

Proceed with Caution: California's Drought and Seawater Desalination

I. INTRODUCTION

For California, 2013 was the driest calendar year ever recorded across virtually the entire state.¹ On January 17, 2014, Governor Jerry Brown proclaimed the drought to be a State of Emergency, directed state officials to take all necessary actions to assist the hardest hit communities, and called for all Californians to pitch in to reduce water use by 20 percent. In short order, lawmakers and the governor enacted a relief package that provides \$687 million in drought relief to fund projects to improve conservation, clean up contaminated groundwater, make irrigation more efficient, and help those hurt most by the drought.²



This bi-partisan, emergency action provides critical support for drought relief alternatives that are the most cost effective, readily available, and beneficial to the environment and communities' quality of life. While the agencies and experts have clearly identified those actions best suited to provide relief, some observers wonder whether the long-term answer to California's drought lies in the ocean through the promotion of seawater desalination.

This white paper—prepared by the Natural Resources Defense Council, California Coastkeeper Alliance, Surfrider Foundation, Heal the Bay, Orange County Coastkeeper, and California Coastal Protection Network, Residents for Responsible Desalination, Southern California Watershed Alliance, the Desal Response Group, and the Sierra Club Angeles Chapter—offers an overview of the science and policy related to seawater desalination and demonstrates why this option is generally the least promising option for drought relief. Other water supply options should be prioritized over seawater desalination because:

- Seawater desalination is very expensive, costing on average four to eight times more than other options;
- Seawater desalination is typically the most energy-intensive water supply option, resulting in significant greenhouse gas (GHG) emissions;
- Multiple large seawater desalination projects are likely to have significant negative impacts to the valuable marine resources that California has invested millions of dollars to protecting; and
- Experience demonstrates that large, expensive desalination facilities and associated infrastructure can take many years to build and bring online, yet the water demand and price may be insufficient to justify continued operation of the desalination plant when less expensive water supply and demand management alternatives are available: this creates significant financial risk for ratepayers and taxpayers.

In preparing this white paper, the signatory organizations have comprehensively reviewed California's water supply options and have determined that seawater desalination should only be pursued with caution and only after conservation, stormwater capture through the use of "green infrastructure," water use efficiency, and wastewater recycling have all been fully implemented. These preferred alternatives are not only less expensive, they prevent pollution, contribute to habitat restoration, and reduce energy usage. Priority drought response measures including efficiency enhancement, water recycling, and greywater opportunities are described in the Recommendations section.

If and when seawater desalination is appropriate, projects should be appropriately scaled to meet demonstrated water supply needs. Then, projects should be designed and sited and the best technology available should be used to: minimize the intake and mortality of marine life; minimize adverse impacts to the marine environment from the facility's

waste discharge; and avoid conflict with ecosystem-based management activities, especially ongoing implementation of the Marine Life Protection Act, and climate change and disaster preparedness. These recommendations are also discussed in greater detail below.

II. WHAT IS SEAWATER DESALINATION?

California's current drought has highlighted the need for improved freshwater management and has elevated seawater desalination in discussion of water supply alternatives. Desalination entails removing salt and other minerals from seawater, brackish water, wastewater, or contaminated groundwater to create pure water for drinking and other purposes.³ With 3,427 miles of tidal shoreline⁴ and 74 percent of the California population living in coastal counties,⁵ it is reasonable to consider that seawater desalination might play a role in the state's water supply portfolio.

There are a range of different desalination technologies, though most modern plants use either distillation or reverse osmosis in which high volumes of saline water pass through membranes to remove salts from water.⁶ A Pacific Institute count of pending seawater desalination projects along the California coast published in July 2012 documents 15 proposals for new plants in the state and two additional plants proposed in Baja Mexico to provide water to Southern California residents.⁷ All of these proposed projects would utilize seawater reverse-osmosis (SWRO), with varying environmental implications depending on the type of source-water intake planned, as well as the size and location of the projects. Absent statewide standards, the proposals that have reached regulatory review have varied greatly in terms of technology, design, capacity, and impacts. Both the comparative impacts of different projects, and the impacts of individual plants vary significantly depending on the location, surrounding habitat, year, and even the season.⁸

III. SEAWATER DESALINATION IS GENERALLY NOT COST COMPETITIVE

Water produced by seawater desalination is very expensive with an average price per acre-foot four to eight times higher than water from other sources. Estimates for plants proposed in California range from \$1,900 to more than \$3,000 per acre-foot.⁹ A 50 million gallon per day (MGD) plant, such as the one under construction in Carlsbad, is projected to have a price between \$2042 to \$2290 per acre-foot.¹⁰ By comparison, the Department of Water Resources data cited in the 2009 California Water Plan Update found that:

- The "estimated range of capital and operational costs of water recycling range from \$300 to \$1,300 per acre-foot" depending on local conditions.¹¹
- The cost to realize an acre-foot of water savings through efficiency measures ranges from \$223 to \$522 per acre-foot.¹²

- The agricultural efficiency improvements that result in water savings of 120,000 to 563,000 acre-feet per year can be achieved at a cost ranging from \$35 to \$900 per acre-foot.¹³

While the cost of seawater desalination has declined over the past 20 years, the cost remains very high and it is not cost-competitive with the less expensive, and less impactful, alternatives described in the Recommendations section of this report.¹⁴ Additionally, alternatives such as water conservation, rainwater harvesting through “green infrastructure” and wastewater recycling result in pollution abatement, habitat restoration, and flood control; the economic value of these benefits are often not included in benefit-cost analyses.

IV. SEAWATER DESALINATION IS ENERGY INTENSIVE

A 2011 life-cycle energy assessment of California’s alternative water supplies commissioned by the California Energy Commission found that, while a desalination system can have a wide array of impacts depending on the water source: “In all cases, the energy use is higher than alternative water supply.”¹⁵ Energy accounts for 36 percent of the cost to run a reverse osmosis seawater desalination plant.¹⁶ The seawater desalination plant under construction in Carlsbad will require 47 percent more energy than water delivered to San Diego from the State Water Project Transfers—currently the highest energy demand in the region’s water supply portfolio.¹⁷ In some areas, seawater desalination is more than twice as energy intensive as other water supply options. The Los Angeles Economic Development Corporation found ocean desalination to indirectly create more greenhouse gases than any other water source.¹⁸ The Inland Empire Utilities Agency has similarly reported that ocean desalination would use more than ten times more energy than water recycling in its service area.¹⁹

California’s current water management system is already extremely energy-intensive: “water-related energy use consumes 19 percent of the state’s electricity, 30 percent of its natural gas, and 88 billion gallons of diesel fuel every year.”²⁰ In its 2008 Climate Change Scoping Plan, the California Air Resources Board noted that one way for the state to reduce GHG emissions is to replace existing water supply and treatment processes with more energy efficient alternatives.²¹ Because seawater desalination is so energy intensive, extensive development of this technology could lead to “greater dependence on fossil fuels, an increase in greenhouse gas emissions, and a worsening of climate change.”²²

To effectively minimize the impacts of climate change and reduce GHG emissions, the state should prioritize water supply and treatment alternatives that are energy efficient, such as those described in the Recommendations section.

V. SEAWATER DESALINATION CAN CAUSE SIGNIFICANT HARM TO THE MARINE ENVIRONMENT

Seawater desalination can have significant impacts on the marine environment through the intake of large volumes of seawater containing marine life, as well as from the discharge of brine. The impacts of seawater desalination should also be evaluated in the context of the many concurrent threats to California’s marine ecosystems including reductions in marine fish populations, water quality degradation, ocean acidification, and marine plastic pollution.²³ California must proceed with caution so that negative impacts of seawater desalination do not undermine California’s investment in maintaining vibrant, economically valuable marine ecosystems.

A. Outdated open ocean intake technology can kill billions of fish and other marine life each year.

If outdated intake technology is used, such as open ocean intakes, which are large pipes in the water column, the process of taking in the source seawater can kill billions of fish eggs, adult fish, and other marine life each year, threatening the productivity of California’s marine ecosystems. Seawater desalination plants typically only convert 45 to 55 percent of the water they withdraw into freshwater, which means they must take in twice as much seawater as the amount of freshwater they intend to produce.²⁴

Many of the proposed desalination projects in California plan to use open ocean intakes, despite the availability of less impactful alternatives such as subsurface intakes, described below. Fish and other marine life are injured or killed when they become trapped or “impinged” on the screens that are put across the front of such intake pipes. Smaller organisms, such as fish eggs and larvae, can pass through the screens but die in large numbers (with nearly 100 percent fatality rate) as they become “entrained” in the plant’s interior workings. To address impingement and entrainment harms, in 2010, the California State Water Resources Control Board (State Water Board) adopted a policy to phase out the use of open ocean intakes for cooling water in coastal power plants,²⁵ based on estimates that these intakes were killing 70 billion fish and marine life annually, including threatened and endangered species.²⁶ Although open ocean intakes are being phased out for coastal power plants, that policy does not prevent the approval of new desalination plants with open ocean intakes, which would undermine California’s ongoing efforts to protect marine life from impingement and entrainment. The State Water Board is working to develop a corresponding policy, which would apply to desalination plants.

B. Discharge of concentrated brine may be toxic to marine organisms.

The desalination process generates waste, known as brine, which can have serious impacts, including acute and chronic toxicity if improperly discharged into the marine environment.²⁷ Brine is composed of highly concentrated constituents normally found in seawater (e.g., magnesium, boron, and sulfate), often combined with a suite of chemicals used throughout the desalination process (e.g., aluminum chloride, polyphosphates, and biocides), which can be toxic to marine organisms even at low concentrations.²⁸ Brine may also contain heavy metals from corroding equipment and it may be warmer than the receiving waters, causing thermal pollution.²⁹

Most seawater desalination facilities discharge their brine into estuaries or the ocean, so the use of brine diffusers, discharging the brine into sub-tidal offshore areas with persistent turbulent flows, and pre-discharge dilution with wastewater can help to minimize the negative impacts of the waste.³⁰ Another way to reduce the impacts of brine is by improving the source water quality through the use of subsurface intakes, which in turn reduces operating costs and contaminants that would be concentrated in the discharge.

Through the natural filtration provided by layers of rock or sand, contaminants such as algae and bacteria are removed, reducing the need for chemicals and corresponding costs in the desalination process.³¹

C. Potential impacts to California's newly created Marine Protected Area network.

In 2012, California finalized the nation's first science-based network of marine protected areas (MPAs), as called for by state's landmark Marine Life Protection Act.³² Stretching the entire length of the state's coastline, this network of 124 protected areas has been created to safeguard the productivity and diversity of marine life and habitats for future generations. Although no projects are likely to be proposed or permitted within MPAs, desalination plants with infrastructure sited near MPAs could result in significant impacts from intakes and brine discharge and may reduce larval connectivity between protected areas through entrainment and impingement, thereby compromising the effectiveness of the broader network. Careful analysis of new desalination facilities and their impacts on protected areas (including an understanding of larval dispersal and areas of sources and sinks) is essential to ensure the lasting success of California's MPA network.

Cautionary Tales of Demand Risk

When evaluating expensive desalination projects in response to pressing drought, California should learn from past mistakes. In response to the 1986 to 1991 drought, the city of Santa Barbara spent \$34 million to build a reverse osmosis desalination plant that was promptly placed into long-term storage because of the plant's high operational costs.³³ Now, the city is considering a two-year process to reactivate the plant, at an additional cost of \$20.2 million and with operating costs of approximately \$1,500 per acre-foot.

Similarly, severe drought from the mid-1990s until 2012 prompted Australia to construct six large-scale seawater desalination plants at a cost of \$10 billion Australian Dollars (AUD) to provide an alternative source of drinking water.³⁴ At the same time, water policy reforms and improved efficiency measures were implemented through the country's National Water Initiative.³⁵ The plants took years to build. By the time they were operational, the drought had eased and cheaper alternatives, made possible by the National Water Initiative, made the water from the desalination plants impractical.³⁶ Today, four of the six Australian plants stand idle.

These two examples illustrate the danger of demand risk, which "is the risk that water demand will be insufficient to justify continued operation of the desalination plant due to the availability of less expensive water supply and demand management alternatives."³⁷ Because of the financial structure of seawater desalination projects:

Project developers may build large plants in an effort to capture economies of scale and reduce the unit cost of water. This can, however, lead to oversized projects that ultimately increase demand risk and threaten the long-term viability of a project.³⁸

The plant in Sydney cost \$2 billion AUD to build, yet in 2012 it was shut down while taxpayers were left to pay \$16 million AUD per month for the cost of building the plant and its pipeline.³⁹ Melbourne also reacted to the drought and built the \$3.6 billion AUD Wonthaggi desalination plant, which came online in 2012.⁴⁰ Similar to the Sydney plant, Wonthaggi is now idle. Nevertheless, water consumers are continuing to pay \$670 million AUD annually for Wonthaggi's construction through water bill surcharges. That is without one drop of water being drawn from the plant.⁴¹ In response to the current drought, California should carefully evaluate these past expensive experiences with seawater desalination and instead prioritize cheaper, less risky alternatives.

Many of the negative impacts associated with seawater desalination can be significantly reduced by careful planning and siting of projects and the use of the best available technology (BAT). Discussed further in the Recommendations section, alternative subsurface intake technologies and appropriate brine dispersal techniques should be designated by the State Water Resources Control Board as BAT because they can greatly reduce the impacts of the seawater intake while also increasing the water quality and reducing energy demands and the need for various chemicals used during reverse osmosis, which in turn can reduce plant operation costs. If and when they are needed, seawater desalination plants should be sited if and where these less impactful technologies can be used.

VI. HOW DOES CALIFORNIA REGULATE SEAWATER DESALINATION?

Multiple California agencies have the authority to create policy or administer regulations governing seawater desalination. The State Lands Commission (SLC), State Water Board, and the California Coastal Commission have regulatory control over seawater desalination projects. The SLC has regulatory authority over public trust lands, including tide and submerged lands (land under navigable waters), and it has authority to “exclusively administer and control all [public trust lands]” to “lease or otherwise dispose of such lands, as provided by law.”⁴² A private company or a public entity must apply to the SLC to use sovereign lands for any public trust use. Applications “must include an outline of the proposed project, supporting environmental data, and payment of appropriate fees.”⁴³

The State Water Board is the designated state water pollution control agency under the Federal Water Pollution Control Act. In conjunction with the Regional Water Boards, it is authorized to issue Waste Discharge Requirements and National Pollutant Discharge Elimination System (NPDES) permits.⁴⁴ The State Water Board also has the authority and duty to regulate seawater desalination intakes. The California Water Code requires that:

*For each new or expanded coastal powerplant or other industrial installation using seawater for cooling, heating, or industrial process, 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.*⁴⁵

The State Water Board is developing new regulations through an Ocean and Estuary Plan Amendment, which will provide consistent guidance to project proponents under the Clean Water Act and California’s Porter-Cologne Act. These new standards are expected to be in place by fall 2014. Building seawater desalination facilities prior to final adoption of those rules may result in expensive retrofits to meet the regulations. Inconsistencies in legal interpretation

of environmental protection requirements found in NPDES permits issued while the SWRCB Ocean Plan Amendment is pending further illustrate the urgent need for a consistent policy.

The California Coastal Commission (CCC) issues coastal development permits (CDP), certifies local governments’ Local Coastal Programs, reviews appeals of locally issued CDPs, and conducts federal consistency review pursuant to the CZMA. As part of the permit review, CCC staff must decide if the development conforms to the Coastal Act and California Environmental Quality Act (CEQA).⁴⁶ CCC staff evaluate individual and cumulative impacts of proposed activities.⁴⁷

The Department of Water Resources does not have a regulatory role. It does, however, prepare the California Water Plan, with stakeholder input. This plan is updated every five years to assess trends, challenges, and opportunities in water management.⁴⁸ The 2013 draft Water Plan Update contains a Desalination Resource Management Strategy that provides local water districts with an overview of issues to consider when developing a desalination project. The strategy, however, is non-binding and is informed largely by the desalination industry.⁴⁹

Local governments, the California State Parks, the Department of Public Health, and water districts may also have roles in siting and overseeing seawater desalination projects. In the case of the Poseidon Water Huntington Beach Seawater Desalination Facility, these entities were respectively tasked with certifying the environmental impact documents, negotiating water purchase agreements, granting easements for proposed pipelines that would carry desalinated water or for other infrastructure, and issuing Wholesale Drinking Water Permits.⁵⁰

Although there are 15 new projects proposed along California’s coast, there has been no comprehensive evaluation of the cumulative impacts or spatially explicit siting and compatible use issues presented by the ramp-up of these facilities.⁵¹ Because these projects require review and oversight by multiple agencies under various state and federal laws, the Ocean Protection Council (OPC) has endeavored to coordinate the work of these agencies through an interagency desalination task force. Additionally, provisions in various state laws support enhanced application of robust scientific information and interagency coordination within the context of existing regulatory mandates. For example, the Coastal Act provides a good foundation for incorporating ecological principles into the decision-making process, stating:

*[m]arine resources shall be maintained, enhanced, and where feasible restored. . . Uses of the marine environment shall be carried out in a manner that will sustain the biological productivity of coastal waters that will maintain healthy populations of all species of marine organisms adequate for long-term commercial, recreational, scientific, and educational purposes.*⁵²

The Water Code requires consideration of the overall ecological balance of the habitat: “where otherwise permitted, new warmed or cooled water discharges into coastal wetlands or into areas of special biological importance, including marine reserves and kelp beds, shall not significantly alter the overall ecological balance of the receiving area.”⁵³ Interagency coordination is required by the Water Code: “during the process of formulating or revising state policy for water quality control, the state board shall consult with and carefully evaluate recommendations of concerned federal, state, and local agencies”⁵⁴

A. Regulation of Existing Open Seawater Intakes.

Our organizations have spent decades working with state and federal agencies to develop regulations to implement the federal Clean Water Act and minimize the intake and mortality of marine life from open ocean intakes and antiquated “once-through cooling” technology for coastal power plants.⁵⁵ Regulations adopted in 2010 by the State Water Resources Control Board documented the significant impact to marine ecosystems from these intake structures, and required power plants on our coast and estuaries to employ “best technology available” to reduce the entrainment and impingement of marine life.⁵⁶ Despite the ongoing phase-out of these open ocean intakes for cooling water, some seawater desalination proponents are seeking to continue their use, which would undermine the policy objective of minimizing marine life mortality from entrainment and impingement established in the Porter-Cologne Act.

VII. RECOMMENDATIONS

The following recommendations describe policies and planning processes that should precede and then inform any decision to site a seawater desalination project. Agencies, flood control districts, and land use managers should integrate these recommendations to achieve water supply goals while minimizing costs and negative environmental impacts associated with seawater desalination.

A. Less costly and impactful water supply options should be prioritized over seawater desalination.

In the vast majority of locations, water conservation, water use efficiency, stormwater capture, rainwater harvesting, and wastewater recycling measures are less expensive, have fewer negative environmental impacts, and have multiple economic and environmental benefits. These options should be pursued to the maximum extent possible before seawater desalination is considered. Given climate change predictions of longer and more severe dry periods, as well as precipitation

changing from snow to more rainfall, Californians must reform water management systems and water use to prepare for future water challenges. Multiple economic and environmental benefits can be realized in California through a better understanding and implementation of “integrated water resource management” (IWRM). The principles of IWRM, both in terms of public process and substantive goals, has been documented by numerous scientific and policy institutions, including a recent publication by the U.S. Army Corps of Engineers summarizing the benefits of more holistic and integrated freshwater management.⁵⁷

1. Urban water efficiency measures can be implemented immediately.

A recent survey of public perceptions of water use showed that respondents underestimate water use by a factor of two on average, with large underestimates for high water-use activities.⁵⁸ Compared with other countries that use desalination, California’s urban water consumption ranks the highest at 201 gallons per capita per day (GPCD), compared with Australia’s urban water use of 80 to 130 GPCD in the early 2000’s, Israel’s 84 GPCD, and Spain’s 76 GPCD.⁵⁹ The California Urban Water Conservation Council (CUWCC) documented that the state could save more than 27.5 billion gallons of water per year.⁶⁰ Specific examples of opportunities readily available to increase urban water use efficiency, highlighted in an NRDC report to the State Water Board, include:⁶¹

- Accelerating the transition to high-efficiency clothes washers by suspending the 6.5 percent state sales tax on the purchase of these machines;
- Requiring installation of water meters on all urban water service connections within 5 years;
- Enforce existing requirements to replace inefficient plumbing in all rental property by 2017 and in residential and commercial buildings by 2019; and
- Ensure that water suppliers send effective price signals to consumers regarding the scarcity and costs of water.

2. Low-impact development techniques, including green infrastructure and rainwater capture should be prioritized.

Stormwater runoff is a drastically underutilized potential resource in California. For example, a one-inch storm in Los Angeles County can result in 10 billion gallons of runoff flowing through the area’s storm drain systems and discharging into the ocean.⁶² At the same time, stormwater runoff is also the leading source of surface water pollution in California, carrying bacteria, metals, and other pollutants into waterways, harming the environment and creating economic loss potentially into the hundreds of millions of dollars every year from public health impacts alone.⁶³

Low-impact development (LID), is a land planning and engineering design approach that emphasizes rainwater harvesting, including infiltration of water into the ground as well as capture in rain barrels or cisterns for later use onsite at new and redeveloped residential and commercial properties in the urbanized areas.⁶⁴ Improved stormwater management enables cities, states, and individuals to increase access to safe and reliable sources of water while reducing the amount of energy consumed and global warming pollution generated by supplying the water.⁶⁵

NRDC and the University of California, Santa Barbara Bren School estimate that LID practices in urban areas of southern California and limited portions of the San Francisco Bay would:

[I]ncrease local water supplies by up to 405,000 acre-feet (af) of water per year by 2030. This volume represents roughly two-thirds of the volume of water currently used by the entire city of Los Angeles each year. The water savings translate into electricity savings of up to 1,225,500 megawatt hours (MWh), avoiding the release of as much as 535,500 metric tons of CO₂ per year, as the increase in energy-efficient local water supply from LID results in a decrease in the need to obtain water from imported sources of water such as the California State Water Project (SWP) or the use of processes such as ocean desalination, both of which require tremendous amounts of energy.⁶⁶

The State Water Board maintains a list of California LID projects. This includes on-site landscape retention, which provides flood protection while also recharging groundwater basins and reducing pollution loading.⁶⁷

3. Water recycling projects should also be prioritized.

Increased recycling of wastewater is another important water supply option that is less impactful than seawater desalination. According to state estimates, development of water recycling projects can readily achieve an estimated 1.4 to 1.7 million acre-feet by 2030, of which 0.9 to 1.4 million acre-feet (62 to 82 percent) would be recycled from discharges that would otherwise be lost to the ocean, saline bays, or brackish bodies of water.⁶⁸ In Orange County, the Sanitation District built a world-renowned water reuse facility, which generates enough purified water to serve 500,000 people.⁶⁹ According to the Report Card for America's Infrastructure, this facility is between 35 and 75 percent less expensive than saltwater desalination and will consume half the energy.⁷⁰

As recommended by NRDC to the State Water Board, by prohibiting ocean discharges from wastewater treatment plants by 2030, the Board could dramatically accelerate the adoption of water recycling and significantly improve the drought resistance of urban communities.⁷¹ This would significantly increase available water supply for

both agricultural and urban water users, at costs that are comparable to imported water and alternative supplies. This policy change would have at least two added benefits: (1) it would improve coastal water quality by reducing ocean discharges, particularly of wastewater that is only treated to secondary levels, and (2) it could potentially reduce greenhouse gas emissions, because recycled water consumes less electricity than many alternative water supply sources, including water imported from the Bay-Delta to Southern California and ocean or brackish water desalination. It is also recommended that the state develop a general permit that would allow for the onsite use of greywater under specific conditions.

4. Sustainable management of groundwater should be prioritized.

California is the nation's largest producer of groundwater, extracting nearly twice as much as Texas, the next state.⁷² More than half of Californians rely on groundwater as a source of drinking water—in certain areas it is the only source of water. In areas where groundwater is the only source of water, desalination may be considered as a last resort if groundwater is not managed properly. Unfortunately, California is pumping more groundwater than it is recharging, causing overdraft in many California basins. Overdraft is associated with a variety of impacts, including land subsidence, increased energy required for pumping water at lower depths, and water quality problems.⁷³ Each of these impacts undermines the aquifer's potential to continue providing a local, reliable source of water.

To avoid these impacts, water districts should manage groundwater basins to utilize their storage capacity, rather than just tapping them for water supply. The Metropolitan Water District of Southern California recently estimated that groundwater basins in the southern California region have 3.2 million acre-feet of storage space available for possible recharge.⁷⁴ Local groundwater management entities should consider land use planning to encourage groundwater recharge. Water districts should also endeavor to sustainably manage their groundwater by balancing the amount of water being pumped with the amount recharging the aquifer. This can be done by monitoring the quantity of water pumped from a basin, and then actively recharging the aquifer through natural recharge, low-impact development strategies, and groundwater recharge with advance treated recycled water. For example, Orange County sustainably manages its groundwater basin by actively recharging it with advanced recycled water. In 1997, the Orange County Sanitation District and the Orange County Water District collaborated to create a system that would preserve local groundwater resources and prevent seawater from infiltrating and contaminating the groundwater basin (a saltwater intrusion barrier).

B. If and when seawater desalination is deemed necessary, it should be guided by comprehensive statewide policy, utilize best available technology, and be located in areas where environmental impacts are minimized.

1. The State Water Board must create and implement strong statewide standards in the Ocean Plan Amendment as soon as possible.

The State Water Board is working to develop an amendment to the Ocean Plan that would address key issues associated with desalination facilities.⁷⁵ As noted above, the California Water Code requires that “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” of coastal desalination facilities using seawater for their industrial processing of water.⁷⁶ The expert panels and reviews commissioned by the State Water Board and latest scientific information indicate that the State Board should establish best available technology to include sub-seafloor intakes and pressurized spray brine diffusers.⁷⁷

A 2013 survey and study of seawater reverse osmosis plants located globally, led by experts at the Water Desalination and Reuse Center at King Abdullah University of Science and Technology in Saudi Arabia summarized important findings arguing strongly in favor of designating subsurface intakes as BAT:

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 retreatment 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 [total and dissolved organic carbon], 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 percent 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.⁷⁸

The study also discusses how energy uses and associated energy costs decrease with subsurface intakes, because they utilize less energy-intensive natural filtration.

The Pacific Institute review of marine impacts associated with seawater desalination also provides an excellent overview of the available subsurface intake technologies.⁷⁹ In California, Long Beach has also been operating a pilot seabed gallery for several years, and several other subsurface systems are being tested around the world.⁸⁰

2. Statewide policy and integrated agency guidance should require that project sites are selected where BAT is feasible and where significant and cumulative impacts are minimized.

It is strongly recommended that all agencies with a regulatory or policymaking role in planning for or managing seawater desalination (i.e., those agencies listed in Section VI) work closely together to develop integrated guidance to help ensure that the selection of seawater desalination project sites is based on identification of areas where BAT can actually be applied.

Identification of appropriate sites for new seawater desalination plants should also be based on the application of the best geospatial data in order to:

- avoid important ecological areas and other ocean and coastal uses such as marine protected areas,
- avoid areas vulnerable to sea level rise and other coastal hazards,
- choose a site that will allow for the application of the best available technology to reduce impacts to marine life,
- select a location that will ensure water quality standards are protected, and
- select a location that will make the best use of existing freshwater delivery infrastructure.

There are important resources available to assist with best site identification. Over the past five years, working with its Science Advisory Team⁸¹ and the California Ocean Science Trust,⁸² the OPC has made significant investments in data collection and the development of a framework for integrating science into state decision-making.⁸³ Some of that information is now available for any interested stakeholder via a collaborative effort between OPC and the State’s Geospatial Information Office in the California Coastal Geoportal.⁸⁴ The Coastal Geoportal contains information—such as the location of marine protected areas, sea level rise projections, and water quality data—that should be used to determine the best available site, design and technology for coastal desalination facilities, per California Water Code § 13142.5(b). OPC has added data layers to the Geoportal according to the level of priority that consulted staff from various agencies have assigned this information.

Any agency reviewing CEQA or other environmental compliance materials for seawater desalination facilities should:

- Ensure a thorough alternatives analysis has been conducted to evaluate the economic and environmental adverse impacts and/or benefits of alternative water supply options.
- Evaluate cumulative impacts of multiple proposed desalination facilities in the same vicinity, as well as in the context of multiple threats to our marine ecosystem, including reductions in marine life populations, water quality degradation, ocean acidification, and marine plastic pollution.
- Conduct a thorough analysis of alternatives that comprehensively evaluates a range of project sites where designated best available technology (e.g., subsurface intakes) can be utilized.
- Assess the energy demand and indirect greenhouse gas emissions of seawater desalination facilities.
- Ensure consistency with other efforts to protect marine life, including the implementation of the Marine Life Protection Act and the State Water Resources Control Board Policy to reduce marine life mortality from once-through cooled power plants.

Whether through the OPC seawater desalination working group or another convening mechanism, it is recommended that these points of guidance be formally adopted and shared with all relevant agencies, for example through formal CEQA guidance or a memorandum of understanding to that effect.

C. California Agencies Should Work with Industry To Collect and Apply New Information About the Impacts of Seawater Desalination.

Although seawater desalination has been utilized for many years, the impacts of these plants' operations have not been thoroughly monitored using baseline data and ongoing evaluation.⁸⁵ There are significant knowledge gaps about the impacts of the technology, and especially about the specific impacts new plant operations will have on California's diverse and sensitive ecosystems. For example, the State Water Board convened an expert panel on the management of brine discharges to coastal waters, and the panel noted the current level of information available about brine discharge:

[A] large proportion of the published work is descriptive and provides little quantitative data that can be assessed independently. Many monitoring studies lacked sufficient details of study design and statistical analyses, making interpretation of results difficult... greater clarity and improved methodologies are required in the assessment of the ecological impacts of desalination plants...⁸⁶

Recent research and analysis conducted by experts with the Center for Ocean Solutions provides valuable guidance for developing effective monitoring, assessment, and adaptive management protocol. A diverse group of experts has determined that by assessing native species diversity, habitat diversity and heterogeneity, populations of key species, and connectivity, resource managers can support resilient ecosystems and make ecosystems less vulnerable to threats and impacts, such as those presented by the development and operation of new seawater desalination facilities.⁸⁷ "These ecological principles can also help planners and managers distill the complexity of ecosystems into specific, measurable dimensions and structure important aspects of ocean planning processes, such as the development of management objectives, thresholds, monitoring programs, and adaptive management measures."⁸⁸

Integrated monitoring, assessment, and adaptive management guidance should be developed through input from all relevant agencies. This guidance should include clear protocol for establishing baseline data as well as monitoring timing and frequency to account for natural seasonal variability. It should also include best practices for data management, reporting, and third-party verification.⁸⁹

Endnotes

- 1 Jon Erdman, "Record Driest Year in California, Parts of Oregon" Jan. 2, 2014, The Weather Channel <http://www.weather.com/news/weather-forecast/california-record-driest-year-20131115>; National Weather Service, <http://www.drought.gov/drought/>.
- 2 "Governor Brown Signs Drought Legislation", March 1, 2014 at <http://www.gov.ca.gov/news.php?id=18432>.
- 3 U.S. Geological Survey, Saline Water: Desalination, <http://water.usgs.gov/edu/drinkseawater.html> (last visited Mar. 27, 2014).
- 4 U.S. Census Bureau, Statistical Abstract of the United States: Geography and Environment 225 (2012), *available at*, <http://www.census.gov/compendia/statab/2012/tables/12s0364.pdf>.
- 5 National Ocean Economics Program, State of the U.S. Ocean and Coastal Economies: Coastal and Ocean Summaries of the Coastal States 7 (2014), *available at* [file:///C:/Users/lmonroe/Downloads/CoastalStatesSummaryReports_2014%20\(1\).pdf](file:///C:/Users/lmonroe/Downloads/CoastalStatesSummaryReports_2014%20(1).pdf).
- 6 Heather Cooley et al. Pac. Inst., Desalination, With a Grain of Salt, A California Perspective 13 (2006), *available at* http://www.pacinst.org/reports/desalination/desalination_report.pdf.
- 7 Heather Cooley et al., Pac. Inst., Key Issues for Desalination in California: Proposed Facilities 3 (2012), *available at* <http://pacinst.org/wp-content/uploads/sites/21/2013/05/desal-proposed-facilities-full-report.pdf>
- 8 Heather Cooley et al., Pac. Inst., Key Issues for Desalination in California: Marine Impacts 3 (2013), *available at* <http://pacinst.org/wp-content/uploads/sites/21/2013/12/desal-marine-impacts-full-report.pdf>. Of the 17 plants described in the report, one is brackish water and the Poseidon Carlsbad plant is now under construction.
- 9 See Heather Cooley et al., Pac. Inst., Executive Summary Key Issues for Desalination in California: Cost and Financing 5 (2012), *available at* http://www.pacinst.org/reports/desalination_2013/financing_exec_sum.pdf.
- 10 See Heather Cooley and Newsha Ajami, Pac. Inst., Key Issues for Desalination in California: Cost and Financing 12 (2012), *available at* http://www.pacinst.org/reports/desalination_2013/financing_final_report.pdf.
- 11 Cal. Dep't of Water Res. California Water Plan: Update 2009 11-10 (2009), *available at* http://www.waterplan.water.ca.gov/docs/cwpu2009/0310final/v2c11_recycmuniwtr_cwp2009.pdf.
- 12 Cal. Dep't of Water Res. California Water Plan: Update 2009 3-25 (2009), *available at* http://www.waterplan.water.ca.gov/docs/cwpu2009/0310final/v2c03_urbwtruse_cwp2009.pdf.
- 13 Cal. Dep't of Water Res. California Water Plan: Update 2009 2-13 (2009) http://www.waterplan.water.ca.gov/docs/cwpu2009/0310final/v2c02_agwtruse_cwp2009.pdf.
- 14 See Cooley et al., Pac. Inst., Executive Summary Key Issues for Desalination in California: Cost and Financing 5 (2012), *available at* http://www.pacinst.org/reports/desalination_2013/financing_exec_sum.pdf See Cooley et al., Pac. Inst., Executive Summary Key Issues for Desalination in California: Cost and Financing 5 (2012), *available at* http://www.pacinst.org/reports/desalination_2013/financing_exec_sum.pdf.
- 15 Arpad Horvath et al. Life-Cycle Energy Assessment of Alternative Water Supply Systems in California, Cal. Energy Comm'n, 4 (2011) *available at* <http://www.energy.ca.gov/2013publications/CEC-500-2013-037/CEC-500-2013-037.pdf>; see also Barry Nelson, et al., Natural Res. Def. Council, In Hot Water: Water Management Strategies to Weather the Effects of Global Warming 19, 35 (2007), *available at* <http://www.nrdc.org/globalwarming/hotwater/contents.asp>.
- 16 See Heather Cooley and Newsha Ajami, Pac. Inst., Key Issues for Desalination in California: Cost and Financing 10 (2012), *available at* http://www.pacinst.org/reports/desalination_2013/financing_final_report.pdf.
- 17 Bill Powers, Memorandum for Surfriider Foundation, "Assessment of Energy Intensity and CO₂ Emissions Associated with Water Supply Options for San Diego County," (Oct. 12, 2007).
- 18 LAEDC, "Where Will We Get the Water? Assessing Southern California's Future Water Strategies," 2 (Aug. 14, 2008) (LAEDC Report); *available at* http://www.laedc.org/sclc/documents/Water_SoCalWaterStrategies.pdf.
- 19 Martha Davis, Inland Empire Utilities Agency, Presentation to the State Water Resources Control Board (March 2009), *available at*: http://www.swrcb.ca.gov/water_issues/programs/climate/docs/ieua_030409.pdf. See also Cal. Energy Comm'n, Life-Cycle Energy Assessment of Alternative Water Supply Systems in California, (CEC-500-2005-101) *available at* http://www.energy.ca.gov/research/environmental/project_summaries/PS_500-02-004_HORVATH.PDF (evaluating the global warming potential of desalination versus recycling and import of water).
- 20 Cal. Energy Comm'n, California's Water-Energy Relationship 1 Cal. Energy Comm'n (2005), *available at* <http://www.energy.ca.gov/2005publications/CEC-100-2005-007/CEC-100-2005-007-CMF.PDF>.
- 21 See Cal. Air Res. Bd., Climate Change Scoping Plan Appendices, Volume I C-134 (2008), *available at* http://www.arb.ca.gov/cc/scopingplan/document/appendices_volume1.pdf.
- 22 Cooley et al. Pac. Inst., Desalination, With a Grain of Salt, A California Perspective 7 (2006), *available at* http://www.pacinst.org/reports/desalination/desalination_report.pdf.
- 23 The California Environmental Quality Act (CEQA) requires that environmental impact reports include a discussion of a project's significant cumulative impacts. Cal. Code Regs. tit. 14, § 15130(a); 15065(a)(3).
- 24 Heather Cooley et al., Pac. Inst., Key Issues for Desalination in California: Marine Impacts 3,5 (2013), *available at* <http://pacinst.org/wp-content/uploads/sites/21/2013/12/desal-marine-impacts-full-report.pdf>.
- 25 State Water Res. Control Bd. Water Quality Control Policy on the Use of Coastal and Estuarine Waters for Power Plant Cooling, Resolution No. 2010-0020, http://www.waterboards.ca.gov/board_decisions/adopted_orders/resolutions/2010/rs2010_0020.pdf; 2014 Amendments http://www.swrcb.ca.gov/water_issues/programs/ocean/cwa316/docs/otc_2014.pdf.
- 26 See State Water Res. Control Bd. & Cal. Envtl. Prot. Agency, Scoping Document: Water Quality Control Policy on the Use of Coastal and Estuarine Waters for Power Plant Cooling 1 (2008), *available at* http://www.swrcb.ca.gov/water_issues/programs/ocean/cwa316/docs/cwa316_may08/scope_doc031808.pdf.
- 27 Scott Jenkins et al., *Management of Brine Discharge to Coastal Waters, Recommendations of a Science Advisory Panel*, 13 prepared by the Southern California Coastal Water Research Project for the State Water Resources Control Board (Mar. 2012) , *available at*, http://www.swrcb.ca.gov/water_issues/programs/ocean/desalination/docs/dpr.pdf.
- 28 Key Issues for Desalination in California: Marine Impacts at 12.
- 29 *Id.*
- 30 *Id.* at 14-15.
- 31 Thomas M. Missimer et al., *Subsurface intakes for seawater reverse osmosis facilities: Capacity limitation, water quality improvement, and economics*, 322 *Desalination* 37, 46 (2013).
- 32 California Dep't of Fish and Wildlife, "California Marine Protected Areas (MPAs)", <https://www.dfg.ca.gov/marine/mpa/>.
- 33 City of Santa Barbara, "Desalination", <http://www.santabarbaraca.gov/gov/depts/pw/resources/system/sources/desalination.asp>.
- 34 Elizabeth Harball, "Aussies warn Calif. that it can't 'magically replub' its way out of drought," E&E Publishing, Inc. (March 19, 2014).
- 35 *Id.*
- 36 *Id.*
- 37 Key Issues for Desalination in California: Cost and Financing at 7.
- 38 *Id.*
- 39 Liz Foschia, "Sydney desalination plant to be switched off," ABC News (June 26, 2012), *available at* <http://www.abc.net.au/news/2012-06-26/sydney-desalination-plant-to-switch-off/4092482>.
- 40 Murray Griffin, "Drought Prompts Australia to Turn to Desalination Despite Cost," Bloomberg (March 6, 2013), *available at* <http://www.bloomberg.com/news/2013-03-06/drought-prompts-australia-to-turn-to-desalination-despite-cost.html>.
- 41 *Id.*
- 42 Pub Res. § 6301

- 43 Cal. State Lands Comm'n, Land Management Division, http://www.slc.ca.gov/Division_Pages/LMD/Documents/LMD_Brochure.pdf.
- 44 Cal. Water Code § 13160.
- 45 Cal. Water Code § 13142.5(b).
- 46 Cal. Code Regs. Tit 14 § 13057(c)(1), (2) (2012).
- 47 Pub. Res. § 30105.5.
- 48 See <http://www.waterplan.water.ca.gov/>.
- 49 Dep't Water Resources, California Water Plan Update 2013 10-1, available at http://www.waterplan.water.ca.gov/docs/cwpu2013/2013-prd/Vol3_Ch10_Desal_PublicReviewDraft_Final_PDFed_co.pdf.
- 50 California Coastal Commission Staff Report: Poseidon Water, Application No. E-06-007, hearing date Nov. 13, 2013, 26-29, at <http://documents.coastal.ca.gov/reports/2013/11/W19a-s-11-2013.pdf>.
- 51 Assessment of cumulative impacts is usually required of these plants, either under the federal National Environmental Policy Act or the state California Environmental Quality Act. These assessments are often very limited. Geographic or spatial analysis of where to locate a new project includes reviewing the location and density of human activities and the range of impacts to the marine environment that could conflict with or be exacerbated by the plant.
- 52 Pub. Res. § 30231; See also Center for Ocean Solutions, *Incorporating Ecological Principles into California Ocean and Coastal Management* (2012) at p. 91 (based on review of sample CCC staff reports and communication with CCC staff).
- 53 Cal. Water Code § 13142.5(c).
- 54 Cal. Water Code § 13144.
- 55 See, "Once Through Cooling Water Policy" available at http://www.waterboards.ca.gov/water_issues/programs/ocean/cwa316/policy.shtml.
- 56 State Water Res. Control Bd. Water Quality Control Policy on the Use of Coastal and Estuarine Waters for Power Plant Cooling, Resolution No. 2010-0020, http://www.waterboards.ca.gov/board_decisions/adopted_orders/resolutions/2010/rs2010_0020.pdf; 2014 Amendments http://www.swrcb.ca.gov/water_issues/programs/ocean/cwa316/docs/otc_2014.pdf.
- 57 See generally, Army Corps of Engineers, Building Strong collaborative Relationships for a Sustainable Water Resources Future: Understanding Integrated Water Resources Management (2014), available at <http://www.building-collaboration-for-water.org/>.
- 58 Shahzeen Attari et al. *Perceptions of Water Use*, Proceedings of the National Academy of Sciences (2014) doi: 10.1073/pnas.1316402111.
- 59 Public Policy Institute of California, Water and the California Economy, 7 (2012), available at http://www.ppic.org/content/pubs/report/R_512EHR.pdf. Australia's urban water use has declined further in recent years due to prolonged drought in the 2000s. *Id.*
- 60 Heather Cooley et al., California's Next Million Acre-Feet: Saving Water, Energy, and Money 6-7 (2010) available at http://www.pacinst.org/reports/next_million_acre_feet/next_million_acre_feet.pdf.
- 61 NRDC Drought Recommendations to the State Water Resources Control Board 8-15 (Feb. 26, 2014), http://docs.nrdc.org/water/files/wat_14022701a.pdf.
- 62 *Id.* at 17.
- 63 *Id.*
- 64 Noah Garrison Et Al., A Clear Blue Future: How Greening California Cities Can Address Water Resources and Climate Challenges in the 21st Century, NRDC Technical Report 4 (2009), available at <http://www.nrdc.org/water/lid/files/lid.pdf> [hereinafter "Clear Blue Future"].
- 65 See, Los Angeles Regional Water Quality Control Board, Final Waste Discharge Requirements for Municipal Separate Storm Sewer System (MS4) Discharges within the Coastal Watersheds of Los Angeles County, Except Those Discharges Originating from the City of Long Beach MS4, 56-57, 107 (posted December 5, 2012), available at http://www.waterboards.ca.gov/losangeles/water_issues/programs/stormwater/municipal/.
- 66 Clear Blue Future at 4.
- 67 California State Water Quality Control Board, "Low Impact Development (LID) Projects", at http://www.waterboards.ca.gov/water_issues/programs/grants_loans/low_impact_development/.
- 68 Cal. Dep't of Water Res. California Water Plan: Update 2009 11-10 (2009), available at http://www.waterplan.water.ca.gov/docs/cwpu2009/0310final/v2c11_recycmuniwtr_cwp2009.pdf.
- 69 Groundwater Replenishment System, Website: Question and Answer page, available at <http://www.gwrssystem.com/about-gwrssystem/questions-answers.html>.
- 70 American Society of Civil Engineers, Report Card for America's Infrastructure, available at <http://www.infrastructurereportcard.org/case-study/groundwater-replenishment-system>.
- 71 Clear Blue Future at 18-19.
- 72 *Id.* at 18.
- 73 *Id.* at 5.
- 74 *Id.* at 6.
- 75 See, State Water Resources Control Board, "Desalination Facilities and Brine Disposal", at http://www.swrcb.ca.gov/water_issues/programs/ocean/desalination/.
- 76 Cal. Water Code § 13142.5(b).
- 77 Cal. Water Code § 13142.5(b).
- 78 Thomas M. Missimer et al., *Subsurface intakes for seawater reverse osmosis facilities: Capacity limitation, water quality improvement, and economics*, 322 Desalination 37 (2013).
- 79 Heather Cooley et al., Pac. Inst., Key Issues for Desalination in California: Marine Impacts 9-11 (2013), available at <http://pacinst.org/wp-content/uploads/sites/21/2013/12/desal-marine-impacts-full-report.pdf>.
- 80 *Id.* at 11.
- 81 <http://www.opc.ca.gov/about/science-advisory-team/>.
- 82 California Ocean Science Trust, "Data Tools and Information Management," <http://calost.org/science-initiatives/?page=data-tools-and-information-management>.
- 83 California Ocean Protection Council, "Science-Based Decision Making," <http://www.opc.ca.gov/2012/06/science-based-decision-making/>.
- 84 California Geospatial Information Office, "California Coastal Geoportal" (version 1.0) <http://portal.gis.ca.gov/geoportal/catalog/OPC/OPC.page>.
- 85 Heather Cooley et al., Pac. Inst., Key Issues for Desalination in California: Marine Impacts 22 (2013), available at <http://pacinst.org/wp-content/uploads/sites/21/2013/12/desal-marine-impacts-full-report.pdf>.
- 86 Scott Jenkins et al., *Management of Brine Discharge to Coastal Waters, Recommendations of a Science Advisory Panel*, 13 prepared by the Southern California Coastal Water Research Project for the State Water Resources Control Board (Mar. 2012) available at http://www.swrcb.ca.gov/water_issues/programs/ocean/desalination/docs/dpr.pdf.
- 87 Melissa M. Foley et al., Improving Ocean Management through the use of Ecological Principles and Integrated Ecosystem Assessments, *BioScience*, 63(8):619-631, 620 (2013) available at <http://www.centerforoceansolutions.org/sites/default/files/Foley%20et%20al%202013.pdf>.
- 88 *Id.*
- 89 Heather Cooley et al., Pac. Inst., Key Issues for Desalination in California: Marine Impacts 22 (2013), available at <http://pacinst.org/wp-content/uploads/sites/21/2013/12/desal-marine-impacts-full-report.pdf>.



Natural Resources Defense Council

40 West 20th Street
New York, NY 10011
212 727-2700
Fax 212 727-1773

Beijing

Chicago

Los Angeles

Bozeman

San Francisco

Washington, D.C.

www.nrdc.org

www.nrdc.org/policy
www.facebook.com/nrdc.org
www.twitter.com/nrdc