Seawater Desalination: Climate Change Adaptation Strategy or Contributor?

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INTRODUCTION

While droughts and water supply challenges have plagued California for decades, climate change will increase the strain on California's water management system.[1] Seawater desalination—the process of removing salt and other minerals from seawater—is often hailed as the solution to the state's water supply challenges.[2] However, proposals to build seawater desalination plants, which demand enormous quantities of energy, could be a shortsighted fix that will ultimately exacerbate climate change due to corresponding greenhouse gas (GHG) emissions. This article explores seawater desalination and alternative strategies for California to adapt to climate change, and concludes that an effective adaptation approach will require strategies to reduce GHG emissions.

CALIFORNIA'S CHALLENGES: WATER AND CLIMATE

Currently, no region in California has sufficient water to meet environmental habitat needs.[3] Additionally, demands for potable drinking water are increasing and will likely continue to increase given projections of population growth exceeding 600,000 people annually.[4] Compounding this problem, rising temperatures due to climate change threaten the Sierra

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1. *See* Cal. Exec. Order No. S-3-05 (June 1, 2005) (recognizing that increased temperatures have decreased Sierra snowpack, one of California's primary sources of water), *available at* http://www.dot.ca.gov/hq/energy/ExecOrderS-3-05.htm.

2. *See* HEATHER COOLEY ET AL., PAC. INST., DESALINATION, WITH A GRAIN OF SALT: A CALIFORNIA PERSPECTIVE 1 (2006), *available at* http://www.pacinst.org/reports/desalination/desalination_report.pdf ("The public, politicians, and water managers continue to hope that cost-effective and environmentally safe ocean desalination will come to the rescue of water-short regions.").

3. *See* CAL. DEP'T OF WATER RES., WATER DESALINATION FINDINGS AND RECOMMENDATIONS 2 (2003), *available at* http://www.water.ca.gov/desalination/pud_pdf/Findings-Recommendations.pdf [hereinafter WATER DESALINATION FINDINGS].

4. *See id.*

snowpack, one of California's vital sources of potable water.[5] The declining snowpack will likely strain California's water system, making it difficult to retain enough water to meet the population's needs during summer months.[6] At current GHG emission rates, spring and summer stream flows are predicted to decline by 20 percent before mid-century, and by about 50 percent before the end of the century.[7]

Water scarcity is particularly severe in Southern California, which receives only about one-third of the state's precipitation but accounts for about two-thirds of the state's water consumption.[8] While the region has historically relied on water imported from the Sacramento-San Joaquin Delta and Colorado River to meet its needs, these sources are potentially unreliable due to periodic droughts.[9] Additionally, water flowing to Southern California from the Sacramento-San Joaquin Delta has been reduced by restrictions on pumping, enacted to keep enough water in the rivers to protect endangered species.[10] With California's population growing and climate change threatening to reduce the water supply, cities throughout California are pressed to find new sources of water.

California is the second highest emitter of GHGs in the United States, and approximately the twelfth highest emitter in the world.[11] In solving the water supply issue, California also has the opportunity to help curb climate change through reductions in GHG emissions and energy demand.

With water delivery and treatment accounting for nearly 20 percent of the state's cumulative energy demand,[12] California's current water management system is extremely energy-intensive. The state can achieve GHG emissions reductions by replacing existing water supply and treatment processes with more energy efficient alternatives.[13] To fight global climate change, California should reduce energy use in current water management, and prohibit building new energy-intensive water projects.

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5. *See* Cal. Exec. Order No. S-3-05, *supra* note 1.

6. *See* Holly Doremus & Michael Hanemann, *The Challenges of a Dynamic Water Management in the American West*, 26 UCLA J. ENVTL. L. & POL'Y 55, 58 (2008).

7. *See id*.

8. *See id*. at 57.

9. *See* GREGORY FREEMAN, MYASNIK POGHOSYAN & MATTHEW LEE, LOS ANGELES CNTY. ECON. DEV. CORP., WHERE WILL WE GET THE WATER? ASSESSING SOUTHERN CALIFORNIA'S FUTURE WATER STRATEGIES 2 (2008), *available at* http://www.laedc.org/sclc/documents/Water_SoCalWaterStrategies.pdf.

10. *See id*.

11. CAL. ENERGY COMM'N., INTEGRATED ENERGY POLICY REPORT 1 (2007), *available at* http://www.energy.ca.gov/2007publications/CEC-100-2007-008/CEC-100-2007-008-CMF.PDF.

12. *See* COOLEY ET AL., *supra* note 2, at 72; *see also* CAL. ENERGY COMM'N, INTEGRATED ENERGY POLICY REPORT 139 (2005), *available at* http://www.energy.ca.gov/2005publications/CEC-100-2005-007/CEC-100-2005-007-CMF.PDF.

13. *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 [hereinafter AB 32 SCOPING PLAN APPENDICES].

DESALINATION TECHNOLOGY AND HISTORY

Desalination is the process of removing salt from water. This process has been around for centuries, and was first developed when salt, not water, was a precious commodity.[14] It can vary both in the technology employed and the type of water used as the input. Some technologies, such as thermal evaporation or distillation, mimic the natural hydrologic cycle to extract the salt from water.[15] Most modern desalination plants use membrane technologies, such as reverse osmosis, that mimic the biological process of osmosis.[16] Membrane technology is usually preferred over thermal systems because it typically has a lower capital cost, requires relatively less energy, and offers added benefits of removing microorganisms and organic contaminates.[17]

Desalination plants can process both seawater and brackish water, which is usually groundwater from fossil aquifers. Brackish water differs from seawater because brackish water has a lower salt content. Thus, it requires less energy and costs less to desalinate via reverse osmosis.[18]

Historically, desalination has been only a minor component of California's water supply portfolio. Most of California's existing desalination plants are small, producing between from 0.002 to 0.600 millions of gallons per day (MGD).[19] These plants are generally used for industrial processes and aquariums.[20] In 2002, due in large part to water supply demands, the California Legislature passed Assembly Bill 2717, which directed the Department of Water Resources to establish a Desalination Task Force (Task Force) to "make recommendations related to potential opportunities for the use of seawater and brackish water desalination."[21] The Task Force estimated that desalination could contribute less than 10 percent of California's water supply needs.[22] Nonetheless, it concluded that desalination could "provide significant value," including providing additional water supply.[23] On the other hand, the Task Force recognized that the environmental impacts of seawater desalination could cause a "potential impediment."[24]

In the nine years since Assembly Bill 2717 passed, privately held corporations and municipal water agencies have proposed new desalination plants.[25] Today, there are over twenty large-scale desalination plants proposed throughout California, ranging in capacity from 0.40 MGD to fifty MGD, with

14. *See* COOLEY ET. AL., *supra* note 2, at 31.
15. *See id.* at 13.
16. *See id*.
17. *See id*. at 13–14.
18. *See* FREEMAN, POGHOSYAN & LEE, *supra* note 9, at 17.
19. *See* COOLEY ET AL., *supra* note 2, at 26.
20. *See id*.
21. WATER DESALINATION FINDINGS, *supra* note 3, at 1; *see also* CAL. WATER CODE § 12949.6(a) (West 2004).
22. WATER DESALINATION FINDINGS, *supra* note 3, at 1.
23. *Id.*
24. *Id.* at 3.
25. *See* COOLEY, ET AL., *supra* note 2, at 31.

some plants possibly expanding up to eighty MGD.[26] The majority of proposed desalination plants in California plan to use seawater.[27]

SEAWATER DESALINATION PROMISES AND REALITIES

Promise of Drought Resistant Water Supply Brings Water Quality Concerns

Seawater desalination is an alluring adaptation strategy because it could provide a reliable, drought-resistant water supply to California's many coastal regions, which have access to the Pacific Ocean.[28] Seawater desalination also has the potential to offer improved water quality compared to existing sources.[29] But these benefits do not come without a cost. Seawater desalination can introduce harmful chemicals and metals into the water it produces.[30] Additionally, source water drawn into the desalination plant could contain biological and chemical contaminants.[31] Contaminants of particular concern include endocrine disruptors, pharmaceuticals, and algal toxins.[32]

Unsupported Promises to Reduce Water Import Needs of Southern California

Desalination proponents contend that building new, large-scale seawater desalination plants in Southern California will reduce the need to import water from the Sacramento-San Joaquin Delta and Colorado River.[33] This is significant for two reasons. First, as mentioned above, these water systems are already stressed, and reducing the amount of water withdrawn from them would produce an environmental benefit. However, there are no enforceable mechanisms in place to ensure that new seawater desalination projects will offset imported water as opposed to just adding to total water supply. Without a concrete mechanism to ensure that desalinated water replaces imported water, this is an empty promise.

Second, because importing water to Southern California requires a great amount of energy, decreasing the total amount of water imported to the region could reduce the amount of energy used for water supply, thereby reducing corresponding GHG emissions. But replacing imported water with desalinated water would not guarantee a reduction in GHG emissions because desalination plants are also extremely energy intensive.[34] Moreover, some desalination

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26. *See id*.
27. *See id*. at 29–31.
28. *See id*.
29. COOLEY ET AL., *supra* note 2, at 51
30. *See id.*
31. *See id*. at 5, 51.
32. *See id*. at 53.
33. *See* Symposium, *Desalination in California: Should Ocean Waters be Utilized to Produce Freshwater?*, 57 HASTINGS L.J. 1343, 1356 (2006).
34. *See* WATER DESALINATION FINDINGS, *supra* note 3, at 4; *see also* FREEMAN, POGHOSYAN & LEE ET. AL, *supra* note 9 ("Assessing California Water Strategies" table); *see also* BARRY NELSON, ET AL., NATURAL RES. DEF. COUNCIL, IN HOT WATER: MANAGEMENT STRATEGIES TO WEATHER THE

proponents argue they are not required to mitigate emissions associated with their energy use because they are not directly emitting GHGs. For example, Poseidon Resources Inc. argued that its proposed project in Carlsbad, California, would emit no GHG emissions and thus would not be subject to AB 32 requirements.[35] Nevertheless, the California Coastal Commission and State Lands Commission mandated a GHG mitigation plan as a condition of Poseidon's permits and lease for the Carlsbad project.[36]

Reality − Large Energy Demand and Associated GHG Emissions

A serious disadvantage to seawater desalination is the amount of energy it requires. Seawater desalination is one of most energy intensive water supply option available.[37] Desalination systems using reverse osmosis technology require about 30 percent more energy than existing inter-basin supply systems delivering water to parts of Southern California.[38] Consequently, desalination would indirectly cause more GHG emissions than alternatives. Studies indeed show that extensive development of seawater desalination could lead to "greater dependence on fossil fuels, an increase in greenhouse gas emissions, and a worsening of climate change."[39]

The cost of energy also makes desalination very expensive. In reverse osmosis plants, the cost of energy accounts for about 50 percent of the plants' operating costs.[40] One proposed seawater desalination plant in the Camp Pendleton area in Southern California estimates that water produced by the plant would cost $2000 per acre-foot.[41] This is extremely high compared to the current cost for treated water in that area, which remains between $600 and $700 per acre-foot.[42]

The high cost of seawater desalination requires that the government heavily subsidize desalination projects in order to ensure projects are profitable. For example, Poseidon requested at least $530 million in tax-free state bonds

EFFECTS OF GLOBAL WARMING 19, 35 (2007), *available at* http://www.nrdc.org/globalwarming/hotwater/contents.asp.

35. *See* Letter from Peter MacLaggan, Posiedon Res., to Chairman Kruer and Honorable Commissioners, Cal. Coastal Comm'n, 2 (Aug. 2, 2008), *available at* http://documents.coastal.ca.gov/reports/2008/12/W16b-12-2008-a1.pdf.

36. *See generally* ADDENDUM TO COMMISSION PACKET FOR ENERGY, OCEAN RESOURCES AND FEDERAL CONSISTENCY ITEM NO. W 5A E-06-013 (2008) (discussing details of required GHG mitigation plan), *available at* http://documents.coastal.ca.gov/reports/2008/8/W5a-8-2008.pdf.

37. *See* WATER DESALINATION FINDINGS, *supra* note 3, at 4; *see also* FREEMAN, POGHOSYAN & LEE ET AL., *supra* note 9 ("Assessing California Water Strategies" table); *see also* BARRY NELSON, ET AL., *supra* note 34, at 19, 35.

38. *See* WATER DESALINATION FINDINGS, *supra* note 3, at 4.

39. COOLEY ET AL., *supra* note 2, at 7.

40. *See id*. at 41.

41. *See* PETER GLEICK, *Salt From Water, Money From Pockets?*, CITY BRIGHTS BLOG (May 29, 2009, 4:40 PM), http://www.sfgate.com/cgi-bin/blogs/gleick/detail?blogid=104&entry_id=40878.

42. *See id*.

for its Carlsbad project.[43] These public subsidies fund projects designed to generate profits for private companies. Poseidon originally projected a total cost of $270 million when it began the Carlsbad project in the late 1990s, but it now appears that it would cost at least twice that amount, with the public subsidizing the cost.[44] The high costs of desalination and the associated GHG emissions call for a serious look at alternative uses of funds. These subsidies could go to conservation measures or municipal water recycling programs that would provide at least the same amount of water at a lower cost and create jobs throughout the state.

Reality – Impingement, Entrainment Harm Marine Life

Another disadvantage is that desalination plants using open seawater intakes pose a serious threat to marine ecosystems.[45] Open seawater intakes withdraw large volumes of water through pipes in the water columns of oceans, bays, and estuaries for industrial processes such as cooling power plants or supplying water for desalination facilities. Large organisms such as fish, marine mammals, and turtles are injured or killed when they become trapped or "impinge[d]" on the screens of the intake pipes.[46] Smaller organisms, such as plankton and larvae, pass through the screens but are killed as they become "entrain[ed]" in the desalination plants.[47]

For decades, California's coastal power plants have used open seawater intakes for cooling systems known as once-through cooling.[48] Combined, these plants were permitted to withdraw over fifteen billion gallons of seawater per day,[49] killing an estimated seventy-nine billion fish and other marine life annually,[50] including threatened and endangered species, such as the Delta smelt.[51] State and federal agencies acknowledged that these power plants degrade marine life, impair coastal habitats, and contribute to declining

43. *See* PETER GLEICK, *Doing Desalination Wrong: Poseidon on the Public Dole*, CITY BRIGHTS BLOG (Nov. 23, 2009, 5:06 PM), http://www.sfgate.com/cgi-bin/blogs/gleick/detail?blogid=104&entry_id=50931.

44. *See id*.

45. *See* Angela Haren Kelley, *A Call for Consistency: Open Seawater Intakes, Desalination, and the California Water Code,* 4 GOLDEN GATE U. ENVTL. L.J. 277, 300–01 (2011).

46. Riverkeeper, Inc. v. EPA, 358 F.3d 174, 181 (2d Cir. 2004).

47. *Id*.

48. *See* STATE WATER RES. CONTROL BD. & CAL. ENVTL. PROT. AGENCY, WATER QUALITY CONTROL POLICY ON THE USE OF COASTAL AND ESTUARINE WATERS FOR POWER PLANT COOLING FINAL SUBSTITUTE ENVIRONMENTAL DOCUMENT 1 (2010), *available at* http://www.swrcb.ca.gov/water_issues/programs/ocean/cwa316/docs/cwa316may2010/sed_final.pdf.

49. *See id.* at 15.

50. *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.

51. *See id.* at 17.

fisheries.[52] To address this serious issue, the California State Water Resources Control Board passed a policy in spring 2010 to phase out the use of once-through cooling.[53]

Despite the fact that the use of open seawater intakes for once-through cooling will be phased out, thirteen of the twenty proposed desalination plants in California plan to use open seawater intakes to withdraw water, and ten of these will likely co-locate with existing power plants in order to share the intake pipes or take over the pipes if and when the power plants shut down.[54] If proposed seawater desalination plants utilize open intakes, they could perpetuate the destruction of marine life. Furthermore, allowing the proposed desalination plants to co-locate with power plants that use once-through cooling could potentially prolong the existence of these old, inefficient, GHG emitting power plants.

Reality – Renewable Energy Sources Could Reduce Emissions from Desalination Plants

One way to reduce the carbon footprint of seawater desalination is to utilize renewable sources, such as solar or wind power, to generate electricity needed to operate the plant. For example, one desalination plant in Perth, Australia, receives most of its electricity from a wind farm.[55] Requiring new seawater desalination plants to only use renewable sources of energy would reduce indirect GHG emissions related to the large energy demand of the desalination plants. If this requirement increased demand for renewable energy, it could also serve as an incentive to invest in more renewable energy production.

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52. *See generally* CAL. OCEAN PROT. COUNCIL, RESOLUTION REGARDING THE USE OF ONCE-THROUGH COOLING TECHNOLGIES IN COASTAL WATERS (2006) *available at* http://www.opc.ca.gov/2006/04/resolution-of-the-california-ocean-protection-council-regarding-the-use-of-once-through-cooling-technologies-in-coastal-waters (stating that the EPA found multiple types of undersirable and unacceptable environmental impacts associated with once-through cooling during its rulemaking for Clean Water Act § 316(b)); *see also* CAL. ENERGY COMM'N, ISSUES AND ENVIRONMENTAL IMPACTS ASSOCIATED WITH ONCE-THROUGH COOLING AT CALIFORNIA'S COASTAL POWER PLANTS: STAFF REPORT 1 (2005), *available at* http://www.energy.ca.gov/2005publications/CEC-700-2005-013/CEC-700-2005-013.PDF.

53. It is widely understood that in order to comply with the required reduction in impingement and entrainment in Track 1, power plants will have to adopt new cooling technology by the deadlines listed in the policy. *See generally* STATE WATER RES. CONTROL BD., STATEWIDE WATER QUALITY CONTROL POLICY ON THE USE OF COASTAL AND ESTUARINE WATERS FOR POWER PLANT COOLING 4 (2010), *available at* http://www.swrcb.ca.gov/water_issues/programs/ocean/cwa316/docs/policy100110.pdf. *See also* NOAH LONG, *Is the Water Board Serious About Protecting California Coastal Waters? Next Week's Vote Will Test Their Resolve, Again,* SWITCHBOARD BLOG (July 15, 2011), http://switchboard.nrdc.org/blogs/nlong/is_the_state_water_board_serio.html.

54. *See* COOLEY, ET AL., *supra* note 2, at 31.

55. *See* PETER GLEICK, *Salt from Water: The Question of Energy*, CITY BRIGHTS BLOG (June 2, 2010, 5:15 PM), http://blog.sfgate.com/gleick/2009/06/02/salt-from-water-the-question-of-energy/.

OTHER WATER SUPPLY OPTIONS

Seawater desalination is only one of many alternatives that would help increase Southern California's water supply. A closer look at the alternatives puts seawater desalination's promises and realities in context.

Urban Water Conservation

Urban water conservation is perhaps the cheapest, quickest, most reliable, and environmentally friendly water supply strategy. Instead of adding water to the system, urban water conservation reduces demand so that less imported water is required. Urban water conservation measures include installing water-efficient appliances and toilets, replacing lawns and other water-hungry gardens with drought-tolerant landscaping, and repairing leaks and broken sprinklers.[56] These types of measures could add about one million acre-feet of water, which accounts for about 25 percent of the regional water use, to Southern California's annual supply.[57]

Such measures would also have climate change benefits. In 2008, the Climate Change Scoping Plan for Assembly Bill 32, California's landmark Global Warming Solutions Act,[58] estimated that statewide water conservation measures could reduce 1.4 million metric tons of GHG emissions by 2020.[59] The government can effectively encourage water conservation through price increases, regulations, and rebates.[60]

Stormwater Capture/Reuse

Although Southern California sees little rain, the precipitation it does experience tends to be heavy. A winter storm can pour over one inch of water in Southern California in a matter of hours.[61] The water flows from roads, freeways, parking lots, and buildings directly to storm drains and into the ocean, rather than soaking into the ground and naturally replenishing underground aquifers. By implementing low-impact development techniques to capture and reuse stormwater or allowing precipitation to soak into the ground and replenish aquifers, Southern California could increase water supply by estimated 333,000 acre-feet of water annually.[62] About 40 percent of Southern California's water is currently from local groundwater sources,[63] so allowing for infiltration and groundwater recharge is crucial. In fact, capture and reuse of stormwater could reduce the need to obtain water from more energy intensive

56. *See* FREEMAN, POGHOSYAN & LEE ET AL., *supra* note 9, at 6.
57. *See id*.
58. *See* CAL. HEALTH & SAFETY CODE § 38560 (West 2010).
59. *See* AB 32 SCOPING PLAN APPENDICES, *supra* note 13, at C-132.
60. *See* FREEMAN, POGHOSYAN & LEE ET AL., *supra* note 9, at 5.
61. *See id*. at 9.
62. *See* AB 32 SCOPING PLAN APPENDICES, *supra* note 13, at C-135.
63. *See* FREEMAN, POGHOSYAN & LEE ET AL., *supra* note 9, at 9.

processes, and could potentially cut 200,000 metric tons of carbon dioxide by 2020.[64]

Stormwater capture and reuse is only as reliable as the rain, and thus is not drought resistant. Despite this limitation, studies suggest that even with minimal precipitation, stormwater recapture and reuse projects would increase the overall reliability of Southern California's water supply by reducing the region's reliance on imported water.[65] Stormwater capture and reuse would also benefit the environment by preventing the contaminants that stormwater accumulates, such as trash, motor oil, and metals, from finding their way to the ocean. However, treating the contaminated water would slightly reduce the GHG benefit because of the extra energy expended.[66]

Water Recycling

Water recycling is the process of cleaning wastewater and returning it to the local water supply.[67] It is drought-proof and reliable because wastewater treatment facilities produce a steady supply of water, regardless of precipitation.[68] Recycling water also reduces the amount of water removed from the environment. Although energy is required to treat wastewater in order for it to be potable, the carbon footprint of using local recycled water is less than that of transporting water. Therefore, Southern California's carbon footprint could be reduced if locally recycled water displaced some of the current imports.[69]

Water recycling lacks public support due largely to a misunderstanding of the process. Opponents refer to water recycling "toilet to tap," and this unfortunate branding might be the biggest obstacle to its widespread acceptance.[70] However, Southern California's current source of water from the Colorado River is far from pristine in comparison. In fact, this drinking water already contains heavily treated wastewater from upstream cities, including Las Vegas.[71] Recycled water is safe and monitored to ensure that it meets state and national drinking water standards.[72] The West Basin Municipal District in Orange County, for example, sells recycled water that has been cleaned through micro filtration, reverse osmosis, ultraviolet light, and oxidation, to customers

64. *See* AB 32 SCOPING PLAN APPENDICES, *supra* note 13, at C-135 (Appendix C: Water-Recommended Actions Table 20).

65. *See* FREEMAN, POGHOSYAN & LEE ET AL., *supra* note 9, at 10.

66. *See id*.

67. *See id.* at 9–10.

68. *See id*.

69. *See id*.

70. FREEMAN, POGHOSYAN & LEE ET AL., *supra* note 9, at 12.

71. *See id*.

72. *See id.; see generally* CAL. DEP'T OF PUB. HEALTH, CALIFORNIA DRINKING WATER-RELATED LAWS (2011), *available at* http://www.cdph.ca.gov/certlic/drinkingwater/Pages/Lawbook.aspx (California's recycled water statutes and regulations).

who need ultra-pure water.[73] Improved public education on the details and value of recycled water would help to increase its acceptance.

Groundwater Desalination

Because groundwater has less salt than seawater, groundwater desalination requires less energy, and thus results in less GHG emissions than seawater desalination.[74] Groundwater desalination can be used to remove salts added from agriculture operations, and can be used with recycled water recharge of underground aquifers.[75] Although groundwater desalination does not pose the same threat to the marine environment that open seawater intakes do, proper disposal of the highly concentrated salty brine water is still an environmental concern.[76]

REGULATORY RECOMMENDATIONS

Implementing new water supply options presents an important corresponding opportunity to reduce GHG emissions. The following recommendations would ensure that adaptation strategies to supply Southern California with much-needed water will not contribute to climate change or cause other environmental damage.

1. Before considering seawater desalination, California's Department of Water Resources and State Water Resources Control Board should **create a comprehensive prioritization of water supply options** requiring local water management plans to first pursue and exhaust all supply options that have less energy demand and indirect GHG emissions. New seawater desalination plants should only be permitted after urban conservation, stormwater capture or reuse, water recycling, and groundwater desalination options have been explored.
2. **Require a study, available to the public, which examines energy demand, indirect GHG emissions, and cumulative marine ecosystem impacts of seawater desalination.** The cumulative impact of additional seawater desalination facilities in California has not been thoroughly researched and documented for regulatory purposes. This is a necessary first step before California can pursue an intelligent water strategy.
3. **Require that any new seawater desalination facility acquire its electricity from non-fossil fuel sources.** Although this may be more spatially or technologically challenging, it would greatly reduce

73. *See* FREEMAN, POGHOSYAN & LEE ET AL., *supra* note 9, at 12.
74. *See id*. at 17.
75. *See id*.
76. *See* COOLEY ET AL., *supra* note 2, at 60–64 (discussing the impacts associated with brine discharge).

concerns that desalination would contribute to climate change. Combining seawater desalination plants with renewable energy generation could also provide an incentive to finance more renewable energy sources.

4. **Require that new seawater desalination facilities be located and designed with a production capacity compatible with the use of sub-seafloor intakes.** This would help to avoid entrainment and impingement of marine life.
5. **Require local water agencies to commit to reducing the amount of imported water if a new seawater desalination plant is built**. This would ensure that seawater desalination is in fact a replacement for imported water and not merely a supplemental water supply.
6. **Prohibit co-location of desalination plants with once-through cooled power plants** to ensure that that new seawater desalination plants do not prolong the life of old fossil-fuel plants.

CONCLUSION

Choosing an adaptation strategy that increases GHG emissions and energy demand (thereby exacerbating the climate change problem) is not a sustainable or reasonable strategy. Other options to increase California's water supply, including conservation, water recycling, and stormwater capture and reuse, would provide as much or more water at a reduced cost and would better facilitate climate change adaptation. Desalination might very well have its place in California's water supply portfolio, however, the marine impacts, energy and GHG issues must be addressed and regulatory safeguards established in order to ensure proper construction and minimize environmental impacts before desalination can reasonably be considered a worthwhile adaptation strategy.