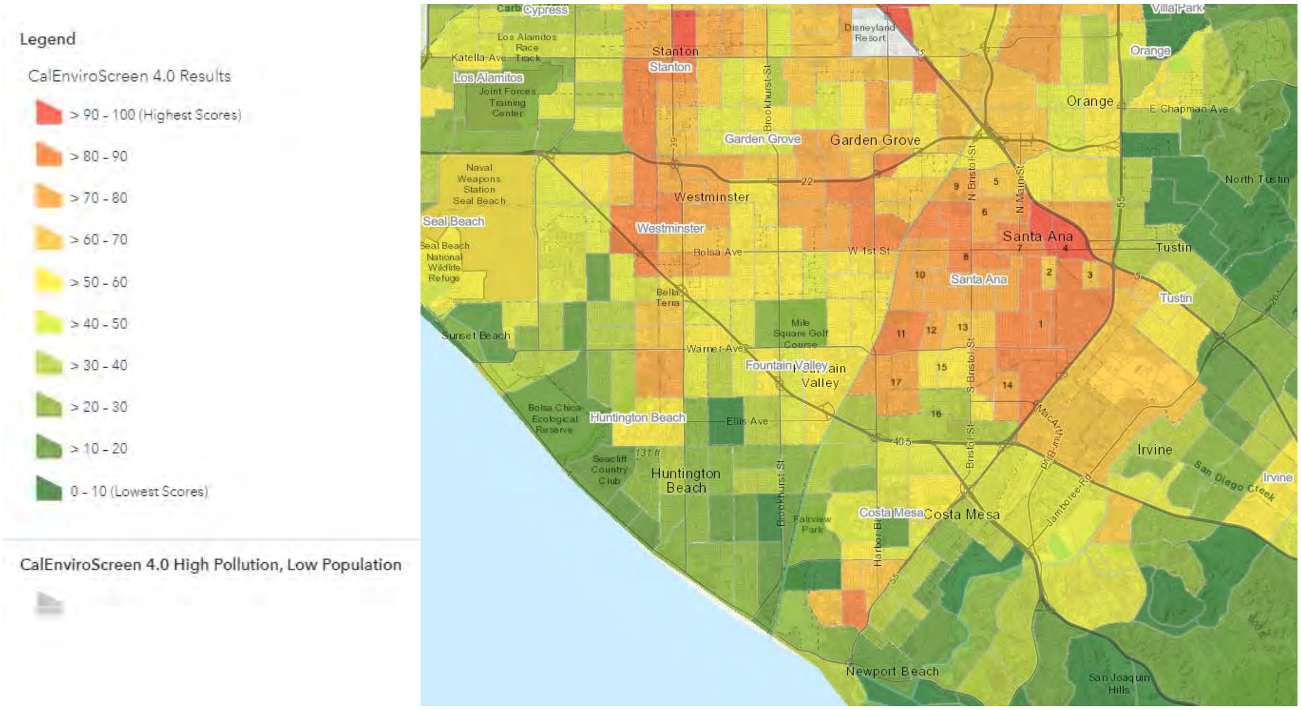


EJ Neighborhood Map

Santa Ana

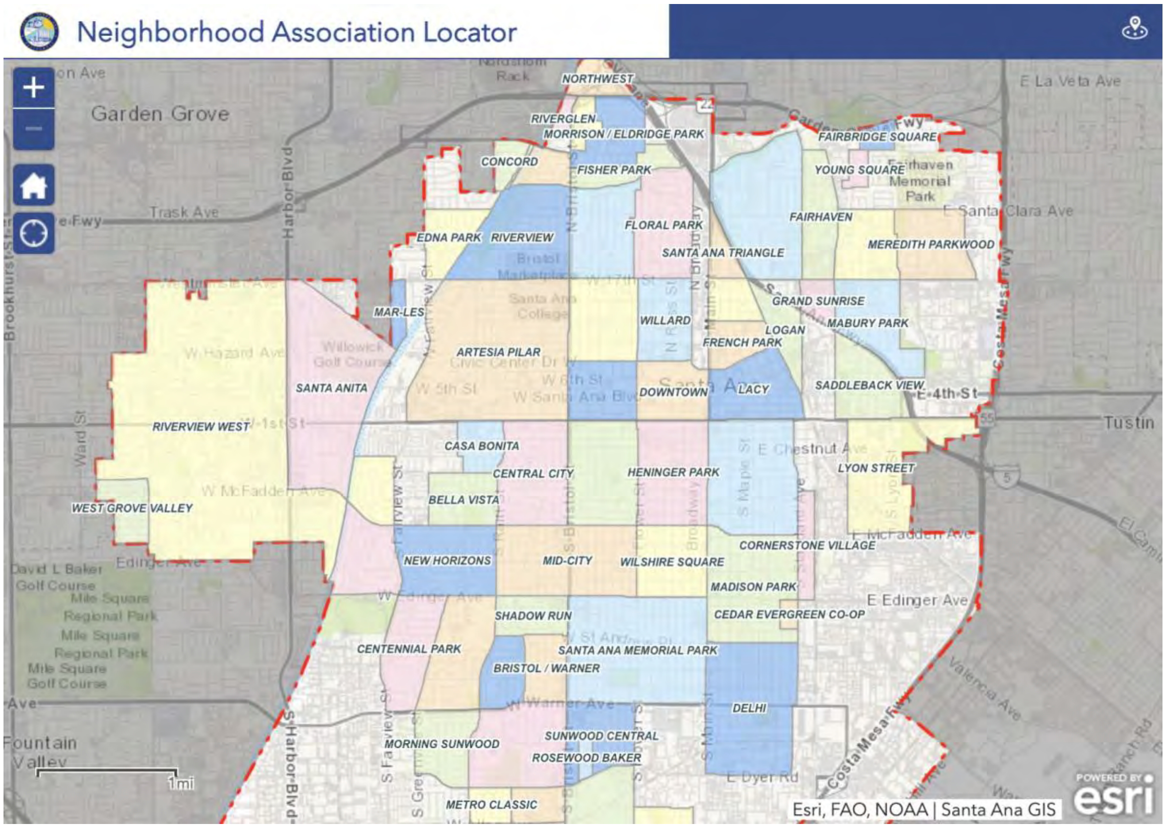
Neighborhoods (1-14, 17 are EJ Neighborhoods)
1 Cedar-Evergreen / Madison Park / portion of north Delhi
2. east edge of Pacific Park (formerly known as Eastside) / Minnie St
3. Lyon Street neighborhood with parts of Tustin
4. Saddleback View / Logan / Lacy / French Park / French Court / northern edge of Pacific Park / northern edge of Lyon Street
5. Floral Park / West Floral Park
6. Washington Square / Willard
7. Downtown
8. South west corner of Artesia Pillar / southern part of Flower Park / northern part of Central City / northern part of Pico-Lowell
9. Riverview
10. Windsor Village North / Sullivan (unofficial) / Bella Vista / Casa Bonita / Central City / and if counting the bottom part of the square - Windsor Village / New Horizons / west part of Mid-City
11. Centennial Park
12. Valley Adams
13. Shadow Run / Laurelhurst / Bristol Warner / western half of Memorial Park
14. Sandpointe
15. Thornton Park / Metro Classic / Republic Homes
16. South Coast (official and unofficial)
17. Morning Sunwood / non-designated neighborhoods

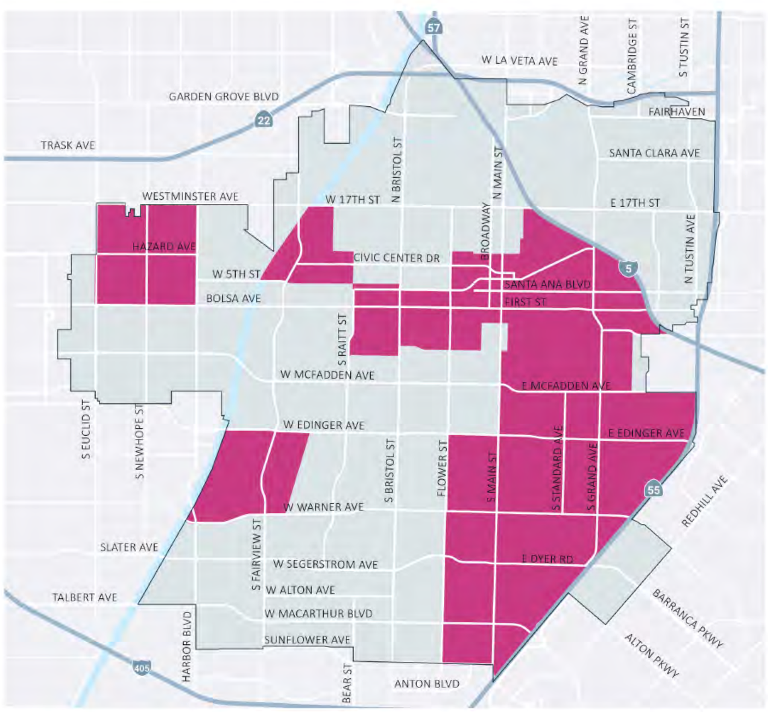
EJ Neighborhood Associations and CES Scores



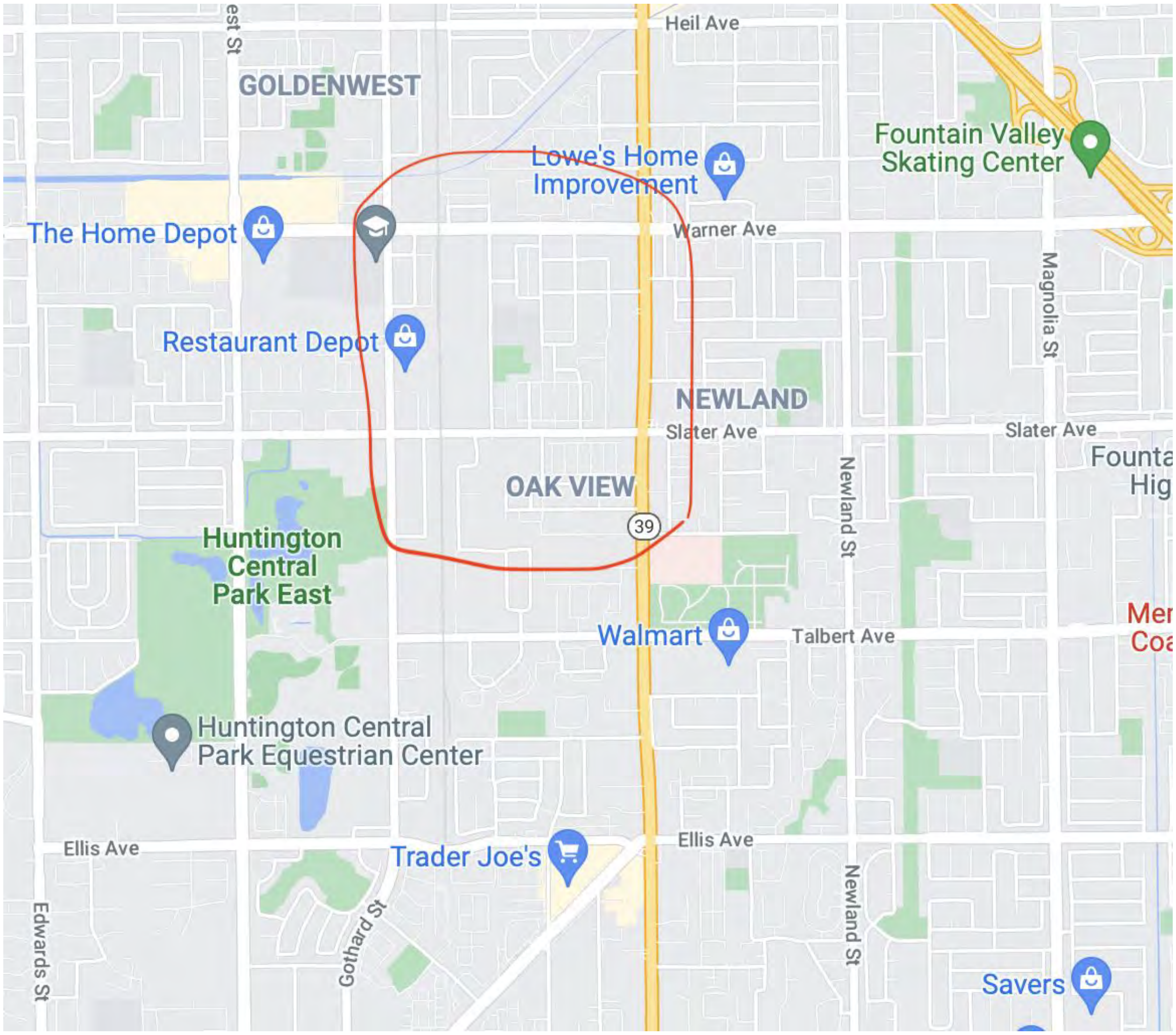
Neighborhood Associations ([City of Santa Ana](#))

Neighborhood Associations Cont.

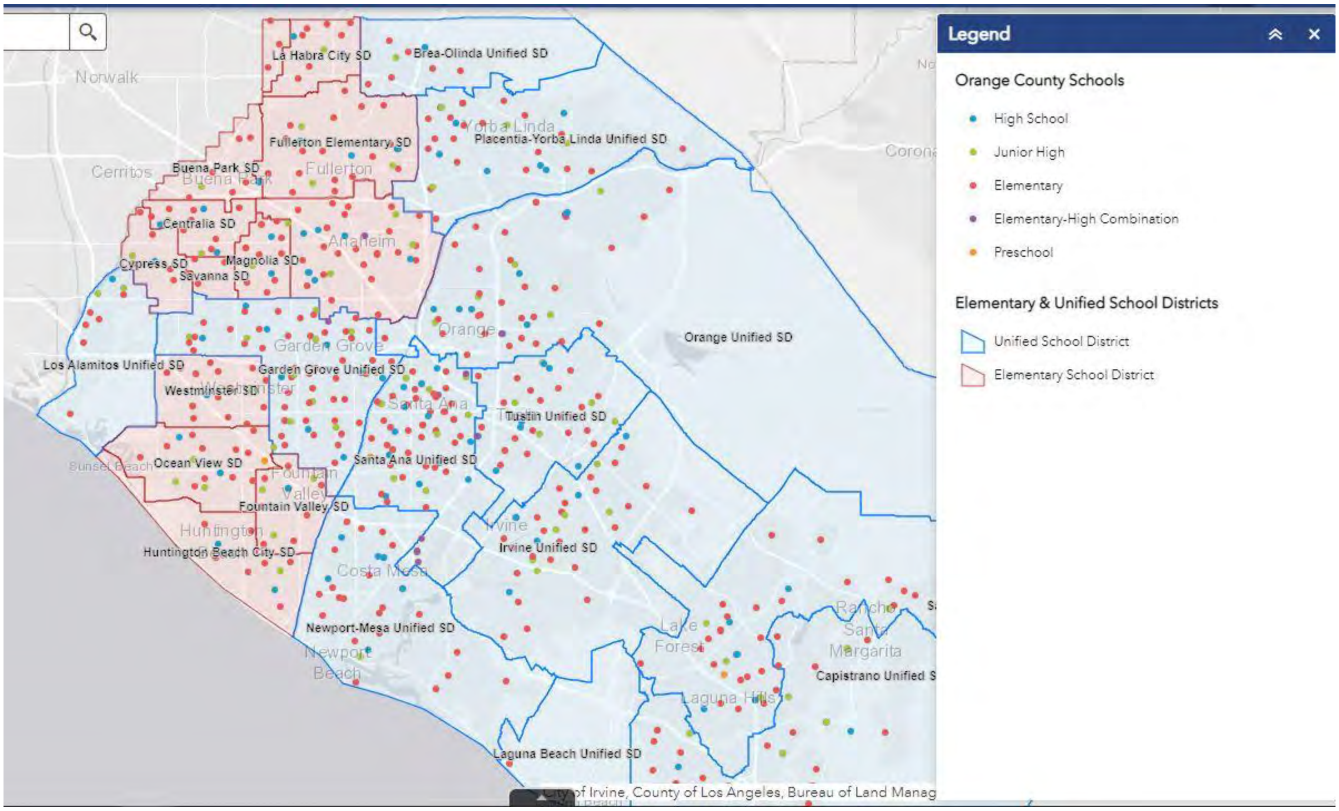




Huntington Beach – Oakview EJ Community

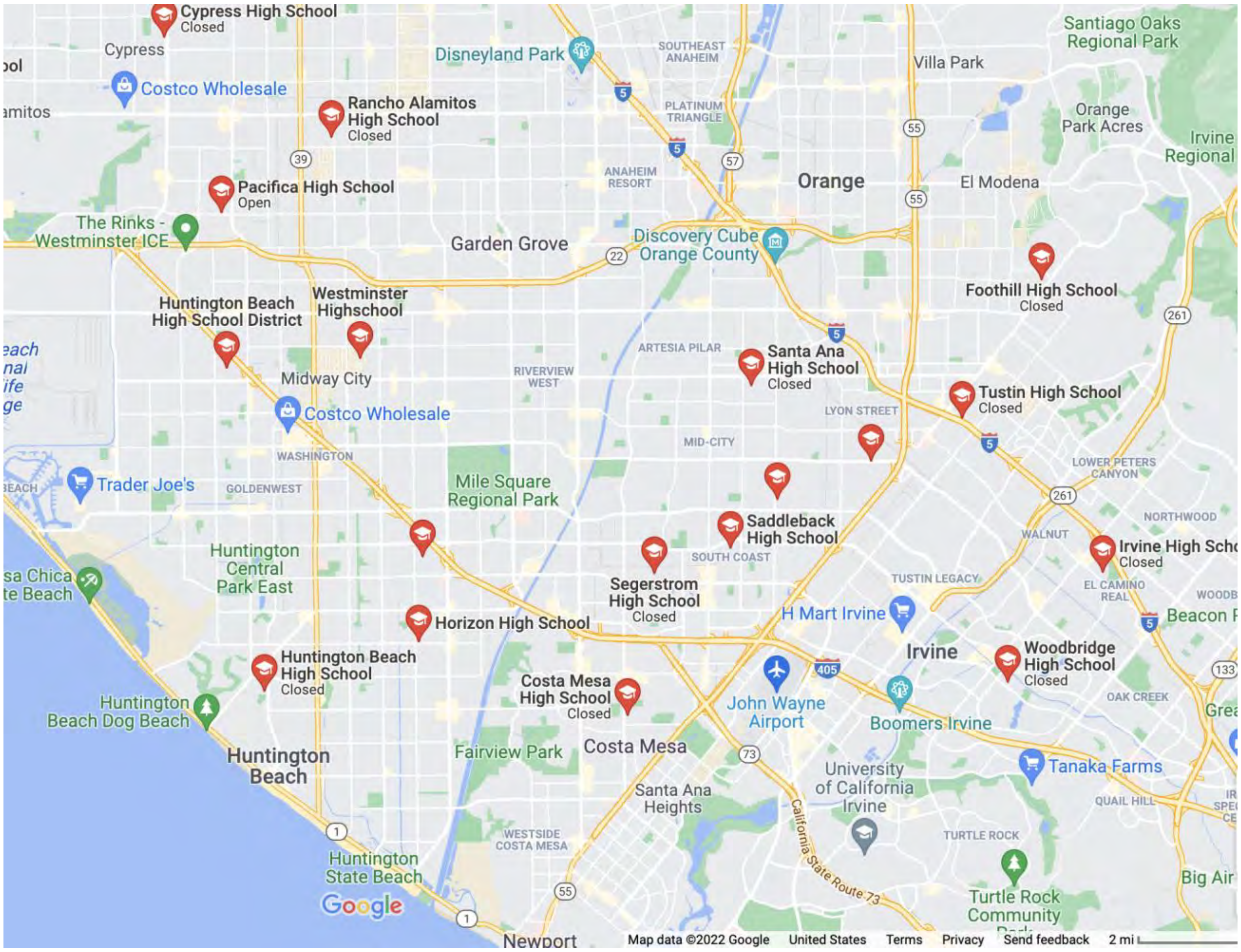


Schools + Learning Centers

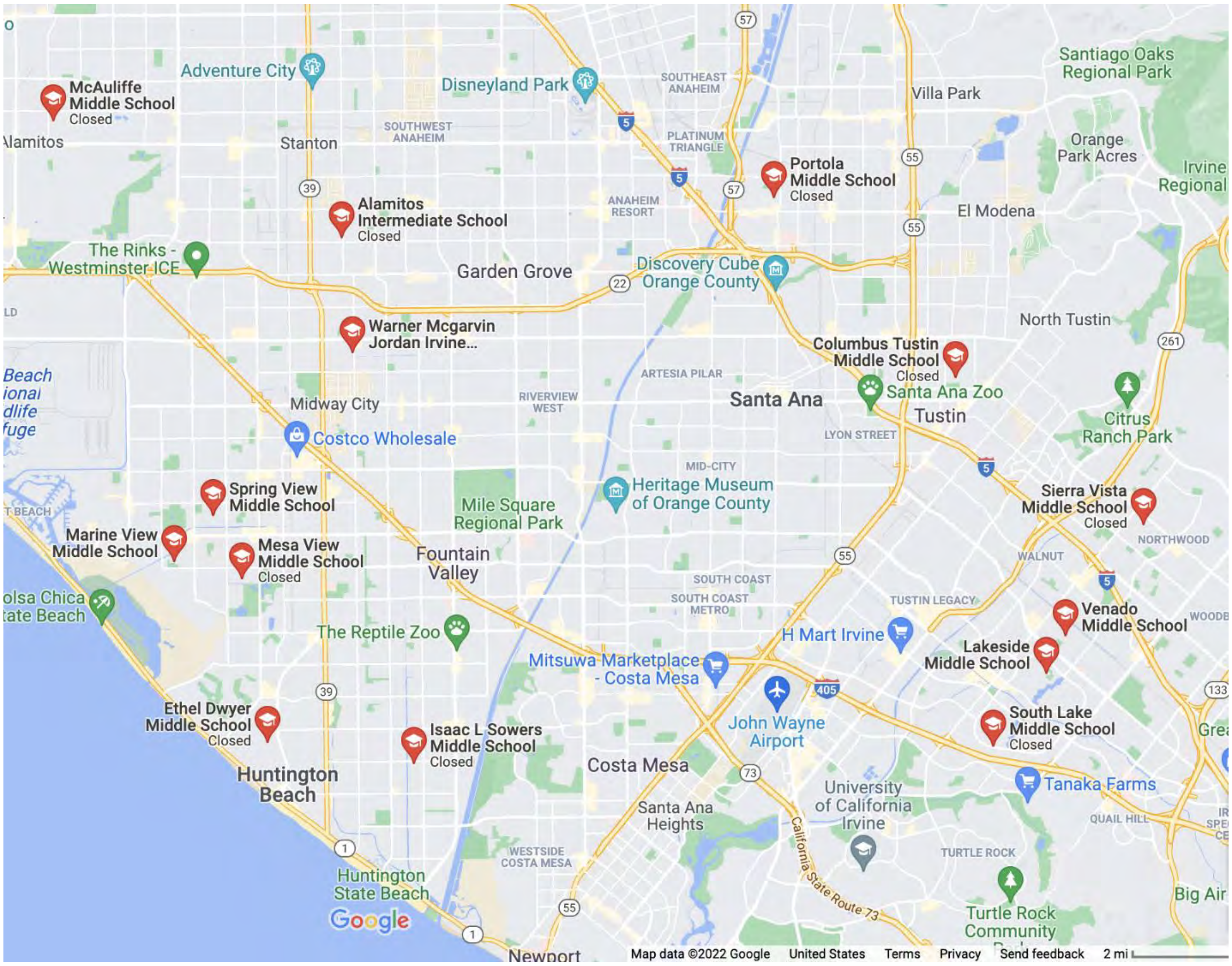


(interactive map of Orange County Schools here:https://www.arcgis.com/apps/webappviewer/index.html?id=c81a8f6f6b544b7f87b96ae3d7ffd27c)

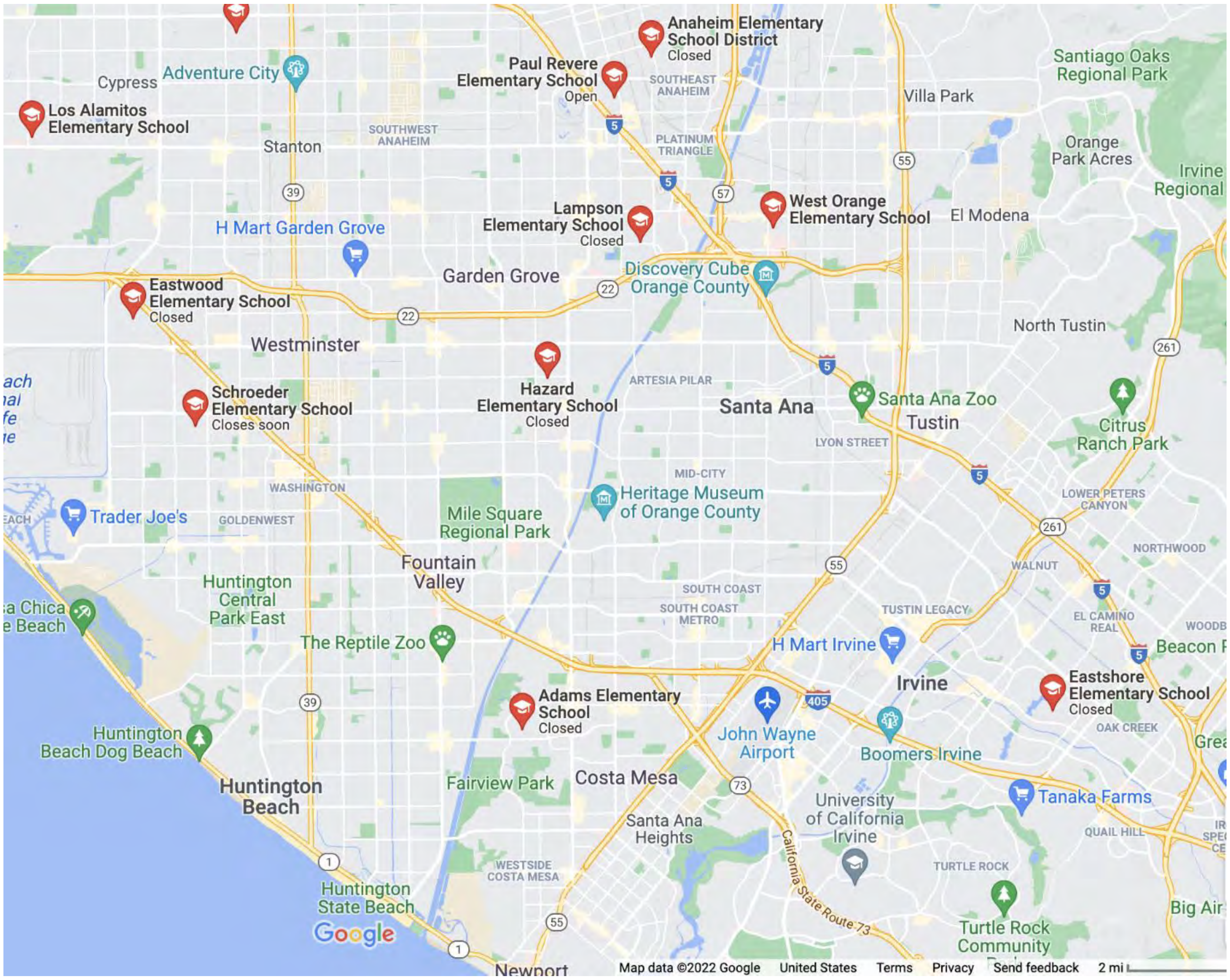
Schools + Learning Centers Cont. - Some OCWD High Schools



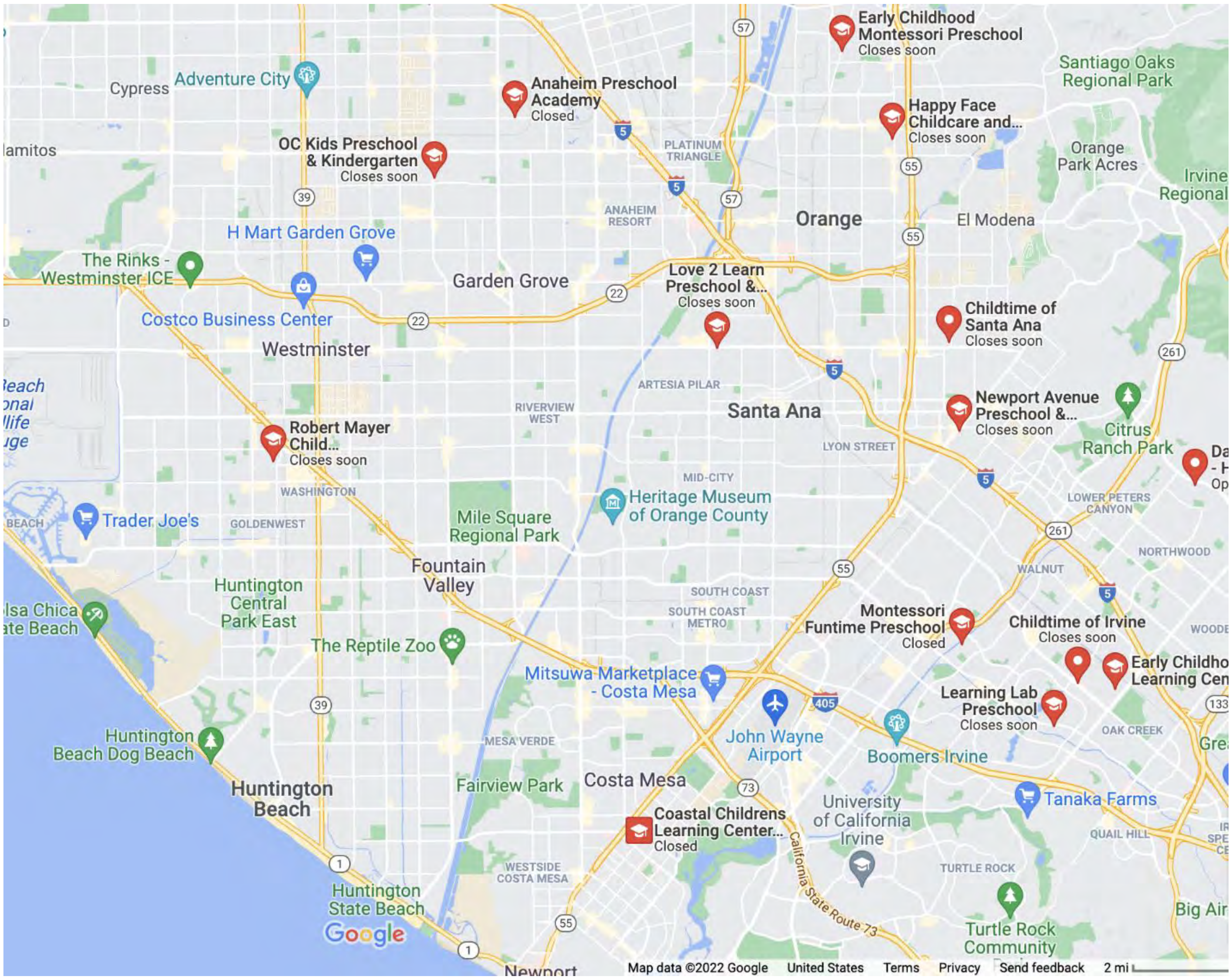
Schools + Learning Centers Cont. - Some OCWD Middle Schools



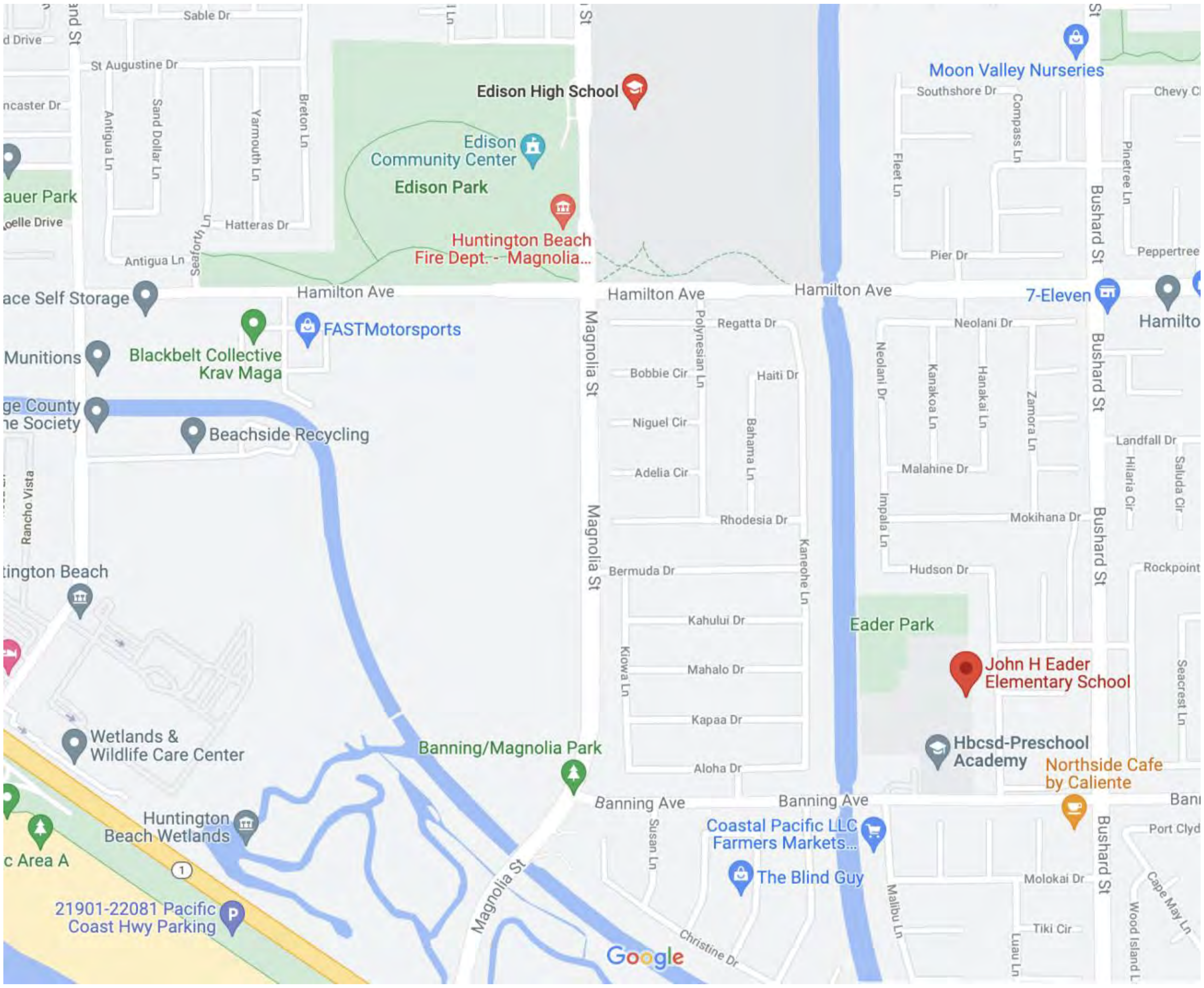
Schools + Learning Centers Cont. - Some OCWD Elementary Schools



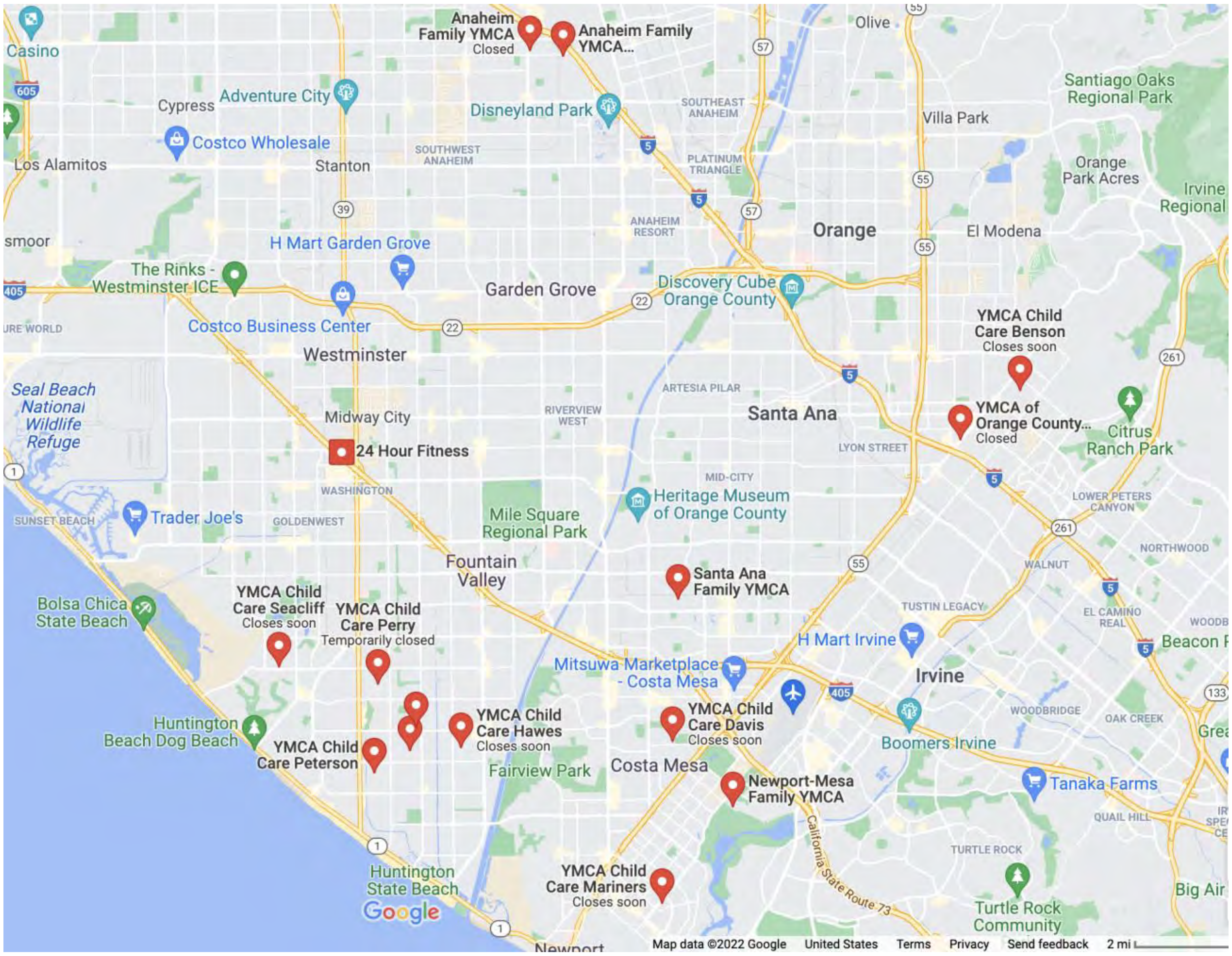
Schools + Learning Centers Cont. - Some OCWD Preschools



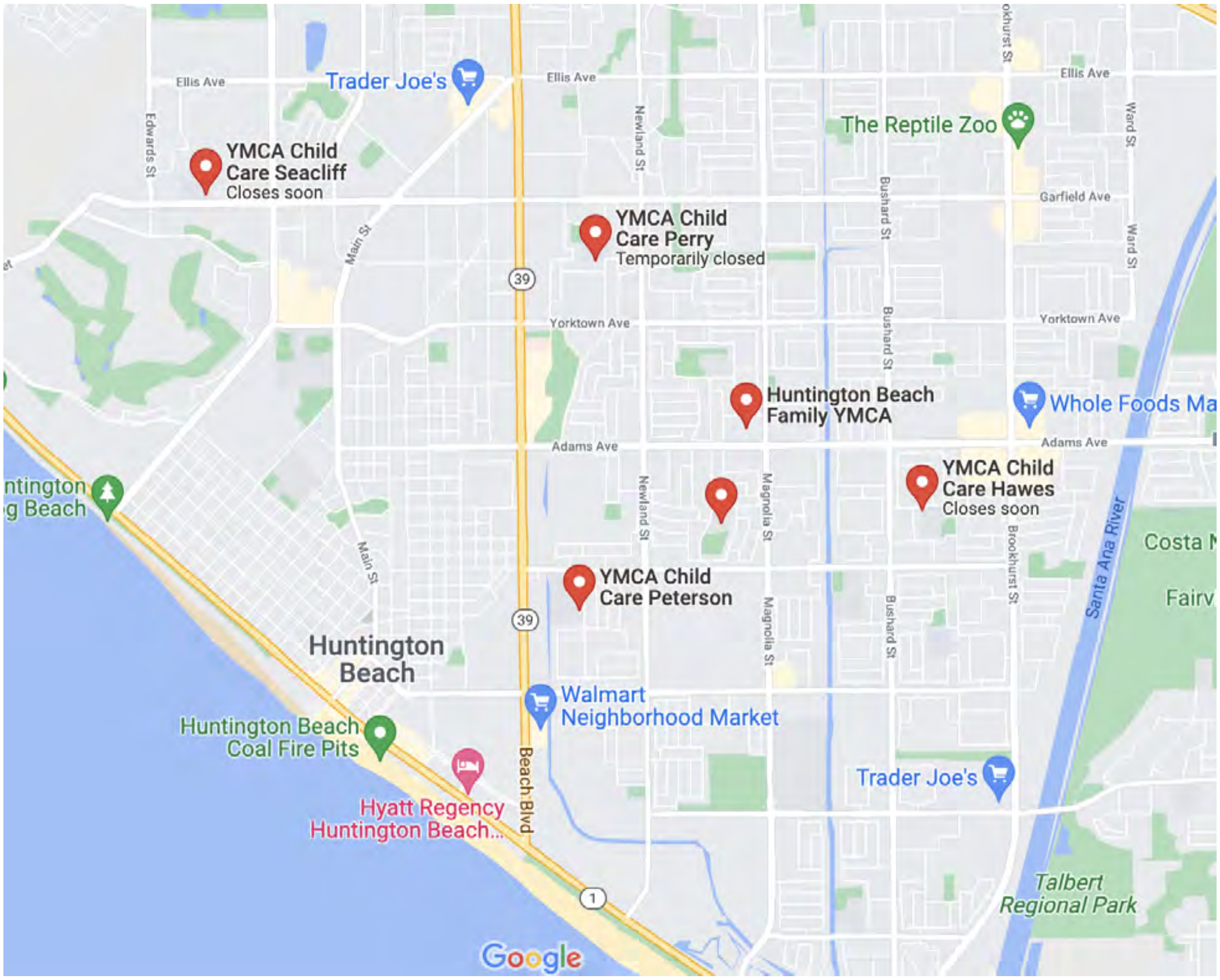
Two Most Proximate Learning Facilities: Edison High School and John H. Eader Elementary School



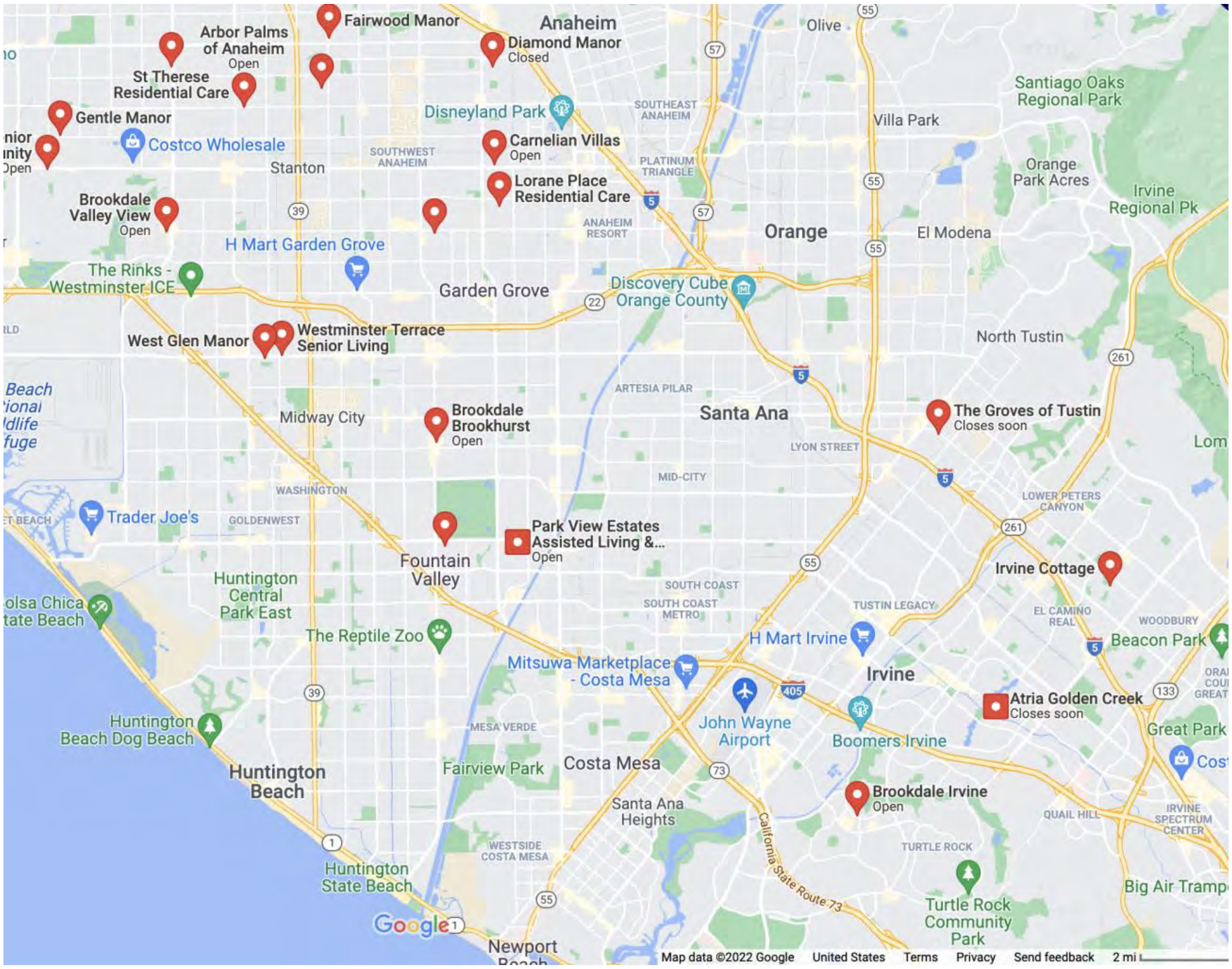
Nearby Community Hubs: OCWD YMCAs



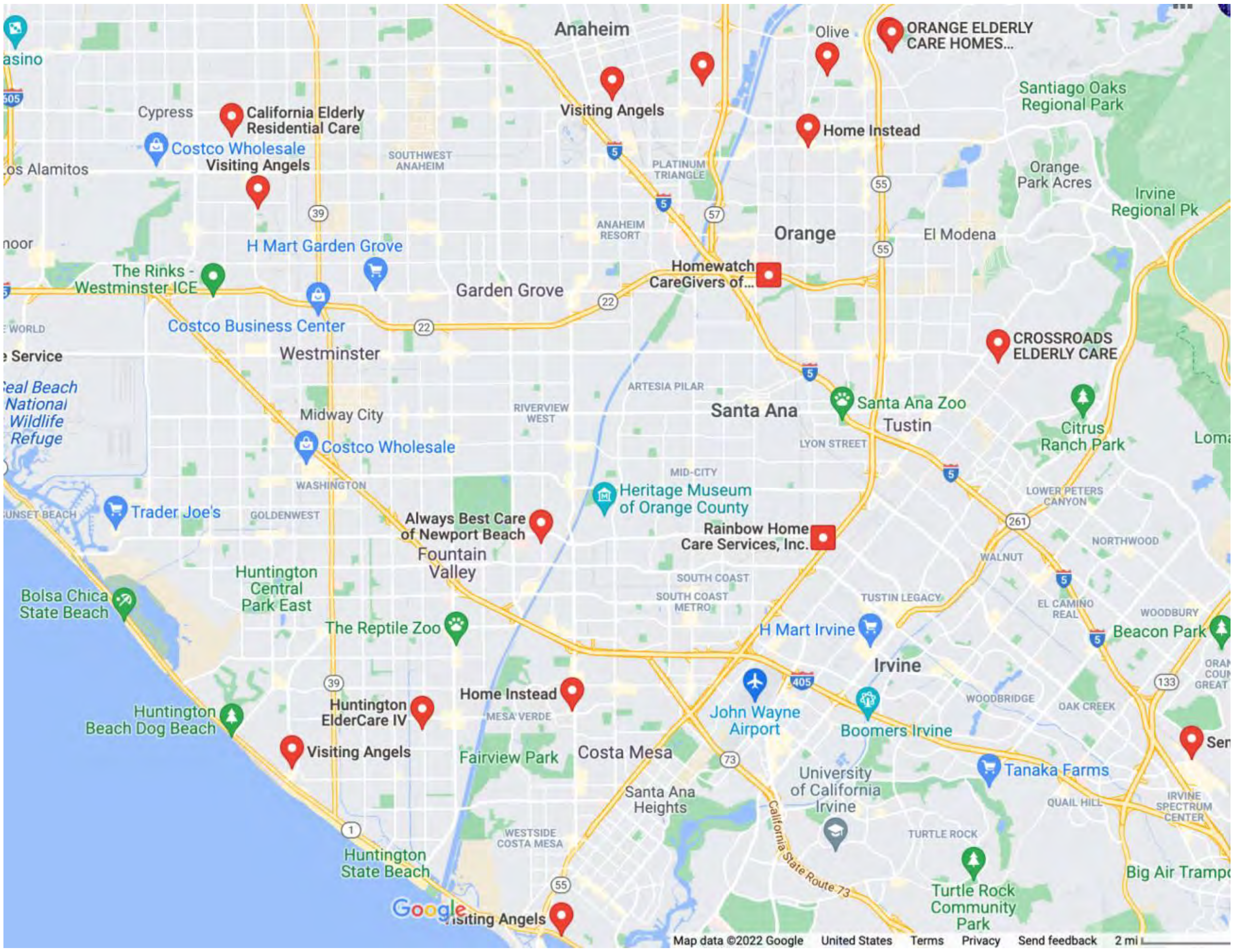
Nearby Community Hubs: OCWD YMCAs



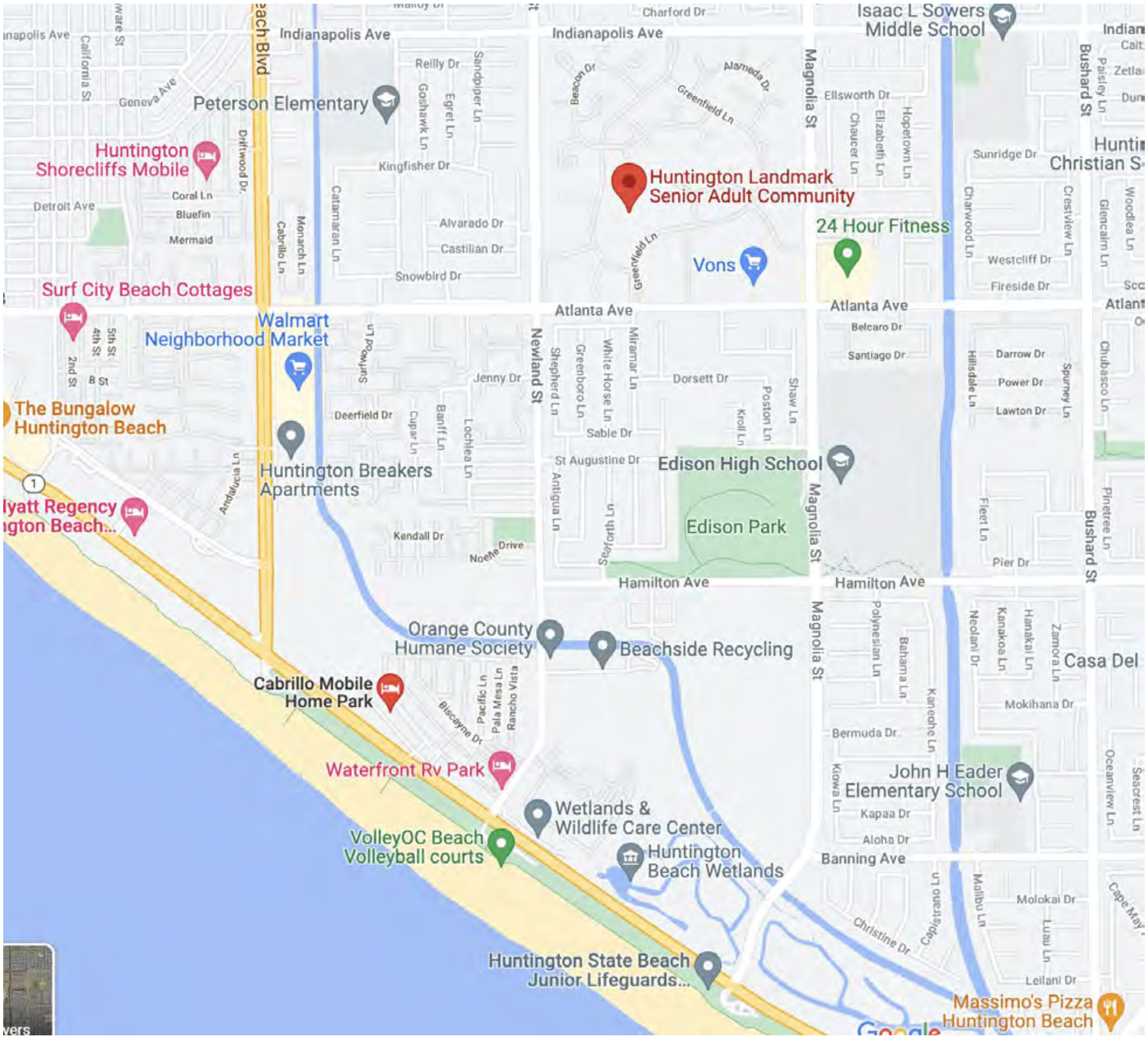
Assisted Living / Elderly Care



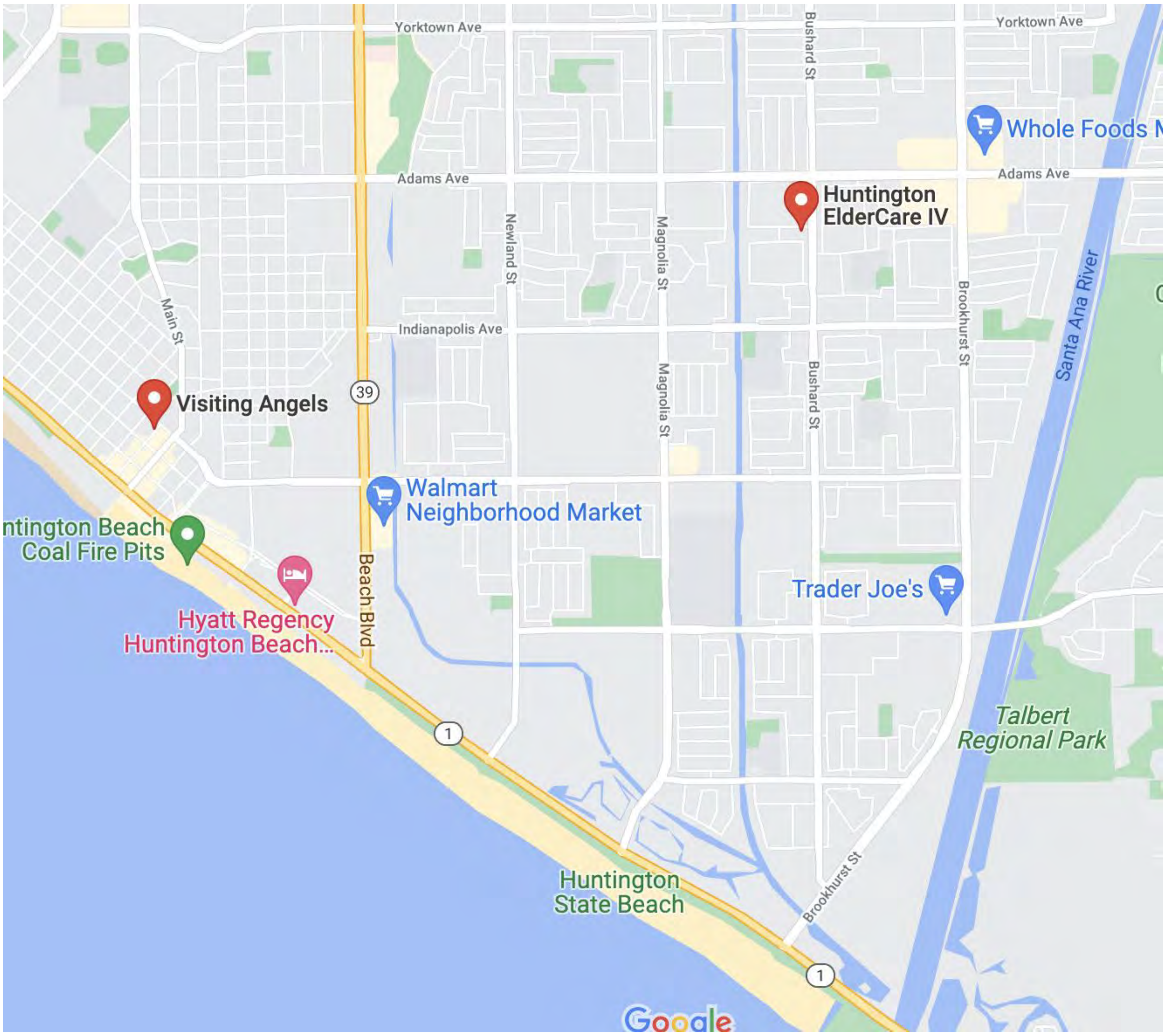
Assisted Living / Elderly Care Cont.



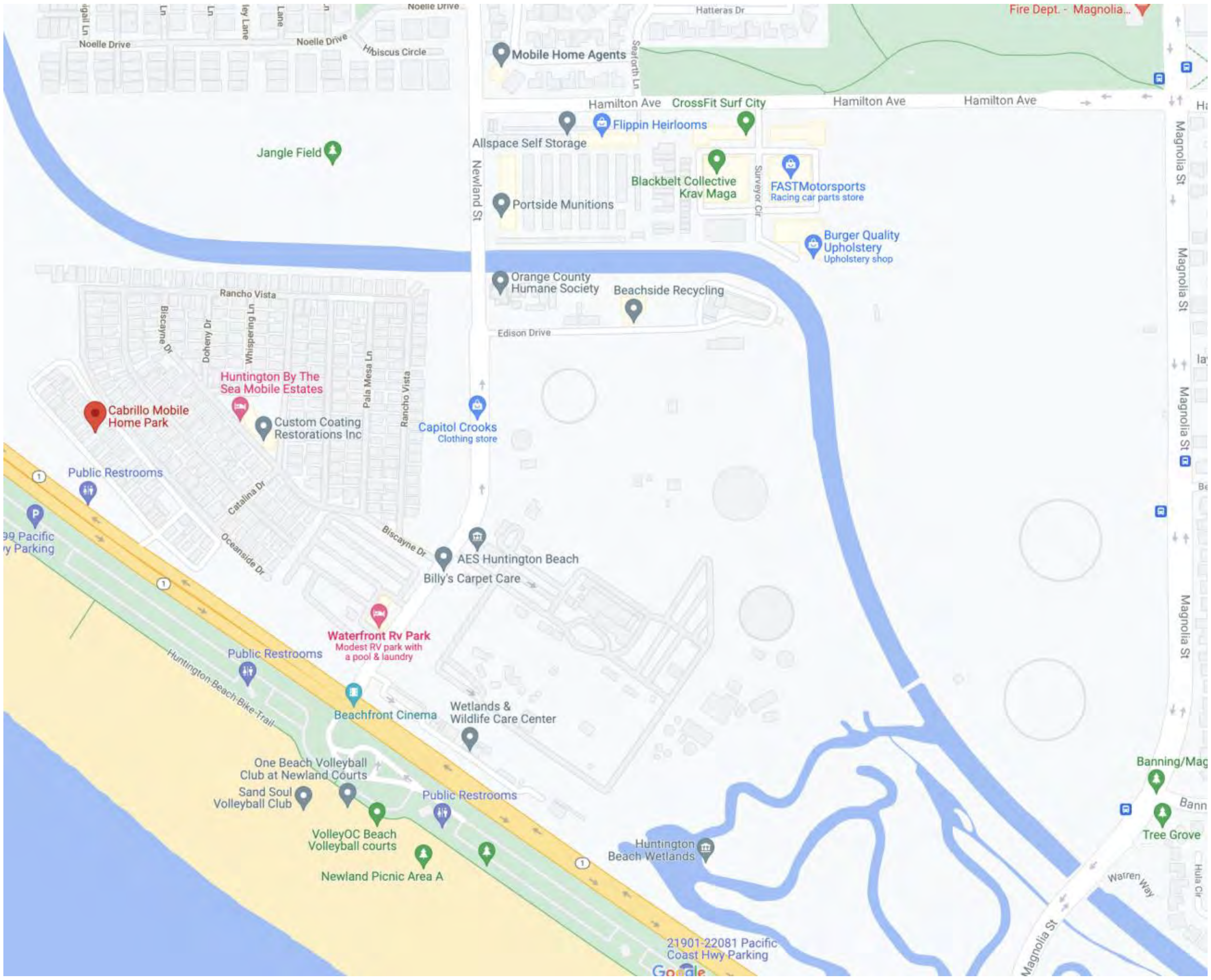
Most Proximate Assisted Living / Elderly Care Facility: Huntington Landmark Senior Adult Community



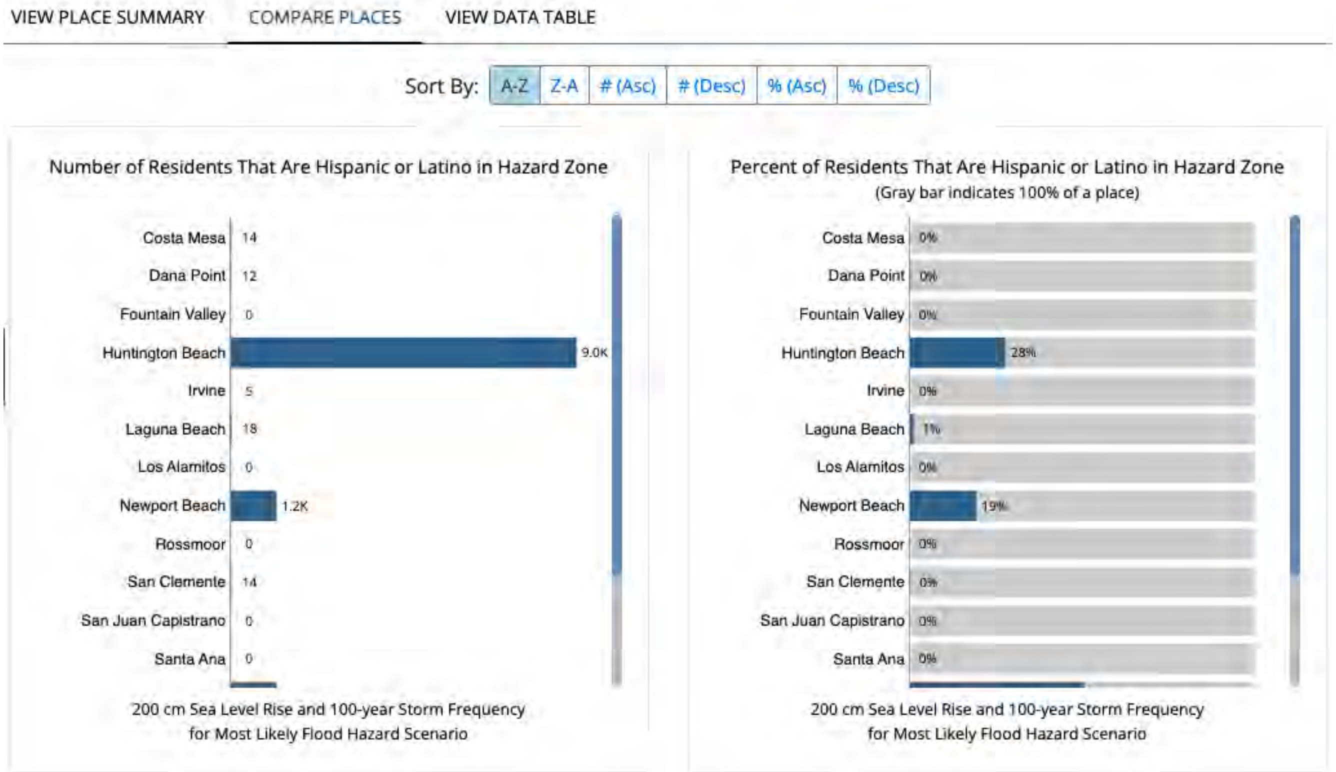
Nearby Living / Elderly Care Facilities: Visiting Angels and Huntington ElderCare



Nearby Mobile Home Parks / RV Parks



Communities Already at Risk because of Sea Level Rise



Project Maps Showing Flood Inundation

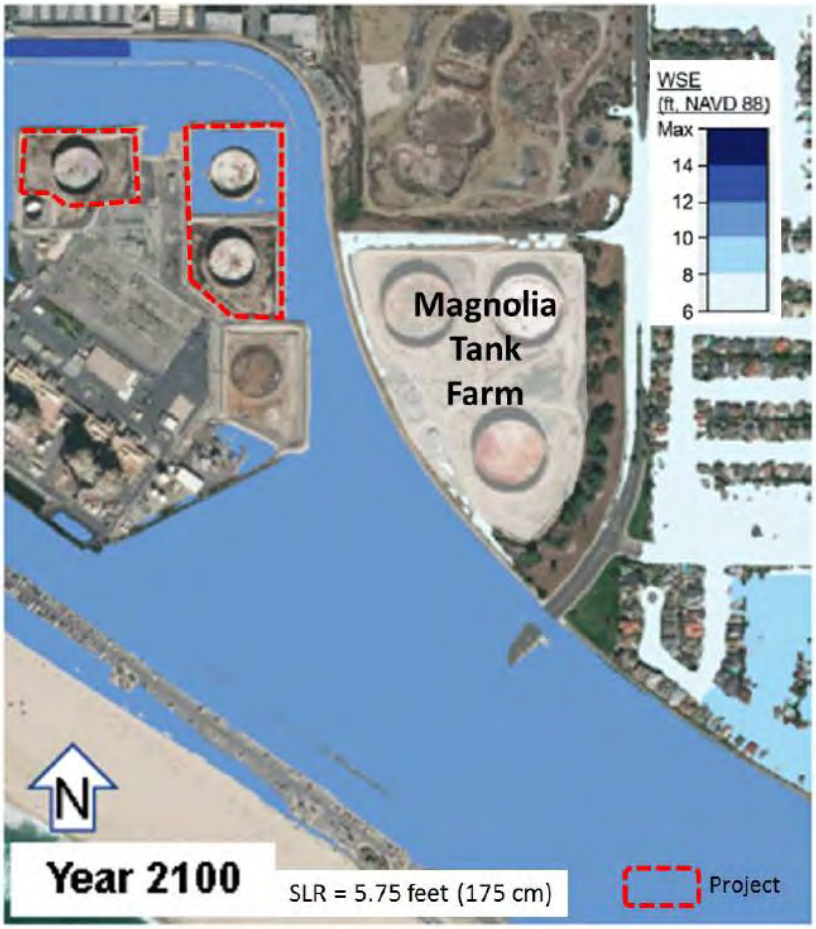


Figure 12: 100-year Fluvial Storm Flood Hazard for Existing Site Elevations (source: Anchor QEA, 2018)

Project Maps Showing Flood Inundation Cont.

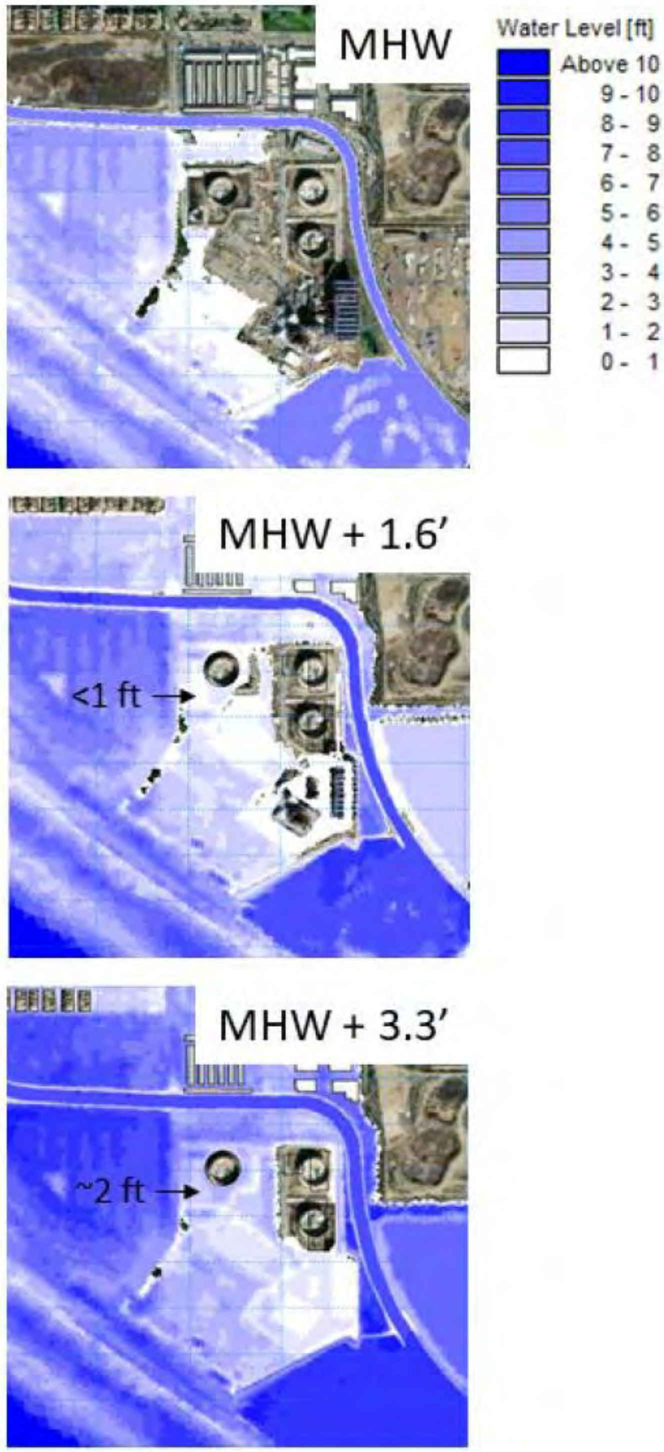


Figure 13: Peak Tsunami Flood Depths for MCT event

Project Elevation Map for Huntington Beach

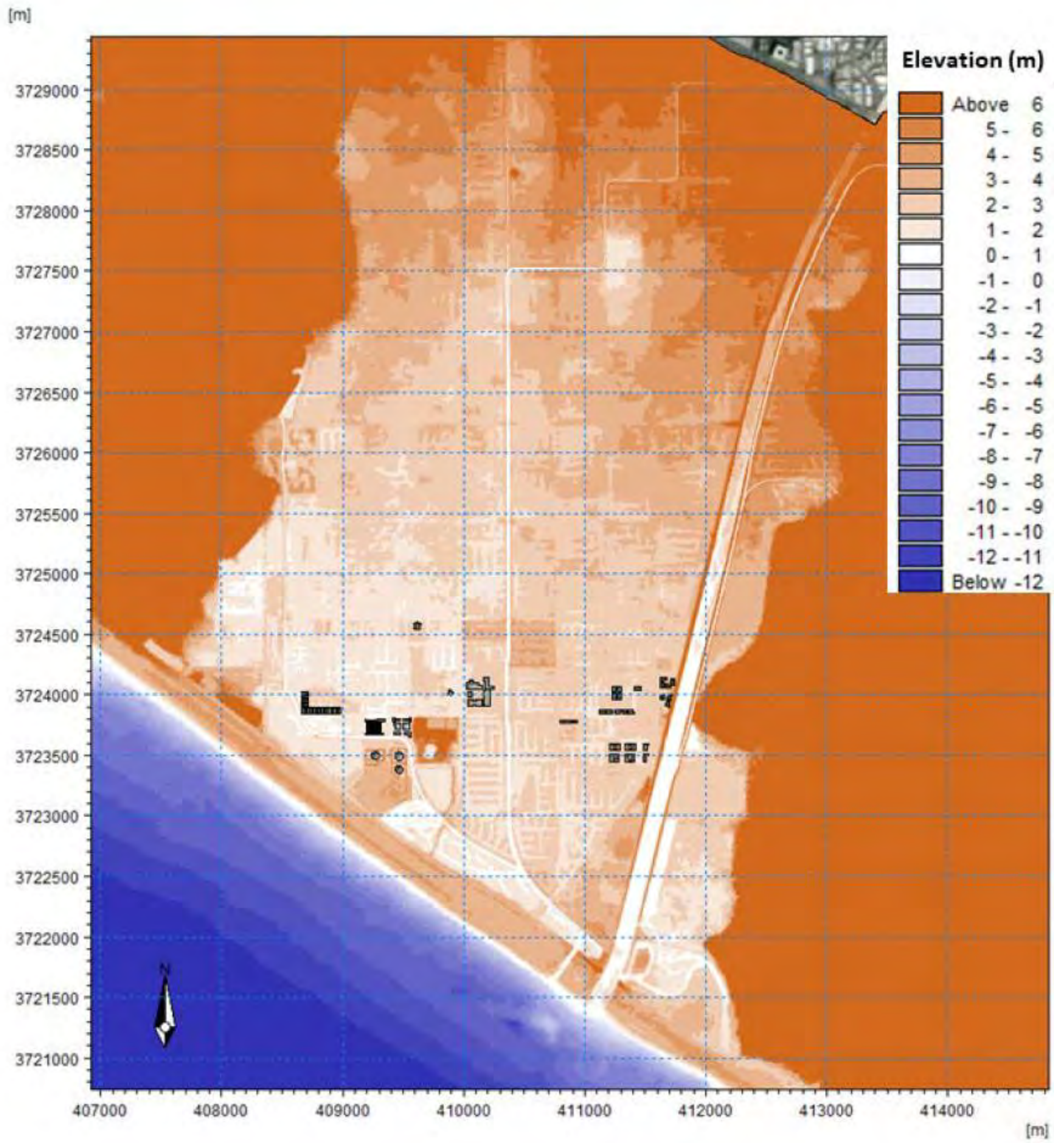


Figure 3: Regional Topography in south Huntington Beach (m NAVD 88).

Project Elevation Map for the Project

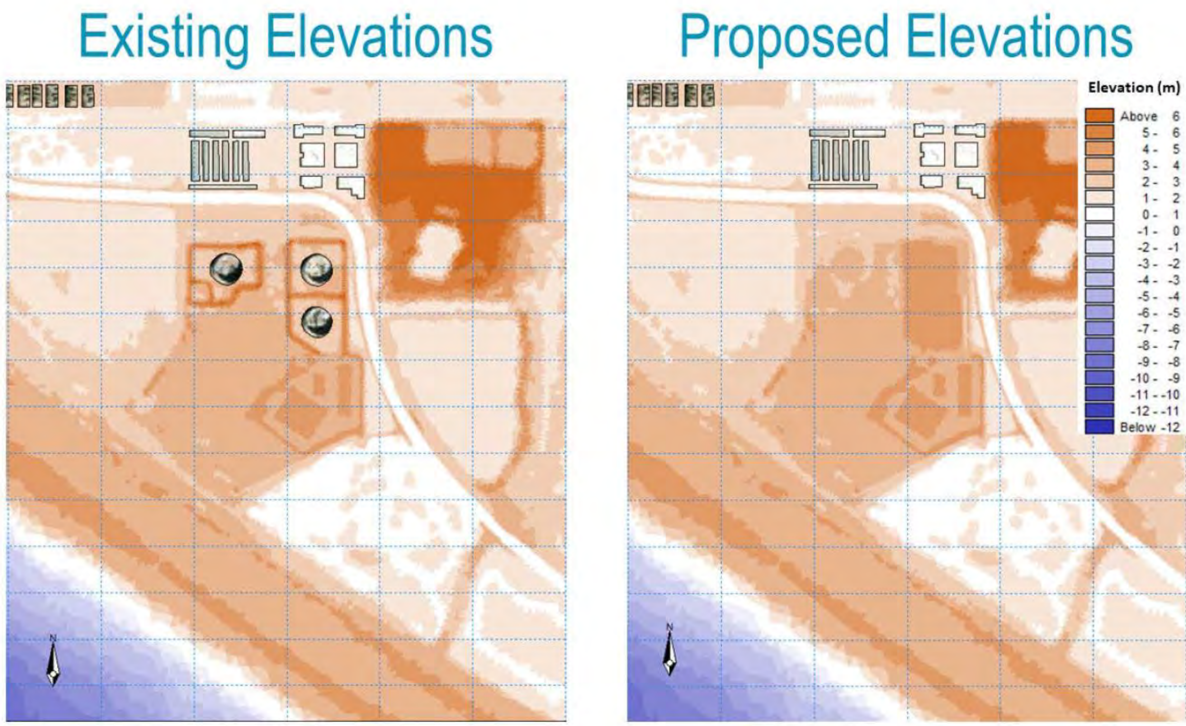


Figure 5: Existing and Proposed Site Elevations (m NAVD 88).

The proposed project will involve some site grading to reconfigure existing containment berms and remove existing tanks to allow for construction of the desalination plant. The earthen containment berms will be leveled out to form the buildings pads where the desalination facilities will be constructed. The proposed finish grade elevations of the key process buildings will range from 14-16 ft (4-5 m) NAVD 88 as shown in the right panel of Figure 5.

Project Elevation Map Cont.

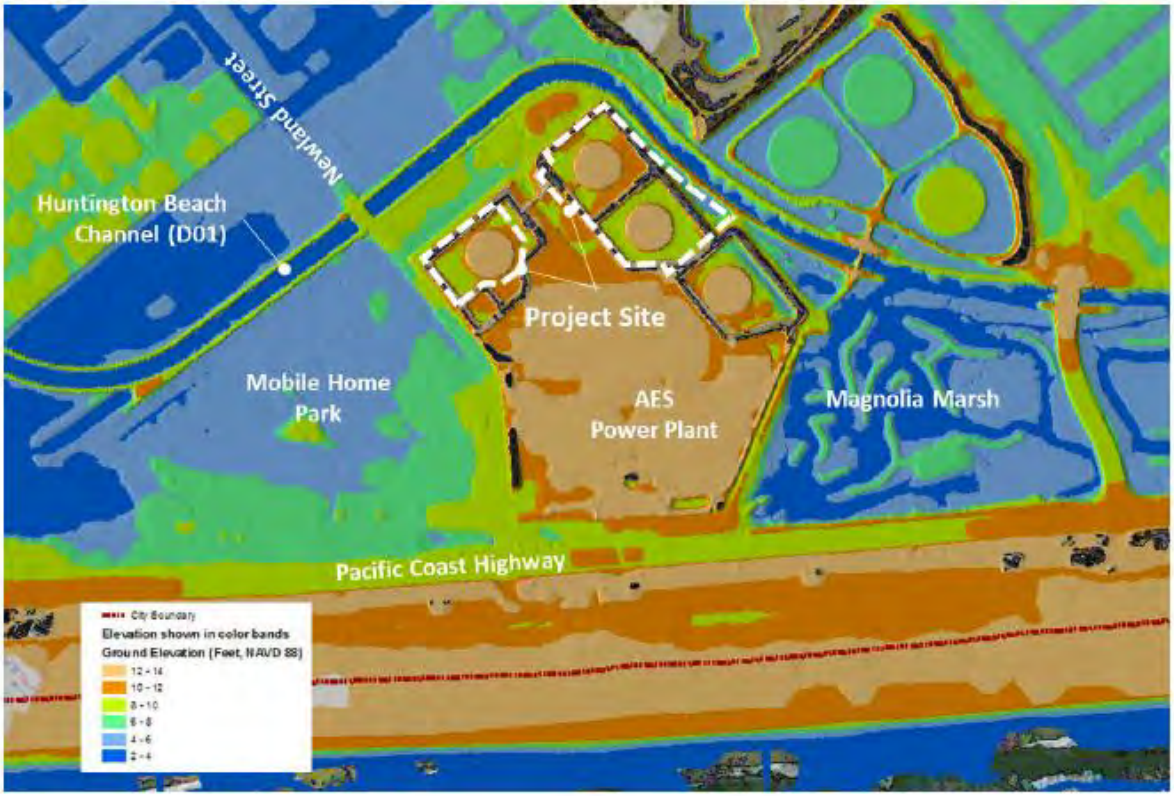
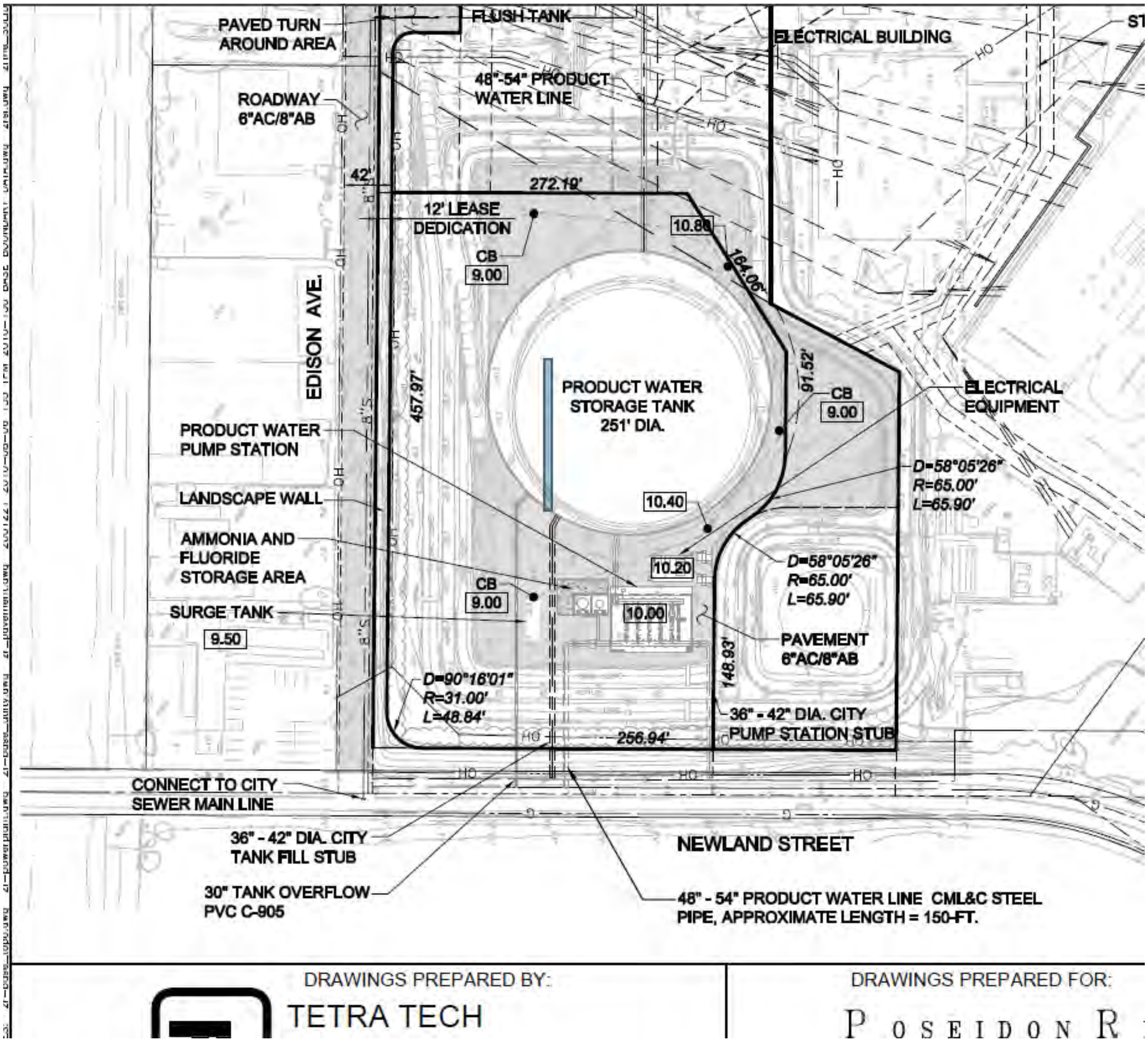


Figure 2: Existing Site Topography

(Source: *Huntington Beach Desalination Project Sea Level Rise Hazard Analysis and Adaptation Plan*, Moffat and Nichol at 11 (2020)). Elevation within the project site ranges from 4-14 feet NAVD88.

Project Site Description



Relevant Air Contaminants

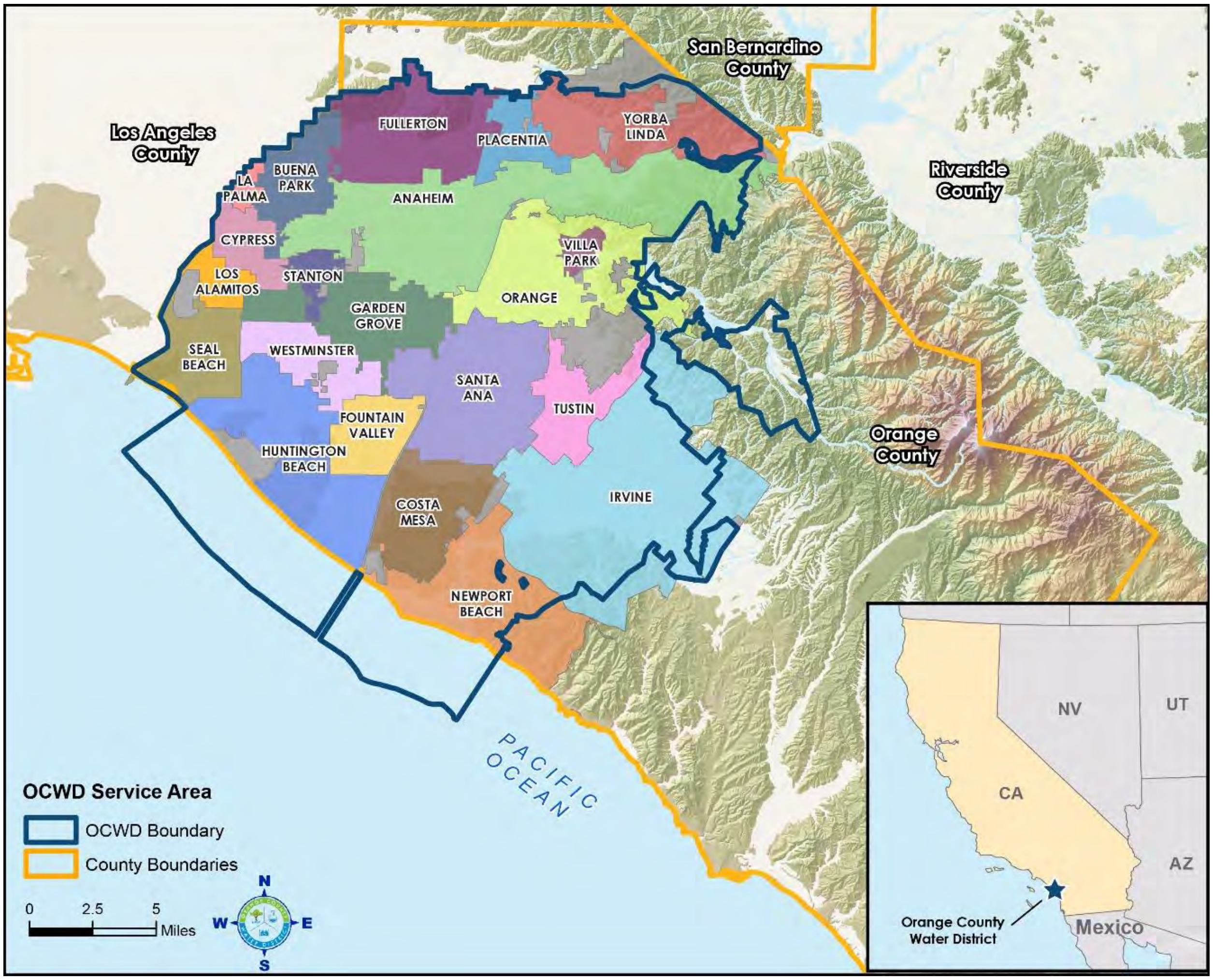
Table 1: SCAQMD CEQA Thresholds of Significance		
Pollutant	Project Construction	Project Operation
	lbs/day	lbs/day
Volatile Organic Compounds (VOC)	75	55
Oxides of Nitrogen (NO_X)	100	55
Carbone Monoxide (CO)	550	550
Oxides of Sulfur (SO_X)	150	150
Respirable Particulate Matter (PM_{10})	150	150
Fine Particulate Matter ($PM_{2.5}$)	55	55
24-hour $PM_{2.5}$ Increment	10.4 µg/m^3	2.5 µg/m^3
24-hour PM_{10} Increment	10.4 µg/m^3	2.5 µg/m^3
Annual PM_{10} Increment	1.0 µg/m^3 annual average	
1-hour NO_2 Increment	0.18 ppm (state)	
Annual NO_2 Increment	0.03 ppm (state) & 0.0534 ppm (federal)	
1-hour SO_2 Increment	0.25 ppm (state) & 0.075 ppm (federal – 99th percentile)	
24-hour SO_2 Increment	0.04 ppm (state)	
24-hour Sulfate Increment	25 µg/m^3 (state)	
1-hour CO Increment	20 ppm (state) & 35 ppm (federal)	
8-hour CO Increment	9.0 ppm (state/federal)	
Toxic Air Contaminants (including carcinogens and non-carcinogens)	Maximum Incremental Cancer Risk ≥10 in 1 million	
	Cancer Burden >0.5 excess cancer cases (in areas ≥1 in 1 million)	
	Chronic & Acute Hazard Index ≥1.0 (project increment)	
Greenhouse Gases (GHG)	10,000 MT/yr CO_2e for industrial facilities	

Source: SCAQMD 2019; ppm = parts per million, µg/m^3 = micrograms per cubic meter; MT/yr = Metric tons per year

Based on information received from SCE and information collected on Google Earth, land use data for CalEEMod input are presented in Table 2.

Applicant's Map of Project's Proximity to Superfund Sites Fails to Include RCRA Site Under Project Site Star Indicator

“Zone of Risk” for the Poseidon Desalination Project - Orange County Water District



Within OCWD, the Huntington Beach Desalination Plant is projected to serve 400,000 people (*Poseidon Resources*, EPA Water Infrastructure Finance and Innovation Act Program (2019). https://www.epa.gov/sites/default/files/2019-10/documents/poseidon_resources_0.pdf)

A-5-HNB-10-225 / 9-21-0488

(Poseidon Water, Huntington Beach)

CORRESPONDENCE:

Form Letters:

Opposition

This item is a form letter sent to the Coastal HB Desal inbox from 18 separate contacts:

Public Comment on May 2022 Agenda Item Thursday 9a - Appeal No. A-5-HNB-10-225 (Poseidon Water, Huntington Beach)h)

To Whom It May Concern at the California Coastal Commission,
I'm writing as a California resident to urge you to reject the proposed Poseidon Huntington Beach Desalination Plant for the following reasons:
The Poseidon project is costly and financially risky.
There are other less expensive, more sustainable options, such as the groundwater replenishment system in Orange County which supplies two times the water the proposed desalination project would. Additionally, water efficiency and conservation improvements could reduce water use by 30 percent.
The water provided by the project would be very expensive compared to other sources and would put an undue burden on local businesses and low-income residents.
The project would harm the environment by emitting fossil fuel-derived greenhouse gasses, and adding chlorides and boron to groundwater which would then have to undergo expensive treatment before being used. It's been estimated that the project would kill 108 million ocean organisms every year. Its intake pipes and the brine byproduct sent back into the ocean would cause further ecosystem disruption.
The Carlsbad Poseidon plant has not delivered a fifth of the promised water and has been issued more than a dozen water quality violations in its first year of operation.
Orange County ratepayers would be committed to pay for the expensive water from the project for 50 years even if it is not needed.
This project is a bad deal and needs to be rejected.

A-5-HNB-10-225 / 9-21-0488

(Poseidon Water, Huntington Beach)

CORRESPONDENCE:

Form Letters:

Support

This item is a form letter sent to the Coastal HB Desal inbox from 24 separate contacts:

Strong Support for the Huntington Beach Desalination Project

Dear California Coastal Commission,
This letter is intended to express my strong support for the Huntington Beach Desalination project.
This project is one of the most studied water infrastructure projects to ever go through California's regulatory process. Using the best available climate change science as identified by the Coastal Commission, the desalination facility's Sea Level Rise Hazard Analysis evaluated impacts to the project site through the year 2100 and analyzed potential sea level rise scenarios. The best available science indicates there is a ~99.5% chance that sea level rise will not exceed 6.6 feet this century — making this a very conservative worst-case probabilistic scenario.
More over, the threat of extreme sea level rise is a problem that every Californian living along the Pacific Coast must address. All of us, both in the public and private sector, will need to work together to adapt to these challenges. It would be illogical to deprive Orange County of a new water supply on such a basis.
I respectfully ask that you approve this project.

This item is a form letter sent to the Coastal HB Desal inbox from 11 separate contacts:

VOTE YES on a Local Water Supply With Zero Carbon Footprinton Footprint

Dear Commissioners & Staff,

It takes an immense amount of energy to pump imported water from Northern California, over the Tehachapi Mountains and into Orange County. From an energy perspective, it makes much more sense to develop a local water supply that has a zero-carbon footprint.

The Huntington Beach Seawater Desalination Plant emits zero greenhouse gasses and has committed to offset any emissions associated with the energy it uses to operate. If it is feasible for this project to be powered entirely by renewables and the plant has committed to do so. Additionally, energy recovery technology allows them to capture and reuse nearly 50% of the power the facility needs.

Projects like this need to be on the forefront of water supply reliability in California. You have the opportunity to move this forward, please do so now!

This item is a form letter sent to the Coastal HB Desal inbox from 5 separate contacts:

I Support the Governor’s Water Resiliency Plan and Desalination

Dear CA Coastal Commission,

I support the Huntington Beach Seawater Desalination Plant because I believe in Governor Newsom’s Water Resilience Portfolio. This is a project that embraces innovation and new technologies. It encourages a regional solution to California’s consistent water sustainability challenges. And it leverages the success desalination has had throughout the world. This is a project that will be the most environmentally sensitive and sustainable desalination plant in the world and addresses our state’s climate change challenges head on.

Please vote to support this project in May and the role it has in the Governor’s water resiliency plan.

This item is a form letter sent to the Coastal HB Desal inbox from 18 separate contacts:

Water Resiliency For All

Dear Commissioners,

This letter is an opportunity to voice my support for the Huntington Beach Desalination project. Please vote “yes” on this facility, which will bring a new source of clean and safe drinking water to Orange County.

The Governor's secretary for environmental protection recently stated that due to the diversity of California and its hydrological zones, we cannot accept a ‘one size fits all’ approach to water. While conservation is the right path for some communities, others, like Orange County, can do their part by identifying new sources of drinking water. Doing so will reduce our dependence on the State Water Project and Colorado Aqueduct.

Many communities in California are entirely dependent on wells, groundwater, snowpack and rainfall. Here in Orange County we are very fortunate to live next to the Pacific Ocean, the world’s largest reservoir. Let’s use the best available technology to turn that water source into drinking water, lessening the burden on supplies that can go to other communities.

We all need to do our part to help solve the water shortage, be it conserving precious drops or identifying new sources. Please vote in support of the Huntington Beach Desalination project.

Thank you all for your hard work and dedication! I most definitely support this project! I know with this many inventive and innovative minds that this project will become an absolute success, and hopefully other areas that are in need will implement the same formula to solve water issues.

This item is a form letter sent to the Coastal HB Desal inbox from 5 separate contacts:

HB Desal will be a boom for the community

Dear Commissioners,

The Huntington Beach Desalination project will be a boom for the community and I strongly urge you to vote to approve the project.

Poseidon, the company behind the desalination project, has pledged to complete four mitigation projects inside the Bolsa Chica Wetlands, for a total of 84 acres of restored habitat.

Four decades ago, volunteers and community stakeholders successfully fought off development and preserved the largest saltwater marsh between Monterey Bay and the Tijuana River Estuary. Today, this area is home to many rare and endangered species, and stands as a tribute to the hundreds of people who gave their time and money to save this invaluable natural resource.

Without a long-term, sustainable source of funds, the wetlands and prior restoration efforts at Bolsa Chica are at risk. The years of work and effort are at risk of being undone. The desalination facility ensures this valuable environmental resource will not be lost.

Please support this project. We — the community — need it.

This item is a form letter sent to the Coastal HB Desal inbox from 8 separate contacts:

Human Right to Water

Dear State of California,

California law makes access to clean, safe and reliable water a Human Right. The Santa Ana Water Board, adopted the human right to water as a core value and resolved that it will continue to consider the human right to water in all activities that could affect existing or potential sources of drinking water, including permitting actions. In adopting the permit for the Huntington Beach Desalination Project the Regional Board found that the facility complies with the Human Right to Water by establishing environmental protections for a new source of drinking water that could improve the reliability of water supply in Orange County.

I encourage you to do the same and approve this Project before you in May.

This item is a form letter sent to the Coastal HB Desal inbox from 26 separate contacts:

The Science Has Spoken, VOTE YES

Dear Commissioners & Staff,

Poseidon Water has done more to prepare for a water shortage eventuality than any project proposed along the coast.

The project itself is more than 2,000 feet behind the shoreline and is inland from Pacific Coast Highway. Studies have shown that even if a combination of worst-case scenarios hit at once including a tsunami at the same time as the king tides and coastal storm flooding, the plant would not be harmed.

This is a desperately needed water reliability project and it will be built to withstand potential natural disasters such as an earthquake. The science has spoken. I urge you to move forward by voting YES on this important permit.

This item is a form letter sent to the Coastal HB Desal inbox from 9 separate contacts:

Water is a Right for All

Dear California Coastal Commission,

Our time is now to vote YES for HB Desal.

Disadvantaged communities in Orange County and throughout the region demand desal as a new water supply opportunity for our community and for our future. The last generation built their families and businesses on the water supplies that were available to them. It's not right that now that it's our time, we're being told to turn off the tap. We need water reliability and sustainability to protect, preserve and grow our future.

We can afford a few extra dollars per month on our water bill. What we cannot afford is the uncertainty of supply that would exist without seawater desalination.

This item is a form letter sent to the Coastal HB Desal inbox from 19 separate contacts:

Unnecessary Permit Conditions on Desal Hurt Disadvantaged Communitiesged Communities

Dear California Coastal Commission,

I'm writing about the final permit before you for the Huntington Beach Desalination Project.

Permits and approvals issued to the Project by the State Lands Commission and Regional Water Board already ensure unavoidable environmental impacts are fully mitigated. Additional mitigation is unnecessary and will only serve to make the cost of water unaffordable for lower income and disadvantaged communities.

ALL humans have a right to reliable, affordable water. Please consider this when approving this permit.

This item is a form letter sent to the Coastal HB Desal inbox from 17 separate contacts:

HB Residents Benefits are Undeniable

Dear Commission,

As a Southern California resident, I look forward to having this desalination plant come online. Beyond the benefits of jobs and tax revenue for my community, this project guarantees the preservation and protection of the Bolsa Chica wetlands, which are close to my heart. Not only that, Huntington Beach has the chance to buy more than a billion gallons of desal water a year for less that we would otherwise pay for imported water. Talk about a win-win for the community!

Preservation of an ecological jewel, tax revenue for our schools, jobs for our families and high quality water at a lower cost. Please support our community and vote yes on the desal project.

This item is a form letter sent to the Coastal HB Desal inbox from 53 separate contacts:

Vote YES on a New Water Supply for Californiansifornians

Dear Commissioners,

I support Poseidon's Huntington Beach Desalination facility and urge your approval of the project. Gov. Newsom has called on Californians to conserve water as the state enters its third year of the drought. In fact, virtually all of the state is under severe or extreme drought conditions.

You may want to consider building new or rebuilding some of the many dams taken out over the past 20-25 years so that when it does rain, all the water is not returned back to the ocean, but is able to be captured and used to mitigate the constant draught conditions we are burdened with.

The truth is that the burden and cost of conservation falls disproportionately on low-income Californians. Mandatory conservation measures that are enforced by water surcharges hurt lower income communities, whose ability to conserve water is less than more affluent communities. Conservation is not enough; we must find new sources of water — like desalination.

Purchasing desalinated water is more affordable than the water surcharges that water agencies add to compensate for the reduction in water usage during times of conservation. The Huntington Beach project will bring a new source of water that is also climate-change-resistant. Our communities deserve flexibility in how we tackle California's ongoing drought.

I sincerely hope you will approval this project in May.

This item is a form letter sent to the Coastal HB Desal inbox from 9 separate contacts:

Desal is California's Future

Dear CA Coastal Commission,

California is the cradle of technological advancements. From the Silicon Valley to the sea, the world looks to California to set the standard when it comes to both high tech solutions and environmental protection. Desalination is a perfect marriage of those two philosophies.

The Huntington Beach Seawater Desalination Plant will be the most technologically advanced, environmentally sensitive desalination plant in the world. The project screens out all fish and marine life larger than the width of a dime. It’s energy consumption has been cut in half thanks to state-of-the-art energy recovery systems. And the mitigation for the project will result in enhanced marine life in the wetlands and beyond.

And best of all, we are able to create a new sustainable water supply for Orange County while reducing demand on imported water sources. Please vote for tomorrow’s water supply by voting yes on this desalination project TODAY!

This item is a form letter sent to the Coastal HB Desal inbox from 5 separate contacts:

Reliable Water for Less Than A Penny a Gallon - APPROVE HB DESAL

Dear Commissioners,

The Huntington Beach Desalination Plant, will be the largest, most technologically advanced and environmentally friendly desalination plant in the Americas and will produce and deliver the most reliable and highest quality drinking water for less than a penny per gallon.

In adopting the Project's permit, the Regional Board found, "Though Orange County Water District (OCWD projects an initial increase in residential water costs to improve water reliability, the desalinated water could result in cost savings in the future."

Please plan for the future NOW but moving this important water supply forward.

A-5-HNB-10-225 / 9-21-0488

(Poseidon Water, Huntington Beach)

CORRESPONDENCE:

Individual Emails:

Opposition

From:	Luster, Tom@Coastal
To:	CoastalHuntingtonBeachDesalComments
Subject:	Fw: DESALINIZATION PLANT COMMENTS
Date:	Friday, April 29, 2022 2:45:26 PM

From: Ainsworth, John@Coastal <John.Ainsworth@coastal.ca.gov>
Sent: Tuesday, April 26, 2022 10:22 AM
To: Luster, Tom@Coastal <Tom.Luster@coastal.ca.gov>
Subject: FW: DESALINIZATION PLANT COMMENTS

From: Kendrick Miller <kwmiller@pacbell.net>
Sent: Tuesday, April 26, 2022 9:45 AM
To: Ainsworth, John@Coastal <John.Ainsworth@coastal.ca.gov>
Subject: DESALINIZATION PLANT COMMENTS

I am appalled how naïve and foolish your advisory commission recommendation for denying approval of the Huntington Beach desalinization plant proposed by Poseidon Water.
1) The current drought is not a one-off event but the persistent future for the western U.S.
2) While concern for the poor is admirable, it calls for income assistance not denial of indispensable infrastructure. Besides, Orange County is not exactly an underprivileged area, and since desalinization would only provide 16% of the County water, it would have a trivial impact on water prices.
3) Recycled water requires storm runoff, ag. runoff, and impeccable cleaning at extraordinary cost. No ran, no runoff. And most people rightfully do not trust promises to completely purify sewer water. Especially since we can’t get our existing domestic water supplies free of deadly toxins. Reverse osmosis of sewer water requires removing untold thousands of toxins at much greater cost than the equivalent technology with all the same infrastructure, energy requirements etc. as applied to desalinization of ocean water.
4) Land subsidence, ocean encroachment from global warming, and earthquake risk applies to the entire west coast. By implication, the Coastal Commission must deny all building along the coast. And all existing coastal building owners must provide proof of bonding sufficient to remove the structure as the sea encroaches. At least this project should be bonded and then approved.
5) The fish and other sea life will suffer comparably to using the ocean to cool power plants, and those are approved uses.
I expect more informed and the intelligent approval of these absolutely necessary desalinization plants, not just the current proposal, all along the entire west coast. The future lives of millions of Californians are at stake.

Kendrick Miller

From: merle moshiri
To: CoastalHuntingtonBeachDesalComments
Subject: Fwd: Poseidon Desal Project
Date: Wednesday, February 2, 2022 8:20:22 AM

From: pars11@aol.com
To: CoastalHuntingtonBeachDesalComments@coastal.ca.gov
Sent: 1/31/2022 7:40:05 PM Pacific Standard Time
Subject: Poseidon Desal Project

To Whom it May Concern,

I have fought the good fight to defend our coastline, the Community of S.E. Huntington Beach, and our marine environment, for 22 years. I am past president of Residents for Responsible Desalination. It was my honor to serve this organization for over 10 years. We were the first citizens to organize and ask for a more thorough study by the Coastal Commission. We are a 501C3 and had pennies to throw at Poseidon's all out invasion , into our elections, into our water district, our City Council and planning commission, and our neighborhoods that would play host to yet one more toxic industry in an area already regarded as the Toxic Triangle in S.E. Huntington Beach. What we DID have was/is dedication, motivation & determination to see this lethal and unnecessary folly come to an end.

We, the receiving party of an incomplete and larcenous plan brought forward by a company that is now a multi-billion dollar global hedge fund operation, ask you, the Coastal Commission, to do the duty you committed to when you took your position, and turn back this hostile take over. You are the court of last resort for the public. Twenty two years is a long time to for ordinary folks to commit to preserving and protecting where we live. But at times, for me, it seems like yesterday. A glorious journey into volunteerism at it's finest, with the end result of every gallon of gas, every trek up & down the coast, every letter and flyer, every neighborhood walked over and over again, is well spent time while attaining our goal of defending and preserving the Coastline.

Join with us.

Merle Moshiri, past president R4RD & a 47 year resident in Huntington Beach: our bit of heaven.

From: Armida Brashears
To: CoastalHuntingtonBeachDesalComments
Subject: Fwd: Poseidon proposal
Date: Friday, October 29, 2021 10:50:22 AM

-----Original Message-----
From: Armida Brashears <armidahb@verizon.net>
To: oceandesalexploration@ocwd.com <oceandesalexploration@ocwd.com>
Cc: de.hamilton@verizon.net <de.hamilton@verizon.net>; ray@coastkeeper.org <ray@coastkeeper.org>; addup@sierraclub.org <addup@sierraclub.org>
Sent: Fri, Oct 29, 2021 10:38 am
Subject: Poseidon proposal

I oppose the Poseidon proposal because we DO NOT need it and it will do GREAT harm to the ocean

It will harm larva and small fish. It will add to the ocean acidification. It will be energy intensive. It will cost rate payers in water rates AND water bonds even though we DO NOT need it.

PLEASE listen to the rate payers. We are the ones that will have to live with it both at our beach/ocean and in our pocket book.

I am a 56 year resident of Huntington Beach and a Grandmother of 11 children who DO NOT want the ocean to be further impacted.

Armida Brashears

21632 Hanakai Lane
Huntington Beach 92646
714 330-3838 cell

From: merle moshiri
To: CoastalHuntingtonBeachDesalComments
Date: Thursday, February 17, 2022 4:47:55 PM

This desalination project is a huge desalination swindle of the public and it's funds. Say NO!

Merle Moshiri

From: Terri Lynn
To: CoastalHuntingtonBeachDesalComments
Subject: No Desal
Date: Wednesday, February 2, 2022 8:59:43 AM

Please care for our coast. A dead zone off shore from desalination is not acceptable. Creating another “issue” isn’t really solving one, is it?

From:	Nancy Curtis
To:	CoastalHuntingtonBeachDesalComments
Subject:	No to Poseidon, HB does not need be dependent on One Gigantic Plant
Date:	Thursday, February 17, 2022 11:30:45 AM

Putting our City's water dependance on an expensive behemoth that has a huge environment impact is poor management by our Coastal Commission. The carbon footprint, energy consumption and salt concentrations are a few of the problems.

Nancy Curtis
nan.sea@earthlink.net
NanC

From: Kim Hendricks
To: CoastalHuntingtonBeachDesalComments
Subject: Oppose Project
Date: Thursday, February 3, 2022 8:47:00 AM

As a long-time Huntington Beach resident I have seen many changes to HB, some good and some not so good. I am not opposed to change but I am opposed to the Poseidon Project for a number of reasons. I will keep this short.
1. HB does not need this project to have an adequate water supply for now and in the future. There are other ways for us to ensure our water supply which I'm sure you have heard by now.
2. This project would have a huge negative impact on the environment. We are currently in the middle of a global crisis and all levels of government should be doing all they can to help the environment - not harm it more!
3. I am disgusted with the way in which Poseidon tries to get what they want with no eye to the community or environment - they want money but the buck needs to STOP here.
Thank you,
Kim Hendricks

From: Isabella Ford
To: CoastalHuntingtonBeachDesalComments
Subject: Please end the Poseidon project
Date: Wednesday, February 9, 2022 2:55:15 PM

There have been so many issues with this project for nearly 20 years and yet it is still a threat of proceeding. From the last meeting I attended with the Dept of Water, there were mitigation steps that Poseidon said they didn't want to even consider until they can just start work on the project. What incentive would they have to follow through with the mitigation steps if they were allowed to proceed without any agreement?

Another argument I heard for why Poseidon should continue is that they have been trying for 20 years...so just let them?? That doesn't make any sense either. Times have changed, technology has changed and options exist that didn't exist 20 years ago. Those are actually reasons the Poseidon project needs to finally end and energies should be better spent taking advantage of the current resources and knowledge.

Huntington Beach has many wells to store collected water run off. We should invest in water collection and storage. This could also help with reducing the amount of pollution washing into our ocean if we focused on collecting before it all goes out into the ocean so we can then clean it up again.

There are so many aspects to the water problem that Poseidon does not address and that proper water infrastructure could and would address.

Thanks for listening.
Isabella Ford, Huntington Beach resident since 1995
714-308-0660

From: Dan Silver
To: CoastalHuntingtonBeachDesalComments
Subject: Poisidon - Opposition
Date: Sunday, February 20, 2022 11:56:22 AM

Dear Chair and Members of the Commission:

Endangered Habitats League opposes this desalination facility as environmentally and economically unsound. Water conservation is a superior option.

Thank you
Dan Silver

Dan Silver, Executive Director
Endangered Habitats League
8424 Santa Monica Blvd., Suite A 592
Los Angeles, CA 90069-4267

213-804-2750
dsilverla@me.com
https://ehleague.org

From: EEJF McKirachan
To: CoastalHuntingtonBeachDesalComments
Subject: Poseidon DeSal Comments - NO POSEIDON
Date: Sunday, April 24, 2022 12:29:53 PM

Dear Costal Commission;

We would like to express our strong opposition to the Poseidon DeSal project. This project should not be granted approval. At this time it is not the correct answer to how we can best provide for sustainable affordable water for Orange County. The Poseidon project will be a huge carbon generator for atmospheric pollution when Global Warming is an issue that needs CO2 to be reduced, not increased. Additionally the water pricing for the water Poseidon would produce is exorbitant and will be borne by citizens already suffering from inflation and rising costs. Additionally the true life cycle cost analysis for this project has not been properly accounted for. Poseidon's proposal to sell the plant to the government for $1 after 50 years will simply leave the taxpayers, not Poseidon, burdened with further costs for retrofit and or disposal of a facility which will essentially be at the end of its expected life. Water infrastructure should not be a privatized corporate commodity. Poseidon's corporate parent's profit margins are outrageous and what should be a municipal project should not be allowed to fund corporate greed. Imagine if those profits could just be used to fix our roads and bridges instead of enriching a few would be oligarchs.

I could go on, but I believe you get our points.

NO to POSEIDON!!!

Sincerely;

John and Elizabeth McKirachan
22032 Malibu Lane
Huntington Beach, CA 92646

From:	Mark Dixon
To:	CoastalHuntingtonBeachDesalComments
Cc:	Dave Hamilton; Marinka Horack; Merle Moshiri; Milt Dardis; Patricia Goodman; Wifey; Debbie Cook; Kim Carr
Subject:	Poseidon in Huntington Beach
Date:	Saturday, February 12, 2022 7:27:58 PM

Dear Friends at California Coastal Commission,

I have lived in Southeast Huntington Beach for 50 years.

My city sits atop an aquifer that supplies ample water locally and for surrounding communities, and is expected to do so well into the future. This groundwater aquifer is managed by the Orange County Water District (OCWD), which supplies its collective members 77% of potable water currently. The other 23% is currently supplied as treated imported water by the Metropolitan Water District of Southern California (a.k.a. "MET").

I am expressing my strong objection to the nearby construction by a foreign-owned company, Poseidon Water, of a 50MGD (56,000ac-ft./year) seawater desalination project. The Orange County Water District is officially deemed Poseidon's "project partner" and as such, admitted in public testimony that the desal project's product water is not "needed" but is "wanted".

My neighbors and I deserve to live in a safe, ecologically diverse environment; I want a quiet, clean, safe neighborhood. We need our residential area to remain residential.

Unlike OCWD, I neither *want* nor *need* the desalination plant's product water. I don't want the price of unneeded water to increase unreasonably. I don't want to have the near offshore marine environment negatively impacted by a desalination plant's seawater intake and hypersaline brine discharge. I don't want the noise and industrial pollution associated with a desalination plant. I don't want nearby streets excavated for multiple years to make way for the pipelines. I don't want an additional massive industrial project across the street from my residential neighborhood.

Aside from the temporary construction jobs, the proposed plant will result in a negligible effect on local employment. The economic benefits are greatly exaggerated. Locally, it's more like economic exploitation.

In summary, please consider the needs of the hundreds of households in the surrounding area instead of those of a private, foreign-owned company that has spent millions of dollars on a disingenuous campaign of untruths and half-truths in the sole interest of lining the pockets of investors, executives and lawyers.

Sincerely,

Mark W. Dixon
21612 Bahama Lane
Huntington Beach, CA
(657)489-3719

cc: Dave Hamilton
Marinka Horack
Merle Moshiri
Milt Dardis
Patricia Goodman
Sandra Fazio
Debbie Cook
Kim Carr

From:	Michelle Black
To:	Luster, Tom@Coastal; CoastalHuntingtonBeachDesalComments
Cc:	Cynthia Kellman
Subject:	Poseidon Resources Huntington Beach
Date:	Friday, February 11, 2022 5:09:10 PM

Good afternoon, Mr. Luster -

Attached, please find comments from the California Coastal Protection Network, California Coastkeeper Alliance, the Orange County Coastkeeper and the Surfrider Foundation submitted regarding the Poseidon Resources Desalination Project under consideration in Huntington Beach. Due to the size of the attachments, they are being submitted separately from the letter.

Thank you,

Michelle N. Black
Chatten-Brown, Carstens & Minteer, LLP
2200 Pacific Coast Highway, Suite 318
Hermosa Beach, CA 90254
Phone: (310) 798-2400
Fax: (310) 798-2402
www.cbcearthlaw.com

From:	M Dardis
To:	CoastalHuntingtonBeachDesalComments
Cc:	de.hamilton@verizon.net; M Dardis
Subject:	Poseidon Resources non performance record
Date:	Tuesday, February 8, 2022 5:59:12 PM

Folks:

Why does Performance Not Count in the final Vote to approve Poseidon Desal Plant in HB.

Carlsbad:

Why has Poseidon not been held accountable for Poor Performance and the San Diego Ratepayers have to make up the difference and have to pay and pay?

2017

Projected Delivery of Water 49,615 a/f

Delivered by Poseidon ....40,419 a/f

Cost a/f 2,368 a/f

Actual 2,412 a/f

Poseidon's Total Penalties $3,584,478 paid ultimately by San Diego Ratepayers with an increase in water rates

****

2018

Projected Delivery of Water 51,772 a/f

Delivered by Poseidon ....40,892 a/f

Cost a/f 2,419 a/f

Actual 2,511 a/f

Poseidon's Total Penalties $5,359,070 paid ultimately by San Diego Ratepayers with an increase in water rates

****

2019
Projected Delivery of Water 50,109 a/f
Delivered by Poseidon ....45,038 a/f

Cost a/f 2,559 a/f
Actual 2,685 a/f

Poseidon's Total Penalties $1,965,989 paid ultimately by San Diego Ratepayers with an increase in water rates

****

Please note that these numbers are from the San Diego County Water Authority's Fiscal Year 2017-2019 Reporting for the Carlsbad Plant. Recent year's numbers are unavailable as they no longer provide them.

HB

1. When the red tide comes in the Poseidon Desal Plant has to shut down.
2. When there is an Oil Spill the Poseidon Desal Plant has to shut down as the Oil cannot be cleansed by the water filters of Poseidon Desal Plant.
3. What are the true mfg costs and final costs of Desal Water.
4. San Diego has the highest water rates in Calif. Will HB be next.

Thank you in advance for reading this review.

Milt Dardis
22052 Capistrano Lane
Huntington Beach Ca 92646

From: Rhys rburchill
To: CoastalHuntingtonBeachDesalComments
Subject: Poseidon Seawater desalination project @ Huntington Beach
Date: Friday, March 4, 2022 7:38:30 PM

The time is way passed due for this ill advised, politically and financially-driven proposal to cease. Anyone able to read and research the antiquated technology, history of other such ventures and last, but certainly not least, the potential havoc such a project would create within our own sea waters and wildlife must, in good conscience, agree that this ridiculous project should best be forgotten. Clearly, the only basis that exists to continue is greed using the political system to pad the pockets of those who lack concern for the future of others and an environment that currently may be without anyone's ability to salvage.

This entire project was a disgusting endeavor from the beginning. It is way past the time to stop what should never have been allowed to begin.

Rhys Burchill

Sent from my iPad

From: norma vander
To: CoastalHuntingtonBeachDesalComments
Subject: Proposed Poseidon location
Date: Wednesday, February 2, 2022 9:42:36 AM

----- Forwarded Message -----
From: norma vander <miltnormavm@yahoo.com>
To: R4rd Info <info@r4rd.org>
Sent: Tuesday, February 1, 2022, 04:56:39 PM PST
Subject: Fw: Failure Notice

Hi,
Can you please sent me the email address for the Coast Commission so I can forward this email on the them? Thanks, Norma

----- Forwarded Message -----
From: "mailer-daemon@yahoo.com" <mailer-daemon@yahoo.com>
To: "miltnormavm@yahoo.com" <miltnormavm@yahoo.com>
Sent: Tuesday, February 1, 2022, 04:54:46 PM PST
Subject: Failure Notice

To: California Coastal Commission
From: Norma Vander Molen

February 1, 2022

I wish to call to your attention that the proposed Poseidon location was in January 2022 warned of a Tsunami Alert. The proposed site is in the Tsunami Warning area of Huntington Beach, and this is one more reason to locate any such plant to another location that is not vulnerable to such huge, destructive waves.

The location is also subject to earthquakes, as it is on an active earthquake fault.

Between these two negative situations, plus the increased cost of Poseidon water to the community, plus the negative effect of a desal plant to the environment and the tremendous cost of the proposed facility to the taxpayer/consumer, I urge you to veto any and all desal facilities in
Huntington Beach.

I propose that the surplus water of Ruth Lake, instead of running into the ocean in Northern California, be brought to the areas of Southern California in need of additional water.
Please consider alternate water sources to replenish any water shortages. A desal plant in Huntington Beach is not the answer.

I look forward to hearing from you as to these alternate water sources, and how residents of Southern California can assist in these efforts.

Yours truly,

Norma Vander Molen
9472 Mokihana Drive
Huntington Beach, CA 92646

cell: 562-303-4222

From:	Patty Tutor
To:	Energy@Coastal
Subject:	Public Comment on May 2022 Agenda Item Thursday 9a - Appeal No. A-5-HNB-10-225 (Poseidon Water, Huntington Beach)
Date:	Wednesday, April 27, 2022 10:32:30 AM

I urge the California Coastal Commission to reject the proposed Poseidon Huntington Beach Desalination Plantfor the following reasons:

The Poseidon project is costly and financially risky.

There are other less expensive, more sustainable options such as the groundwater replenishment system in Orange County which supplies two times the water the proposed desalination project would. Additionally, water efficiency and conservation improvements could reduce water use by 30 percent.

The water provided by the project would be very expensive compared to other sources and would put an undue burden on local businesses and low-income residents.

The project would harm the environment by emitting fossil fuel derived greenhouse gasses, adding chlorides and boron to groundwater which would then have to undergo expensive treatment before being used, is estimated would kill 108 million ocean organisms every year by the project's intake pipes and the brine byproduct sent back into the ocean would cause further ecosystem disruption.

The Carlsbad Poseidon plant has not delivered a fifth of the promised water and has been issued more than a dozen water quality violations in its first year of operation.

Orange County ratepayers would be committed to pay for the expensive water from the project for 50 years even if it is not needed.

This project is a very bad deal for residents and the environment, and needs to be rejected.

Thank you,

Patricia Tutor

From:	schartier-grable@ochabitats.org
To:	Energy@Coastal
Subject:	Public Comment on May 2022 Agenda Item Thursday 10a - Application No 9-21-0488 (Poseidon Water, Huntington Beach)
Date:	Friday, April 29, 2022 8:00:56 AM
Attachments:	image003.png image004.png

Dear Coastal Commission,

Good morning. My name is Stacey and I have lived and worked in Orange County for the last 25+ years. I have watched this area, along with countless others across the state and nation, be developed with little concern for the impacts of the future of future generations or our natural lands and non-human species. In this area and California, we continue to develop raw land when we don't have the water resources to support them. In one of the heavier droughts in the last 10 years, a friend of mine from Tustin was telling me she was reading a notice about not watering her lawn as she peered out her window to the new homes being built across the street. This is a problem that needs to be resolved and pulling water out of the ocean to support continued growth in our area is not the answer.

I wanted to speak out against the Poseidon desalination plant proposed for Huntington Beach, California. I am amazed that the proposal has actually made it this far and that there is a real chance that our state is going to allow this to happen in Orange County. Our county is already heavily urbanized and our natural habitats are incredibly encroached upon and reduced making life for species outside of humans incredibly difficult. By adding Poseidon we are essentially saying that we have little regard for the species that live in our oceans and estuaries and are ignoring the importance of microbial organisms that are the foundation of life in the ocean. Taking water from the ocean does not solve our water issue in California, it provides a bandage for the moment that will eventually fall off and become infected with the same issues as before and additional ones caused by manipulating our marine systems. It is time that our state, country, and world realize that these "bandages" are not going to keep this planet going but are actually speeding the demise of our earth and the chance of a safe and healthy future for generations to come.

I strongly urge you to deny this proposal and not allow the Poseidon plant to move further in the process. I ask you this as a citizen of our local area and as an environmental professional. Thank you for your time in reading this comment.

Sincerely,

Stacey C. Chartier-Grable
949.697.8651
Schartier-grable@ochabitats.org
www.ochabitats.org

From:	George Mason
To:	matthew.szabo@latimes.com; carol.cormaci@latimes.com; John Kennedy; Merle Moshiri; Dan.Kalmick@surfcity-hb.org; Travis Hopkins; Rhonda.Bolton@surfcity-hb.org; CoastalHuntingtonBeachDesalComments; firoozeh@coastkeeper.org
Subject:	Red Tides and Its Impact on Desalination
Date:	Thursday, April 28, 2022 9:11:39 AM

Much is being said about the proposed Poseidon desalination plant leading up to May 12's meeting of the California Coastal Commission. Here's a another relevant and timely example of one more reason why permitting this project to move forward as currently planned is not in Orange County residents' best interests.

Daily Pilot, April 28, 2022: Wildlife experts fear seabird deaths as red tide washes up near Newport Pier - Los Angeles Times (latimes.com)

How do red tides affect desalination plants? (theenergyofchange.com)

red tide influence on desalination - Search (bing.com)

George Mason
Huntington Beach resident

From:	Debby Koken
To:	CoastalHuntingtonBeachDesalComments
Subject:	Stop the Poseidon desalination plant
Date:	Sunday, February 13, 2022 11:01:36 AM

To the California Coastal Commission:

Poseidon is an expensive boondoggle which will only benefit the Poseidon corporation at public expense. We could add the same amount of water to our supply with conservation, recycling and stormwater recapture for a fraction of the cost, which would also reduce runoff, with the added benefit of cutting down on pollution and helping with flood control.

In addition to destroying sea life, the Poseidon project will instantly add a city's worth of electricity demand to the Southern California grid. Water rate-payers will have to shoulder the enormous cost of buying Poseidon water annually for 50 years whether it's needed or not.

If approved, this project will create a dead zone off the Orange County coast, pollute our acquifer with boron-contaminated water which is harmful to agriculture and home gardens, and increase the cost of water for everyone. Please deny a permit to this project which is so detrimental to the California coast and the public interest.

Deborah Koken
1778 Kenwood Pl
Costa Mesa, CA 92627

From:	Terry Koken
To:	CoastalHuntingtonBeachDesalComments
Subject:	The Poseidon Desal Major Rip-off
Date:	Sunday, February 13, 2022 1:20:38 PM

Coastal Commissioners and Staff,
It appears that Poseidon is up for a smash-and-grab followed by a fast getaway.

The wheels have thus far ground slowly, although not very fine. Two decades' worth of Poseidon's entreaties for lax standards, matched against two decades' worth of citizens' logical arguments, citizens' pleas that we not be robbed by the "wonderful plan" that these thieves have charted out for us, and citizens' observations that we don't *need* Poseidon, have finally come to a head with Poseidon's strategy of building an obsolete, polluting, death-dealing, and expensive desal plant and then *selling* it to Orange County and getting out of our lives, and the life of the plan. An educated guess as to what they are going to do with the money is probably to move to a middle-east country and live in luxury with it.

We've heard all about their previous intention to sell the plant to us in fifty years for a dollar, which, since after twenty years it will have attained the status of superfund cleanup site, is a rip-off all by itself; now, they've changed their mind, and want much more for it.

We don't have any quarrel with desalination per se. Done in sustainable, ecological, economical fashion, it might increase our water supply without burdening us with a 300% cost increase, polluting our groundwater, and creating a dead zone in the ocean. We just don't rightly believe that Poseidon has anyone's best interest in mind than Poseidon's, and we are not eager to grasp a deal that leaves us poorer with a contractual obligation to stay that way, and holding the filthy end of the stick.

You are the last bastion of decency, sanity, and fiscal responsibility in this matter, with your charter to keep the California coast for us all. Won't you, please, hold to that charter, and tell Poseidon that rather than move to Dubai and live in luxury, they must set up housekeeping with the rest of the homeless under a bridge somewhere?
Yours sincerely,
Terrell E. Koken
1778 Kenwood Pl.
Costa Mesa, CA 92627

From: Armida Brashears
To: CoastalHuntingtonBeachDesalComments
Subject: Fwd: Poseidon proposal
Date: Friday, October 29, 2021 10:50:22 AM

-----Original Message-----
From: Armida Brashears <armidahb@verizon.net>
To: oceandesalexploration@ocwd.com <oceandesalexploration@ocwd.com>
Cc: de.hamilton@verizon.net <de.hamilton@verizon.net>; ray@coastkeeper.org <ray@coastkeeper.org>; addup@sierraclub.org <addup@sierraclub.org>
Sent: Fri, Oct 29, 2021 10:38 am
Subject: Poseidon proposal

I oppose the Poseidon proposal because we DO NOT need it and it will do GREAT harm to the ocean

It will harm larva and small fish. It will add to the ocean acidification. It will be energy intensive. It will cost rate payers in water rates AND water bonds even though we DO NOT need it.

PLEASE listen to the rate payers. We are the ones that will have to live with it both at our beach/ocean and in our pocket book.

I am a 56 year resident of Huntington Beach and a Grandmother of 11 children who DO NOT want the ocean to be further impacted.

Armida Brashears

21632 Hanakai Lane
Huntington Beach 92646
714 330-3838 cell

A-5-HNB-10-225 / 9-21-0488

(Poseidon Water, Huntington Beach)

CORRESPONDENCE:

Individual Emails:

Support

From: Shatila, Makrom
To: CoastalHuntingtonBeachDesalComments
Subject: APPROVE Huntington Beach Desal Project!!
Date: Thursday, April 28, 2022 1:07:23 PM

CCC:

Good day, I just want to provide my support for the Huntington Beach Seawater Desalination Project. The Poseidon 50 MGD Carlsbad desal project is providing upwards of 10% of the counties water supply and there is no reason why a seawater desalination facility can't be doing the same for our northern orange county neighbors! All we read in the news today is drought, drought, drought, and about to be worst drought on record… cut back water usage, etc. etc. And yet we want to stop the development of a new drought proof water supply… that just makes no logical sense to me and many others.

I appreciate you listening and hope CCC board does not blindly deny the CDP based on staff recommendation but look at the big picture and how this project will help the whole state with its water woes.

Thanks,
Mak Shatila

Makrom Shatila, P.E. | Sr. Associate / Technical Manager - Water
9755 Clairemont Mesa Blvd Suite 100 | San Diego, CA 92124-1333 | [O] 858-614-5032 | [M] (858)401-2268
mshatila@mbakerintl.com | www.mbakerintl.com

From:	Diane Hemelstrand
To:	CoastalHuntingtonBeachDesalComments
Subject:	Desal is a Much Needed Climate Resilient Supply
Date:	Monday, April 4, 2022 11:40:23 PM

Dear Coastal Commissioners & Staff,

The Pacific Ocean is the world's largest reservoir, and the ONLY 100% climate resilient water supply available. Now, more than ever, the importance of a safe and secure water source is critical to Orange County and the region.

The Huntington Beach Desalination Plant will provide Orange County with an independent, secure and safe water supply. Water that will be uninterrupted by world or local crises, natural disasters or other potential interruptions. Conservation is a critical tool, but alone cannot ensure a reliable water supply for Orange County.

I urge you to approve this final permit to move this project forward.

Thank you,

Diane Hemelstrand
6141 paseo Palero
Warner Springs, CA 92086

From: Dennis Vannote
To: CoastalHuntingtonBeachDesalComments
Subject: HB Desal Helps Us Avoid Water Shortages
Date: Monday, April 4, 2022 11:36:03 PM

Dear Comissioners,

California is constantly facing dry years, even drier years and extremely dry years. We cannot predict how long, or when and if rain will come, but we do know that climate change is here and increasing the frequency of droughts. Climate scientists predict more severe droughts in the future.

Seawater Desalination offers the state a 100% drought-proof water supply. Faced with these realities the Huntington Beach Desalination Plant will help us avoid catastrophic water shortages.

Desal is an immediately available new source of water. I urge you to support this Project before you.

Sincerely,

Dennis Vannote
14311 Thunderbird Cir
Huntington Beach, CA 92647

From: Charlotte Smith
To: CoastalHuntingtonBeachDesalComments
Subject: HB Desal Project
Date: Wednesday, March 30, 2022 7:44:34 PM

Dear Chair Brownsey and fellow Commissioners:

I'm writing to let you know that I strongly support the Poseidon Water HB Desal Plant application for their Coastal Development Permit. I've been following this project throughout its 20-plus year permitting process. Every day I open the newspaper I see that climate change is impacting California's water supply. I know this project is no magical solution to our water supply needs, but it will help drought-proof Orange County.

It will add a few dollars on our monthly water bill. But the value makes that increase worthwhile.

I have changed out my lawn for California friendly plants (which are beautiful!). I have water efficient indoor fixtures and even have a rain barrel (with the proper screening to prevent mosquitos), but I still recognize the need for a reliable water supply not for me but for my grandchildren.

I hope you will vote yes on this important project and I thank you for your time and consideration.

Sincerely,

Charlotte Mason Banks
Huntington Beach, CA

From:	Lucas Henry
To:	CoastalHuntingtonBeachDesalComments
Subject:	High Quality, RELIABLE Water
Date:	Monday, April 4, 2022 11:44:07 PM

To whom it may concern,

The Huntington Beach Desalination Plant will provide Orange County with a locally controlled, climate-resilient supply of high-quality water that will meet or exceed all state and federal drinking water standards. Drinking water that will be produced at the Plant will be some of the highest quality drinking water in Orange County.

The high quality of this water will help to reduce the wear and tear costs of manufacturing equipment and household appliances. These savings are passed on to ratepayers and will keep costs low long-term. All Californians deserve this water!

Please move forward with a viable permit for this Project.

Thank you,

Lucas Henry
2428 S Fremont Ave
Alhambra, CA 91803

From:	Julia Raymond
To:	CoastalHuntingtonBeachDesalComments
Subject:	OCWD Needs the HB Desal Plant
Date:	Monday, April 4, 2022 11:38:11 PM

Dear CA Coastal Commission,

The Huntington Beach Desalination Plant will provide Orange County with a locally controlled, drought-proof, high-quality supply of drinking water, reducing the need to import water and provide flexibility in how the Orange County Water District manages the groundwater basin.

OCWD's Updated 2020 Orange County Reliability Plan identifies the Facility as providing the District with up to 50 million gallons per day of new water supply, and the District's Long-Term Facilities Plan identifies the Huntington Beach Desalination Facility as a priority facility and the single largest source of new, local drinking water supply available to the County.

This is a shovel ready project, delivering a new water supply! I ask you to support the HB Desal project!

Thank you,

Julia Raymond
11964 Candlewood St
Rancho Cucamonga, CA 91739

From: Stephen Sharp
To: CoastalHuntingtonBeachDesalComments
Subject: OCWD Needs the HB Desal Plant
Date: Monday, April 4, 2022 11:38:50 PM

Dear CA Coastal Commission,

The Huntington Beach Desalination Plant will provide Orange County with a locally controlled, drought-proof, high-quality supply of drinking water, reducing the need to import water and provide flexibility in how the Orange County Water District manages the groundwater basin.

OCWD’s Updated 2020 Orange County Reliability Plan identifies the Facility as providing the District with up to 50 million gallons per day of new water supply, and the District’s Long-Term Facilities Plan identifies the Huntington Beach Desalination Facility as a priority facility and the single largest source of new, local drinking water supply available to the County.

This is a shovel ready project, delivering a new water supply! I ask you to support the HB Desal project!

Thank you,

Stephen Sharp
626 19th St
Huntington Beach, CA 92648

From:	Richard Jones
To:	CoastalHuntingtonBeachDesalComments
Subject:	We Need a Climate- Resilient Water Supply - WE NEED DESAL!
Date:	Monday, April 4, 2022 11:33:53 PM

Dear California Coastal Commissioners & Staff,

Thanks to climate change, our snowpack in the High Sierras is shrinking every year, which makes our imported drinking water supply more vulnerable. We need a local climate-resilient water supply and desalination must be part of the equation.

Climate change is increasing the frequency of droughts and climate scientists predict they will be more severe in the future. Seawater desalination offers the state a 100% drought-proof water supply.

For the future of all Californians I ask you to vote yes on the final permit for the Huntington Beach Seawater Desalination Facility.

Thank you,

Richard Jones
20581 Troon Ln
Huntington Beach, CA 92646