Final Staff Report Including the Final Substitute Environmental Documentation
Adopted May 6, 2015

Amendment to the Water Quality Control Plan
For Ocean Waters of California

Addressing

DESALINATION FACILITY INTAKES, BRINE DISCHARGES, AND THE INCORPORATION OF OTHER NON-SUBSTANTIVE CHANGES

May 6, 2015

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CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

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LIST OF ACRONYMS AND ABBREVIATIONS

AEL	Adult Equivalent Loss
APF	Area of Production Foregone
ASBS	Areas of Special Biological Significance
Basin Plan	Regional Water Quality Control Plan
BMP	Best Management Practices
Cal. Code. of Regs.	California Code of Regulations
CalCOFI	California Cooperative Oceanic Fisheries Investigations
CARB	California Air Resources Board
CCAA	California Clean Air Act
CDFW	California Department of Fish and Wildlife
CEQA	California Environmental Quality Act
CH4	Methane
CO2	Carbon Dioxide
CWA	Clean Water Act
DCPP	Diablo Canyon Power Plant
DTSC	Department of Toxics Substance Control
EIR	Environmental Impact Report
EPRI	Electrical Power Research Institute
ERP	Expert Review Panel
ETM	Empirical Transport Model
FH	Fecundity Hindcasting
GHG	Greenhouse Gas
ISTAP	Independent Scientific Technical Advisory Panel
kWh/mgal	Kilowatts-hours per million gallons
LEED	Leadership in Environmental and Energy Design
LOEC	Lowest Observed Effect Concentration
MGD	Million Gallons per Day
$\mu g/m^3$	Micrograms per cubic meter
MMA	Marine Managed Area
MPA	Marine Protected Area
MRZ	Mineral Resources Zones
N2O	Nitrous Oxide
NGO	Non-governmental organization
NOAA	National Oceanic and Atmospheric Administration
NOEC	No observed effect concentration
NPDES	National Pollutant Discharge Elimination System
Ocean Plan	Water Quality Control Plan for Ocean Waters of California
OTC	Once-Through Cooling
OTC Policy	Statewide Water Quality Control Policy on the Use of Coastal and Estuarine Waters for Power Plant Cooling
P_m	Proportional Mortality
Porter-Cologne	Porter-Cologne Water Quality Control Act
ppt	Parts Per Thousand
ppm	Parts per million
psu	Practical Salinity Units
Pub. Resources Code	Public Resources Code
regional water boards	Regional Water Quality Control Boards
RECs	Renewable Energy Credits

RO	Reverse Osmosis
Basin Plans	Regional Water Quality Control Plans
SONGS	San Onofre Nuclear Generating Station
SCE	Southern California Edison
scwd^2	City of Santa Cruz Water Department and Soquel Creek Water District
SED	Substitute Environmental Documentation
SMCA	State Marine Conservation Area
SMR	State Marine Reserve
SMRMA	State Marine Recreational Managed Area
State Water Board/SWRCB	State Water Resources Control Board
SWPPP	Storm Water Pollution Prevention Plan
SWQPA	State Water Quality Protection Area
TDS	Total Dissolved Solids
TUa	Acute Toxicity units
TUc	Chronic toxicity units
U.S.C	United States Code
U.S. EPA	United States Environmental Protection Agency
VOCs	Volatile Organic Compounds
Water Boards	State and Regional Water Boards
Water Code	California Water Code
WBMWD	West Basin Municipal Water District
WDR	Waste Discharge Requirements
WET	Whole Effluent Toxicity
WWTP	Wastewater Treatment Plant

1 INTRODUCTION AND EXECUTIVE SUMMARY

1.1 Executive Summary

This report was prepared in support of the proposed amendment to the Water Quality Control Plan for Ocean Waters of California (Ocean Plan) to address desalination facility intakes, brine discharges, and incorporate other non-substantive changes. The Desalination Amendment described here is intended to protect ocean water quality and marine life from those impacts associated with the construction and operation of seawater desalination facilities. Desalination facilities produce freshwater by removing salts from brackish or saltwater for municipal, industrial, or other uses. Although desalination provides an important alternative source of potable water, surface water intakes and discharges associated with facilities that desalinate seawater can have significant impacts on aquatic life-related beneficial uses.

The purpose of this document is to present the Desalination Amendment as well as the basis for and rationale applied in the development and analysis of the amendment, and other alternatives considered in accordance with the California Water Code (Water Code) and California Environmental Quality Act (CEQA). The Desalination Amendment, if adopted, would establish a uniform statewide approach for protecting beneficial uses of ocean waters from degradation due to seawater intake and discharge of brine wastes from desalination facilities. The Desalination Amendment (see Appendix A of the Staff Report with SED) contains four primary components intended to control potential adverse impacts to marine life associated with the construction and operation of desalination facilities as described below.

- Clarify the State Water Board's authority over desalination facility intakes and discharges
- Provide direction to the regional water boards regarding the determination required by Water Code section 13142.5, subdivision (b) for the evaluations of the best available site, design, technology, and mitigation measures feasible to minimize the intake and mortality of all forms of marine life at new or expanded desalination facilities.
- A narrative receiving water limitation for salinity applicable to all desalination facilities to ensure that brine discharges to marine waters meet the biological characteristics narrative water quality objective and do not cause adverse effects to aquatic life beneficial uses.
- Monitoring and reporting requirements that include effluent monitoring, as well as monitoring of the water column bottom sediments and benthic community health to ensure that the effluent plume is not harming aquatic life beyond the brine mixing zone.

The Desalination Amendment, if adopted, would apply intake-related provisions to all new and expanded seawater desalination facilities that intake state seawater. Discharge requirements would apply to all desalination facilities. The Desalination Amendment would be implemented through National Pollutant Elimination System (NPDES) permits or Waste Discharge Requirements (WDR) issued by the applicable regional water board in consultation with State Water Board staff.

The process to develop the Desalination Amendment was assisted by the formation of expert review panels, an interagency workgroup, and extensive stakeholder outreach that provided the

State Water Board with many concepts and recommendations to consider in the development of the proposed amendment. Pursuant to the California Environmental Quality Act (CEQA) (Pub. Resources Code section 21000 et. seq.), the State Water Board held scoping meetings on June 26, 2007 in San Francisco and again on March 30, 2012 in Sacramento. On March 15, 2011, the State Water Board adopted the Ocean Plan Triennial Review Work Plan (2011-2013) by Resolution 2011-0013 directing staff to review high priority issues identified in the work plan, including desalination facilities and the associated brine disposal, and to make recommendations for any necessary changes to the Ocean Plan. The State Water Board held a number of stakeholder meetings and public workshops in 2011 through 2013, to provide an overview of key amendment issues and to receive feedback on development of the proposed Desalination Amendment. Staff also convened the interagency working group comprised of representatives from the regional water boards and other state and federal agencies that met several times between 2012 and 2015 to review and comment on the proposed Desalination Amendment.

The State Water Board circulated the draft Desalination Amendment and supporting draft Staff Report, for public comment on July 3, 2014. A public workshop was held on August 6, 2014 in Sacramento to provide information on the proposed Desalination Amendment and the draft Staff Report including the draft SED and to answer questions from the public. On August 19, 2014, the State Water Board conducted a public hearing to receive comments from public agencies and members of the public on the proposed Desalination Amendment and draft Staff Report, including the draft SED. Twenty eight written public comment letters were timely submitted, and the State Water Board provided written responses to those comments as well as to public comments received during the workshop and public hearing.

Based on the oral and written comments, the State Water Board revised the proposed Desalination Amendment and draft Staff Report, including the draft SED. On March 20, 2015, the State Water Board distributed and posted the proposed final Desalination Amendment and proposed final Staff Report, including the proposed final SED. The deadline for submission of written comments on changes to the proposed Desalination Amendments and changes to the proposed final Staff Report, including the proposed final SED, was April 9, 2015. On March 20, 2015, the State Water Board provided notice to the public that the State Water Board would consider adoption of the proposed final Desalination Amendment and approval of the proposed final Staff Report, including the proposed final SED, at its regularly scheduled meeting on May 6, 2015.

Table 1-1: Summary of Environmental Impacts and Mitigation Measures.

SECTION	IMPACT	MITIGATION MEASURES
12.4.1	AESTHETICS	
	Impact 1: Construction activities related to the installation of intake and outfall structures may have a substantial adverse effect on a scenic vista.	Mitigation Measure 1: Limit construction to spring, fall, and winter weekdays to avoid disrupting recreational, pleasure boating or site-seeing activities associated with the summer tourist season.

	Impact 2: Construction activities related to the installation of intake and outfall structures may substantially degrade the existing visual character or quality of the site and its surroundings.	Mitigation Measure 2: See Mitigation Measure 1
	Impact 3: Permanent infrastructure (i.e., pumps, power supply, and piping) may have a substantial adverse effect on a scenic vista.	Mitigation Measure 3: • Install power supply and piping below ground; • Install pumping stations in utility vaults or site them outside of where public or recreational uses are anticipated.
	Impact 4: Permanent infrastructure (i.e., pumps, power supply, and piping) may substantially degrade the existing visual character or quality of the site and its surroundings.	Mitigation Measure 4: See Mitigation Measure 3
SECTION	**IMPACT**	**MITIGATION MEASURES**
12.4.2	Air Quality	
	Impact 5: Construction activities related to the installation of intake and outfall structures may have the potential to conflict with or obstruct implementation of an applicable air quality plan.	Mitigation Measure 5: • To minimize emissions from all internal combustion engines ○ Where feasible, use equipment powered by sources that have lowest emissions, or powered by electricity ○ Utilize equipment with smallest engine size capable of completing project goals to reduce overall emissions ○ Minimize idling time and unnecessary operation of internal combustion engine powered equipment • For diesel powered equipment ○ Utilize diesel powered equipment meeting Tier 2 or higher emissions standards to the maximum extent feasible. ○ Utilize portable construction equipment registered with the States portable equipment registration program ○ Utilize low sulfur diesel fuel and minimize idle time ○ Ensure all heavy duty diesel powered vehicles comply with state and federal standards applicable at time of purchase. ○ Utilize diesel oxidation catalyst and catalyzed diesel particulate filters or other approved emission reduction retrofit devices installed on applicable construction equipment used during individual projects. • To control dust emissions:

		○ Spray down construction sites with water or soil stabilizers ○ Cover all hauling trucks ○ Maintain adequate freeboard on haul trucks ○ Limit vehicle speed in unpaved work areas ○ Suspend work during periods of high wind or ○ Install temporary windbreaks ○ Use street sweeping to remove dust from paved roads during earth work • Monitor on-site air quality in relations to local agency and Air District standards and mitigate impacts • Earthwork in areas known to contain naturally occurring asbestos. ○ Relocate earthwork to avoid geologic material containing asbestos ○ Develop asbestos dust mitigation plan in accordance with local air quality management district requirements ○ Spray down construction sites with water or soil stabilizers ○ Pre-wet the ground to the depth of anticipated cuts; ○ Suspend grading operations when wind speeds are high ○ Apply water prior to any land clearing; or ○ Shake or wash wheels of vehicles leaving sites ○ Cover all exposed piles
	Impact 6: Construction activities related to the installation of intake and outfall structures may have the potential to violate air quality standards or contribute substantially to an existing or project air quality violation.	Mitigation Measure 6: See Mitigation Measure 5.
	Impact 7: Construction activities related to the installation of intake and outfall structures may have the potential to result in considerable net increase of any nonattainment pollutant for which the project region is under an applicable federal or state ambient air quality standard.	Mitigation Measure 7: See Mitigation Measure 5.
SECTION	**IMPACT**	**MITIGATION MEASURES**
12.4.3	Biological Resources	
	Impact 8: Construction activities related to the installation of intake and outfall structures may cause the loss or	Mitigation Measure 8: • Construction surveys • Relocation of impacted species

	modification of sensitive habitat including habitat for sensitive species.	• Consultation with NOAA Fisheries and CDFW to identify seasonal work windows, avoidance technology and required monitoring • Obtaining Clean Water Act 404 permit from the US Army Corps of Engineers to mitigate for impacts to wetlands • Avoidance or replacement of trees greater than a specific size and at a ratio agreed upon with local permitting agencies
	Impact 9: Construction activities related to the installation of intake and outfall structures may cause the conversion of riparian or wetland habitat supporting a variety of resident and migratory species.	Mitigation Measure 9: See Mitigation Measure 8
	Impact 10: Construction activities related to the installation of intake and outfall structures may be a cause of disturbance or interference with fish migration patterns due to underwater pile-driving noise.	Mitigation Measure 10: Noise abatement
	Impact 11: Construction activities related to the installation of intake and outfall structures may cause adverse impacts to migratory bird nesting and feeding habitat.	Mitigation Measure 11: Exclusion buffers and postponement of activities till after nests have been vacated
	Impact 12: Construction activities related to the installation of intake and outfall structures may cause disturbance of marine and onshore habitat through generation of noise and vibration.	Mitigation Measure 12: See Mitigation Measure 10
SECTION	**IMPACT**	**MITIGATION MEASURES**
12.4.4	Greenhouse Gas Emissions	
	Impact 13: Construction activities related to the installation of intake and outfall structures may cause local thresholds of significance for greenhouse gases.	Mitigation Measure 13: See Mitigation Measure 5
SECTION	**IMPACT**	**MITIGATION MEASURES**
12.4.5	Hydrology and Water Quality	
	Impact 14: The operation of subsurface wells may cause or exacerbate saltwater intrusion into freshwater aquifers.	Mitigation Measure 14: • Relocate wells • Reduce pumping rate
	Impact 15: The operation of subsurface wells may alter groundwater flow to freshwater aquifers and wells.	Mitigation Measure 15: See Mitigation Measure 14

1.2 Purpose

This report was prepared by the State Water Resources Control Board (State Water Board) staff to support the proposed amendment to the Water Quality Control Plan for Ocean Waters of California (Ocean Plan) that would address Desalination Facility Intakes, Brine Discharges, and

Incorporate Other Nonsubstantive Changes (Desalination Amendment). The proposed Desalination Amendment described here are intended to protect ocean water quality and all forms of marine life from those impacts associated with seawater desalination facility intakes and discharges. Desalination facilities produce freshwater by removing salts from brackish or saltwater for municipal, industrial, or other uses. Although desalination provides an important alternative source of potable water, surface water intakes and discharges associated with facilities that desalinate seawater can have significant impacts on aquatic life-related beneficial uses. For the purpose of this document, “beneficial uses” refers to the beneficial uses of ocean waters of the State, defined as:

> *“**I. BENEFICIAL USES***
> *A. The beneficial uses of the ocean* waters of the State that shall be protected include industrial water supply; water contact and non-contact recreation, including aesthetic enjoyment; navigation; commercial and sport fishing; mariculture*; preservation and enhancement of designated Areas* of Special Biological Significance (ASBS); rare and endangered species; marine habitat; fish migration; fish spawning and shellfish* harvesting.”*

The purpose of this document is to describe the Desalination Amendment as well as the rationale and factors considered in the development and analysis of those amendments, and other alternatives considered in accordance with the California Water Code (Water Code) and California Environmental Quality Act (CEQA).

The Desalination Amendment addresses potentially adverse impacts of seawater intakes and brine discharges on aquatic life and other beneficial uses of California’s ocean waters. The Desalination Amendment includes:

- The applicability of the proposed requirements.
- Implementation procedures for conducting Water Code section 13142.5, subdivision (b) (hereafter 13142.5(b)) evaluations of the best available site, design, technology, and mitigation measures feasible to minimize the intake and mortality of all forms of marine life at new or expanded desalination facilities.
- A narrative receiving water limitation for salinity applicable to all desalination facilities to ensure that brine discharges to ocean waters do not cause adverse effects to aquatic life beneficial uses.
- Procedures for applying for regional water board approval of an alternative intake screening technologies, brine disposal methods, or receiving water limitation for salinity.
- Monitoring and reporting requirements.

Appendix A of this document is the Ocean Plan with the implementation provisions for desalination facilities inserted in chapter III.M, the revisions to Table 2 that address the point of compliance with the Table 2 effluent limitations for facilities that commingle brine, the conforming changes in section 10.1 in Appendix III that address salinity monitoring from point-source discharges, and non-substantive changes in the Ocean Plan. All changes are reflected in blue strikethrough or double underline.

2 SEAWATER DESALINATION IN CALIFORNIA

2.1 Desalination Process

Although desalination may use surface water, groundwater, or municipal water as the source water, the scope of the Desalination Amendment is limited to seawater. Seawater is salt water that is in or from the ocean. For the purposes of chapter III.M of the Desalination Amendment, seawater includes tidally influenced waters in coastal estuaries and lagoons and underground salt water beneath the seafloor, beach, or other contiguous land with hydrologic connectivity to the ocean. In a desalination facility, seawater is pumped from a surface or subsurface intake into the desalination facility. To prevent fouling and damage of the reverse osmosis (RO) membranes, pretreatment of the seawater water is typically necessary to remove organic matter, inorganic particulates, colloids, oils, and other suspended solids. Most existing and planned desalination facilities in California rely on RO as part of the treatment process to remove remaining salts and other compounds from the source water. The prevalence of RO is due to this technology's higher energy efficiency compared with other or older technologies, such as thermal desalination, used in countries surrounding the Persian Gulf and the Gulf of Oman. (Elimelech et al. 2011) RO technology uses membranes to separate large molecules, dissolved salts, and other ions from source water by applying directional pressure. The resulting desalinated water then undergoes additional treatment to be made suitable for human consumption, municipal use, irrigation, industrial use, or groundwater replenishment.

Brine is generated as a byproduct of the desalination process. The concentrated brine is typically discharged as a waste back into the ocean if the facility is situated near the coast. Brine wastes may also be discharged deep underground, into percolation ponds, pumped to a Wastewater Treatment Plant (WWTP), or commingled with industrial or municipal wastewater to provide dilution prior to discharge. As production efficiency improves and desalination technologies advance, it is possible that some facilities will significantly reduce or eliminate brine discharges. However, even if production efficiency reaches 100 percent (i.e., 100 percent freshwater production and no brine discharge), the salts and other formerly dissolved components in the seawater will need to be disposed.

2.2 Impacts to Aquatic Life Related Beneficial Uses

The intake of seawater for desalination can harm aquatic life beneficial uses. Intakes that bring water into desalination facilities may directly harm aquatic organisms by entrainment or impingement. Entrainment occurs when organisms are drawn in with the source water and transported into the system. In the context of desalination intakes, organisms may be trapped or entrained in the source water as it is drawn into the facility for processing. Studies have shown that organisms do not survive entrainment. (U.S. EPA 2011; Pankratz 2004) Mortality via entrainment occurs as a result of shearing and compressive forces within pumps, exposure to high pressures and temperature occurring during processing, and osmotic shock from exposure to significantly higher salinities during processing and discharge. Entrainment typically affects smaller organisms in the water column such as algae, plankton, fish and invertebrate larvae (e.g. shellfish), and eggs.

Organisms may also become impinged (trapped) against intake screens by the flow of water being drawn into the facility. Impingement typically involves adult aquatic organisms. Organisms may be able to survive impingement on intake screens or fish return systems, but some impingement survival statistics indicate 24-hour survival rates of less than 15 percent for some juvenile fish. (Pankratz 2004) Juvenile and adult fish able to dislodge themselves from the screens may experience stress or bodily damage. Organisms like sea jellies and other planktonic organisms cannot swim away and will most likely die on the screens.

Few impingement and entrainment studies are available at existing desalination facilities in California, although there are some impingement and entrainment studies on cooling water intakes, which function in a similar way. These studies estimated that, on average, from 2000 to 2005, 19.4 billion fish larvae were entrained at intakes withdrawing from 78 to 2,670 million gallons per day (MGD). (SWRCB 2013) During the same time period, approximately 2.7 million fish (84,250 pounds) annually were impinged at power plants, along with marine mammals and sea turtles. (SWRCB 2013) No direct estimates exist for the amount of invertebrate larvae, zooplankton, or phytoplankton entrained within this same period, although the numbers are likely orders of magnitude larger (on a per organism basis) based on the relative abundance of plankton in seawater compared to fish larvae.

In addition to impacts from the intake of ocean water, the discharge from a desalination facility can also impair beneficial uses. The salinity of ocean water near the surface in California ranges from 33-34 parts per thousand (ppt). (Lynn 1966) Brines generated from desalination facilities may be twice the salinity of ocean waters. Brine is typically discharged into coastal waters through either a brine-specific outfall or as part of a larger effluent stream from a WWTP or power generating facility. Concentrated brine can behave differently than traditional effluent plumes because of greater density. The increased density can cause the plume to sink and spread on the seafloor instead of mixing with the surrounding water. (Roberts et al. 2012) Bottom-dwelling marine life can thus have increased exposure to the brine and other potentially toxic constituents, which may have deleterious effects. Neutral or buoyant brine plumes that stay suspended in the water column may cause osmotic shock to organisms exposed to poorly-mixed plume water. Lab and field studies have shown the potential for acute and chronic toxicity and small-scale alterations to community structure after being exposed to concentrations of brine near discharge sites. (Roberts et al. 2010) Laboratory studies conducted by the University of California at Davis, Department of Environmental Toxicology at Granite Canyon, reported effects in some indigenous species at concentrations of only two to four ppt above background seawater. (Phillips et al. 2012)

2.3 Existing Facilities

Table 2-1 and Figure 2-1 show the eleven small existing desalination facilities situated on the coast of California (pilot projects and test facilities in California are not included). Many operate intermittently when existing water supplies need to be supplemented. Currently active desalination facilities have a combined production capacity of approximately 6.1 MGD. The largest continuously operating desalination facility is located at the Diablo Canyon Nuclear Power Plant. This facility is capable of producing 0.576 MGD that is used for the power plant's operational needs. (Cooley and Donnelly 2012)

Table 2-1 Desalination facilities located on the California Coast. The Station IDs correspond with their location on the map in Figure 2-1. (Modified from Cooley et al. 2006)

Station ID	Operator	Purpose	Ownership	Production Capacity (MGD)	Status
1	Monterey Bay Aquarium	Aquarium visitor use	Non-profit	0.04	Active
2	Marina Coast Water District	Municipal/ domestic	Public	0.3	Temporarily idle
3	Duke Energy, Moss Landing	Industrial processing	Private	0.5	Active
4	Sand City	Municipal/ domestic	Public	0.3	Active
5	City of Morro Bay	Municipal/ domestic	Public	0.6	Intermittent use
6	Duke Energy	Industrial processing	Private	0.4	Not known
7	Pacific Gas & Electric (PG&E)	Industrial processing	Private	0.6	Not known
8	Chevron USA	Industrial processing	Private	0.4	Active
9	City of Santa Barbara	Municipal/ domestic	Public	2.8-8.9	Temporarily idle
10	U.S. Navy	Municipal/ domestic	U.S. Navy	0.02	Not known
11	Southern California Edison (SCE)	Municipal/ domestic	Public	0.2	Inactive

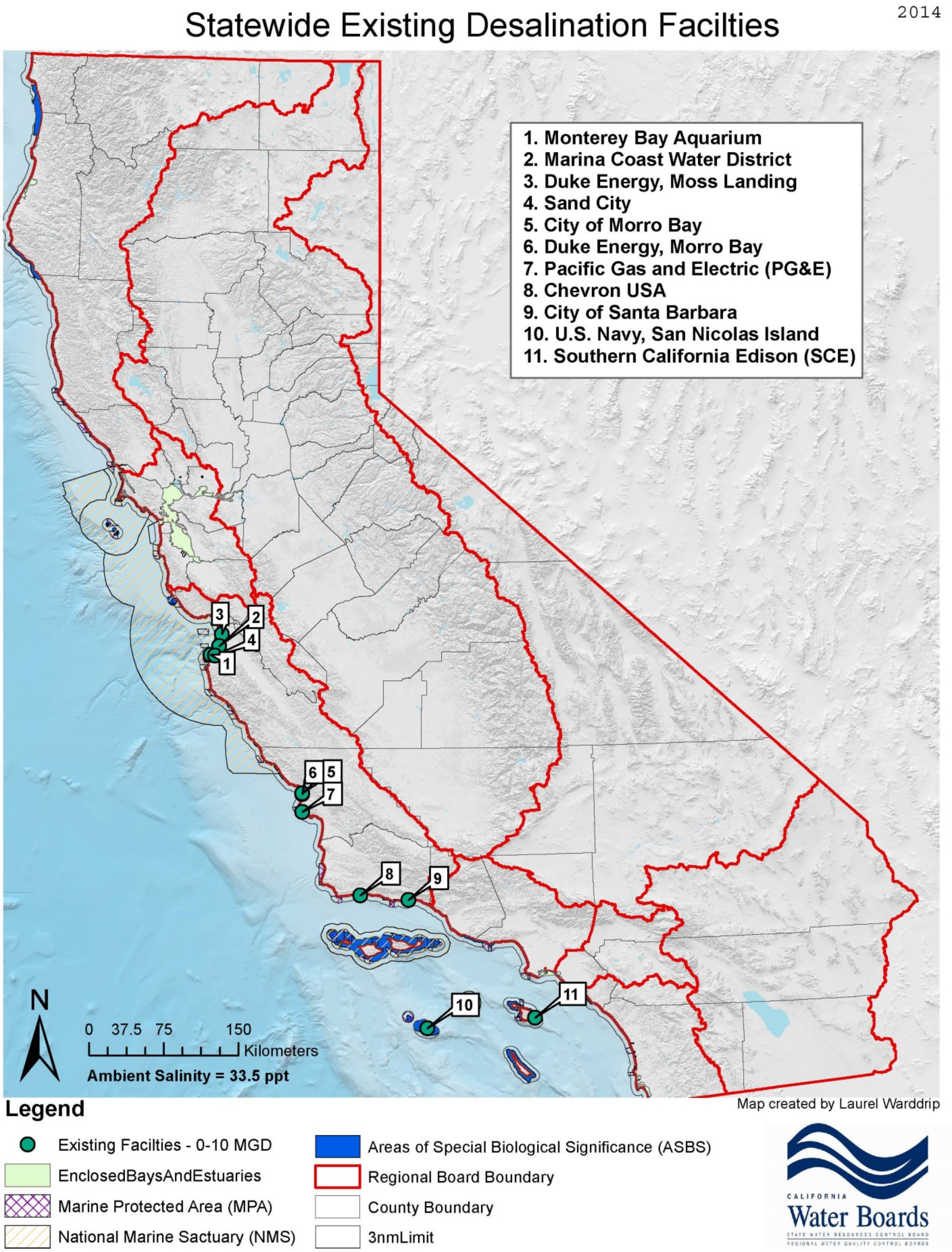

Figure 2-1 Existing coastal desalination facilities in California.

2.4 Proposed Facilities

At this time, there are 15 seawater desalination plants proposed for development along the California coast, with a combined production capacity of 250 to 370 MGD. (Cooley and Donnelly 2012; Table 2-2 below) The 15 facilities all propose to use RO technology, and range in production capacity from 0.5 to 150 MGD product water (using 1 to 300 MGD source water[1]). Five of the projects are small and would each produce less than 5 MGD. Seven plants would each produce 5 to 25 MGD. Three of the proposed facilities are large and would each produce 50 to 150 MGD of fresh water. The combined capacity from these plants is enough to supply 5 to 7 percent of the average urban water demand in California, based on water use data from 2000 to 2005. (CDWR 2009)

Planned facilities are being considered in Camp Pendleton, Oceanside, Dana Point, Huntington Beach, Redondo Beach/ El Segundo, Oceano, Cambria, Monterey, Santa Cruz, Moss Landing, and in the San Francisco Bay area, with the largest of the proposed plants located in Southern California (Figure 2-2). Construction is underway at the Carlsbad Desalination Project, which will, at completion, be capable of producing 50 MGD of potable water. The facility is expected to begin producing desalinated water in 2016, and may supply up to seven percent of San Diego County's water supply. (SDCWA 2009) Locations of these facilities are shown in Figure 2-2.

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[1] In general, most desalination facilities are designed to intake twice the amount of ocean water as their rated production capacity.

Table 2-2 Proposed coastal desalination facilities as of 2014. The Station IDs correspond with their location on the map in Figure 2-2. (Modified from Cooley and Donnelly 2012)

Station ID	Project Partners	Location	Production Capacity (MGD)	Intake	Brine Discharge
1	Bay Area Regional Desalination Project	Contra Costa, Oakland, or San Francisco	25	Surface	Commingled with wastewater
2	California Water Service Company	Unknown	5	Undetermined	Undetermined
3	City of Santa Cruz, Soquel Creek Water District	Santa Cruz	2.5 to 4.5	Undetermined	Commingled with wastewater
4	DeepWater, LLC	Moss Landing	25	Surface	Commingled with cooling water
5	People's Water Desal Project	Moss Landing	10	Surface	Surface
6	Ocean View Plaza	Monterey	0.25	Subsurface	Surface
7	Monterey Peninsula Water Management District	Monterey	2	Undetermined	Undetermined
8	Monterey Peninsula Water Supply Project	North Marina	9.6	Subsurface	Commingled with wastewater
9	Cambria Community Services District	Cambria	0.6	Subsurface	Subsurface
10	Oceano Community Services District	Oceano	2	Subsurface	Commingled with wastewater
11	West Basin Municipal Water District	Redondo Beach	18	Undetermined	Surface
12	Huntington Beach Desalination Project	Huntington Beach	50	Surface	Surface
13	South Coast Water District	Dana Point	15	Subsurface	Commingled with wastewater
14	City of Oceanside	Oceanside	5 to 10	Subsurface	Undetermined
15	Carlsbad Desalination Project	Carlsbad	50	Surface	Surface
16	San Diego County Water Authority	Camp Pendleton	50 to 150	Undetermined	Surface

Figure 2-2. Proposed desalination facilities in California as of 2014.

3 CALIFORNIA OCEAN PLAN

3.1 Content and Organization

The Ocean Plan establishes water quality objectives for California's ocean waters and provides the basis for regulation of wastes discharged into the California's coastal waters. The State Water Board adopts the Ocean Plan, which has regulatory effect and also applies to other agencies unless they have statutes to the contrary. The State Water Board and six coastal Regional Water Quality Control Boards (regional water boards) interpret and implement the Ocean Plan. The Ocean Plan is typically implemented through National Pollutant Discharge Elimination System (NPDES) permits issued by the regional water boards for all discharges into ocean waters of the State. Waste Discharge Requirements (WDR) regulate point source discharges into surface water and groundwater, therefore, all NPDES permits are also WDR's. The 2012 Ocean Plan contains three chapters that describe beneficial uses to be protected, water quality objectives, and a program of implementation necessary for achieving water quality objectives. (SWRCB 2012)

3.2 Applicability to desalination facility intakes and discharges

There are only a few provisions in the Ocean Plan that protect aquatic life from impacts associated with seawater intakes. Chapter III.E.4 of the Ocean Plan limits waste discharges within an Area of Special Biological Significance (ASBS), a subset of SWQPA. Within ASBS-SWQPAs, only limited-term activities are permissible, provided that the activity will not degrade background water quality or result in water quality lower than that necessary to protect beneficial uses. Chapter III.E.5 includes provisions that address seawater intakes within those areas designated as SWQPA – General Protection. These provisions include:

> *"(b) Implementation provisions for existing seawater intakes*
>
> > *(1) Existing permitted seawater intakes must be controlled to minimize entrainment and impingement by using best technology available. Existing permitted seawater intakes with a capacity less than one MGD are excluded from this requirement."*
>
> *"(d) Implementation Provisions for New Discharges*
>
> > *(2) Seawater intakes*
> >
> > *No new surface water seawater intakes shall be established within an SWQPA-General Protection. This does not apply to sub-seafloor intakes where studies are prepared showing there is no predictable entrainment or impingement of marine life."*

Discharges from desalination facilities would be regulated under the Ocean Plan in the same way as other industrial discharges of waste. Some desalination facility discharge permits require salinity monitoring and some permits include salinity limitations. The regional water boards determine the salinity limitations based on facility-specific modeling of the zone of initial dilution. However, there are no existing water quality objectives or effluent limitations for salinity in the Basin Plans or Ocean Plan. Thus, permit writers are left to regulate discharges using their best professional judgment.

Because the Ocean Plan currently lacks provisions to ensure adequate, consistent protection of beneficial uses of ocean waters from the effects associated with desalination facility intakes and discharges, State Water Board staff proposes the Desalination Amendment to Chapter III.M of the Ocean Plan, presented in Appendix A.

4 PROJECT SUMMARY

4.1 Project Title

This Project is titled “An Amendment to the Water Quality Control Plan for Ocean Waters of California to address Desalination Facility Intakes, Brine Discharges, and to Incorporate Other Non-substantive Changes,” and is referred to as the Desalination Amendment.

4.2 Project Description

The Desalination Amendment, if adopted, would establish a uniform approach for protecting beneficial uses of ocean waters from degradation due to seawater intake and discharge of brine wastes from desalination facilities. The Desalination Amendment would protect and maintain the highest reasonable water quality possible for the use and enjoyment of the people of the state while supporting the use of ocean water as an alternative source of water supply. The Desalination Amendment contains four primary components intended to control potential adverse impacts to all forms of marine life associated with desalination facility intakes and brine discharges as described below.

1. Clarify the State Water Board’s authority over desalination facility intakes and discharges
2. Provide direction to the regional water boards regarding the determination required by Water Code section 13142.5, subdivision (b) (hereafter 13142.5(b)) for the evaluations of the best available site, design, technology, and mitigation measures feasible to minimize the intake and mortality of all forms of marine life at new or expanded desalination facilities.
3. A narrative receiving water limitation for salinity applicable to all desalination facilities to ensure that brine discharges to marine waters meet the biological characteristics narrative water quality objective[2] and do not cause adverse effects to aquatic life beneficial uses.
4. Monitoring and reporting requirements.

The Desalination Amendment, if adopted, would apply intake-related provisions to all new and expanded desalination facilities that intake state ocean waters. Discharge requirements would apply to all desalination facilities. The Desalination Amendment would be implemented through a NPDES permits or WDR issued by the applicable regional water board in consultation with State Water Board staff.

4.3 Project Goals

The Desalination Amendment has the following primary goals:

1) Provide a consistent statewide approach for minimizing intake and mortality of all forms of marine life, protecting water quality, and related beneficial uses of ocean waters. Meeting this goal will address the need for a uniform statewide approach for controlling adverse effects of desalination facilities that are not currently addressed in the Ocean

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[2] The 2012 Ocean Plan Section II. E (biological characteristics water quality objective) requires that, “marine communities, including vertebrate, invertebrate, and plant species, shall not be degraded.” (SWRCB 2012)

Plan or the Statewide Water Quality Control Policy on the Use of Coastal and Estuarine Waters for Power Plant Cooling (Once-Through Cooling [OTC] Policy).

2) Support the use of ocean water as a reliable supplement to traditional water supplies while protecting beneficial uses.
3) Promote interagency collaboration for siting, design, and permitting of desalination facilities and assist the State and regional Water Boards (Water Boards) in regulating such facilities.

4.4 Necessity and Need for Project

Population growth in California combined with extended droughts and dwindling local water supplies have increased the demand for reliable sources of water. As a result, many water providers are either planning for or considering desalination to supplement traditional water supplies in water management portfolios. As described in section 3.2 of this document, there are few existing provisions in the Ocean Plan that specifically protect beneficial uses from the potential impacts associated with desalination facility intakes and discharges. Additionally, the Ocean Plan does not have implementation provisions for the water quality objective in chapter II.E.1 that would address the degradation of marine communities as the result of desalination-related activities. At desalination facilities, stress, injury, or mortality to marine life may result from:

- Construction of the facility
- Impingement against intake screens
- Entrainment through the desalination facility intakes
- Discharge of high salinity brines to the receiving water

If the Desalination Amendment is not adopted, the coastal regional water boards will continue to permit new or expanded facilities using best professional judgment on a case by case basis. Evaluation of the technical and biological issues related to reducing impacts from desalination facility intakes and discharges is complex and requires significant resources, particularly when done on a case by case basis. Sufficient resources or subject expertise may not be available at each regional water board. These challenges can lead to varying decision criteria and different conclusions regarding the most appropriate requirements for desalination facilities.

The State Water Board considered the need to regulate desalination facilities and brine disposal in its California Ocean Plan Triennial Review Workplan 2011- 2013[3]. The State Water Board identified the project as a high priority, and planned for adoption of a narrative water quality objective for salinity, limits on impingement and entrainment of organisms from desalination intakes, and an implementation policy. The Workplan further identified plans for a limitation on in-plant dilution of brine prior to discharge. Comments submitted as part of the Triennial Review Workplan process and through later scoping and stakeholder meetings raised concerns with adoption of a water quality objective for salinity, as well as other aspects of the previously identified approach.

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[3] Resolution 2011-0013, adopted March 15, 2011.

The project goals set forth in section 4.3 above reflect issues and concerns identified through the State Water Board’s public outreach process, informed by the Water Board’s central objective of protecting beneficial uses of waters and attaining the highest water quality which is reasonable, considering all demands to be made on those waters. In addition, the State Water Board seeks to ensure an efficient approach to permitting desalination facilities to address needed water supplies, while carrying out its legislative mandate to require that seawater intakes utilize the best available site, design, technology and mitigation measures feasible to minimize intake and mortality of all forms of marine life.

5 WATER QUALITY PLANNING REQUIREMENTS AND PROCESSES

5.1 Federal Clean Water Act

The Clean Water Act (CWA) is the primary federal water pollution control statute. The State Water Board is designated as the State Water Pollution Control Agency for all purposes under the CWA. The CWA also creates the basic structure under which point source discharges of pollutants are regulated and establishes the statutory basis for the NPDES permit program.

5.2 Porter-Cologne Water Quality Control Act

The Porter-Cologne Water Quality Control Act (Porter-Cologne) is the primary water quality law in California. The California legislature has assigned the responsibility for protecting and enhancing water quality in California to the State Water Board and the nine regional water boards. Porter-Cologne addresses two primary functions: water quality control planning, and waste discharge regulation. In adopting Porter-Cologne, the State Legislature directed that California's waters, "shall be regulated to attain the highest water quality which is reasonable, considering all demands being made and to be made on those waters and the total values involved, beneficial and detrimental, economic and social, tangible and intangible" (§ 13000).

Porter-Cologne is administered regionally, within a framework of statewide coordination and policy. The State Water Board provides state-level coordination of the water quality control program by establishing statewide policies and plans for the implementation of state and federal laws and regulations. The regional water boards adopt and implement Regional Water Quality Control Plans (Basin Plans) that recognize the unique characteristics of each region with regard to water quality, actual and potential beneficial uses, and water quality problems. State Water Board staff oversees and guides the regional water boards through adoption of statewide water quality control plans and policies.

The State Water Board is authorized under Water Code section 13170 to adopt Water Quality Control Plans in accordance with the provisions of Water Code section 13240 (all further statutory references are to the Water Code unless otherwise indicated). State plans supersede Basin Plans for the same waters (§ 13170). The Ocean Plan which is specifically required by section 13170.2 provides the basis for regulation of wastes discharged into the state's coastal waters by establishing beneficial uses and narrative and numeric water quality objectives to protect all ocean waters of California and prescribing programs to implement those objectives, together with the State's Antidegradation Policy. (SWRCB 1968) The implementation program includes limitations on waste discharge, requirements for monitoring and compliance determination, and applies to both point and non-point source discharges.

The State Water Board must follow state and federal procedural requirements for public participation including approval by the state Office of Administrative Law when amending the Ocean Plan. Substantive amendments are also subject to the regulations for implementing the California Environmental Quality Act of 1970, as discussed below. Additionally, while the proposed action does not include establishing new or revised water quality objectives, the proposed receiving water limits are similar enough in function that the State Water Board has determined it appropriate to consider the Porter Cologne section 13241 factors, which include:

a. Past, present, and probable future beneficial uses of water.
b. Environmental characteristics of the hydrographic unit under consideration, including the quality of water available thereto.
c. Water quality conditions that could reasonably be achieved through the coordinated control of all factors which affect water quality in the area.
d. Economic considerations.
e. The need for developing housing within the region.
f. The need to develop and use recycled water.

5.3 California Environmental Quality Act

The State Water Board must comply with the procedural and substantive requirements of CEQA when proposing to amend water quality control plans and policies. (Pub. Resources Code. § 21000 et seq.) CEQA authorizes the Secretary for Natural Resources to certify that state regulatory programs meeting certain environmental standards are exempt from the majority of the procedural requirements of CEQA, including the preparation of a separate environmental impact report (EIR), negative declaration, or initial study. (Cal. Code. of Regs., tit. 14, §15251, subd., (g)) The Secretary for Natural Resources has certified as exempt the State Water Board adoption or approval of standards, rules, regulations, or plans to be used in the Basin/208 Planning program for the protection, maintenance, and enhancement of water quality in California. (Cal. Code. of Regs., tit. 23, §§ 3775 – 3781) This exemption includes the State Water Board's process to adopt this Desalination Amendment. Under this exemption, the State Water Board must still comply with CEQA's goals and policies, including the policy of avoiding significant adverse effects on the environment where feasible. (Cal. Code. of Regs., tit. 14, § 15250) In addition, the State Water Board must also evaluate environmental effects, including cumulative effects; consult with other agencies; conduct early public consultation and review; respond to comments on the draft environmental document; adopt CEQA findings; and provide for mitigation monitoring and reporting, as appropriate.

The CEQA Guidelines provide for the use of a "substitute document" by State agencies with certified Programs. (Cal. Code. of Regs., tit. 14, § 15252) State Water Board regulations (Cal. Code. of Regs., tit. 23, § 3777) require that Draft Substitute Environmental Documentation (SED) be prepared for a certified regulatory program. The Draft SED must include:

1. A written report prepared for the board that contains a brief description and an environmental analysis of the proposed project;
2. An identification of any significant, or potentially significant, adverse environmental impacts of the proposed project;
3. An analysis of reasonable alternatives to the project;
4. An analysis of mitigation measures that would avoid or reduce any significant, or potentially significant, adverse environmental impacts;
5. An environmental analysis of the reasonably foreseeable methods of compliance;
6. A completed Environmental Checklist; and
7. Other documents the State Water Board may decide to include.

Accordingly, State Water Board staff has prepared this Staff Report, including SED for the adoption of the Desalination Amendment. The Staff Report and the associated administrative record fulfill the requirements of SED.

CEQA (Pub. Res. Code, § 21083.9) also requires state agencies to engage the stakeholders and public agencies early in the planning and formulation stages of the project to scope the range of actions methods of compliance significant impacts and cumulative impacts that should be analyzed in the study. A scoping meeting for this project was held March 30, 2012 in Sacramento, California. Public workshops were held on August 22, 2012 and September 23, 2013 in Sacramento, California. Notices and materials for these meetings are available at http://www.waterboards.ca.gov/water_issues/programs/ocean/desalination/. Additionally, State Water Board staff held targeted stakeholder outreach meetings in June and July 2013 to solicit additional feedback on key issues in the Desalination Amendment.

In formulating the Desalination Amendment, State Water Board staff consulted with staff from the affected regional water boards and staff from the following state agencies: Coastal Commission, Coastal Conservancy, California Department of Fish and Wildlife (CDFW), Ocean Protection Counsel, State Lands Commission, Department of Public Health, and Department of Water Resources.

5.4 California Health and Safety Code Scientific Peer Review

In 1997, section 57004 was added to the California Health and Safety Code (Senate Bill 1320-Sher) which requires external scientific peer review of the scientific basis for any rule proposed by any board, office or department within Cal/EPA. Scientific peer review is a mechanism for ensuring that regulatory decisions and initiatives are based on sound science. Scientific peer review also helps strengthen regulatory activities, establishes credibility with stakeholders, and ensures that public resources are managed effectively. The scientific and technical information supporting Desalination Amendment underwent external scientific peer review in June of 2014 by the following reviewers: Dr. Ben R. Hodges from University of Texas at Austin, Dr. Lisa A. Levin from Scripps Institution of Oceanography at University of California San Diego, Dr. E. Eric Adams from the Massachusetts Institute of Technology, Dr. Bronwyn Gillanders, from the University of Adelaide, Dr. Robert Howarth from Cornell University, Dr. Nathan Knott, from the University of Wollongong, and Dr. Scott A. Socolofsky from Texas A & M University. Comments from peer reviewers and staff responses can be found in Appendix I of this Staff Report with SED and are posted at the Water Boards website located at: http://www.waterboards.ca.gov/water_issues/programs/ocean/desalination/

5.5 Expert Review Panels

To ensure the Desalination Amendment adequately address the potential water quality impacts associated with seawater desalination facilities, State Water Board staff convened a series of expert panels as described below. Findings and recommendations from these panels are discussed in greater detail in section 8 of this document.

Expert Review Panel on Impacts and Effects of Brine Discharges (ERP I)- State Water Board staff established the first panel of experts to discuss issues related to potential environmental impacts associated with brine discharges, effective disposal strategies, models for assessing plume characteristics, evaluation of cumulative water quality impacts from multiple plumes and appropriate monitoring strategies for brine discharges. The panel members were: Dr. Philip Roberts (chairman), Dr. Scott Jenkins, Dr. Jeffrey Paduan, Dr. Daniel Schlenk, and Dr. Judith Weis. The panel met several times to develop recommendations for the State Water Board. A public meeting was held on December 8-9, 2011. The panel met in February 2012 and a Final Report with their findings and recommendations was finalized submitted to the State Water Board in March 2012.

Expert Review Panel II on Intake Impacts and Mitigation (ERP II) - State Water Board staff contracted with the Moss Landing Marine Laboratory to establish an expert panel to address issues associated with minimizing and mitigating intake impacts from power plants and desalination facilities. The panel members were Dr. Michael Foster, Dr. Gregor Cailliet, Dr. James Callaway, Dr. Peter Raimondi, and Mr. John Steinbeck. The panel met on August 8, 2011 and on November 15, 2011. A public meeting was held March 1, 2012 at the Moss Landing Marine where panel members presented their recommendations and took questions and comments from the public on the panel's Draft Report. The panel members finalized the report on March 14, 2012 Expert Review Panel on Intakes: Final Report.

Expert Review Panel III on Intake Impacts and Mitigation (ERP III)- The Expert Review Panel on Intake Impacts and Mitigation was reconvened to address questions raised at a January 30, 2013 Stakeholder Meeting in Moss Landing Marine Laboratory. State Water Board staff convened this panel to provide recommendations related to potential effects of discharge multiport diffusers on marine life and methods for calculating mitigation fee for the entrainment impacts caused by desalination plant intakes. The panel members were Dr. Michael Foster, Dr. Gregor Cailliet, Dr. John Callaway, Dr. Kristina Mead Vetter, Dr. Peter Raimondi, and Dr. Philip Roberts. A Draft Report was submitted to the State Water Resources Control Board staff. A Final Report was submitted on October 9, 2013.

Information materials and reports from the expert panels is posted at: http://www.waterboards.ca.gov/water_issues/programs/ocean/desalination/

5.6 Water Board Funded Studies

State Water Board staff commissioned a study by researchers at the University of California at Davis Marine Pollution Studies Laboratory at Granite Canyon to investigate the ecological impacts of concentrated brine discharges on benthic communities. The study evaluated the tolerance of Ocean Plan test species to hyper-saline brines in the laboratory. The findings discussed in detail in section 8.6 were used to assist staff in the evaluation of ecologically relevant salinity thresholds for consideration by the State Water Board. In support of the Desalination Amendment, U.S. EPA funded a study by Abt Associates Inc. of Bethesda, Maryland to conduct an economic analysis of the Desalination Amendment. This study is summarized in section 9.

6 REGULATORY SETTING FOR DESALINATION IN OCEAN WATERS

This section describes state and federal laws and regulations governing the construction and operation of desalination facility intakes and discharges into ocean waters. Federal law and implementing regulations address requirements for the location, design, construction, and capacity of cooling water intake structures such as those associated with power plants or other industrial facilities requiring water for cooling purposes. However, there are no federal laws or regulations specific to water intakes such as those for desalination purposes that are not primarily associated with cooling water. At the state level, discharges from desalination facilities are regulated through WDRs that may also serve as NPDES permits issued by the Water Boards. The existing regulatory framework under which water quality impacts associated with desalination facilities may be addressed is described in the sections below.

6.1 Clean Water Act Requirements Governing Desalination Facilities

CWA sections 402, 316(a), and 316(b) apply to cooling water intakes. CWA section 402 governs the NPDES program, which establishes permitting requirements for point source discharges to protect receiving waters. CWA section 316(a) specifically addresses thermal discharges, which could potentially apply to some desalination facilities, particularly those that commingle brine discharges with cooling water effluent. CWA section 316(b) indirectly applies to desalination facilities co-located with power plants and other industrial cooling water intakes insofar as a cooling water intake structure, used to withdraw water for use by both facilities, must meet the requirements of the federal statute and applicable regulations. Thus, a desalination facility that collects source water through an existing, operational cooling water intake associated with a power plant, or certain other types of industrial facilities, may be required to comply with technology-based standards for minimizing impingement and entrainment impacts.

For more information about CWA and the NPDES Program, please visit the following link:
http://cfpub.epa.gov/npdes/outreach/training/presentationcwa.cfm

For more information about CWA section 402, please visit the following link:
http://water.epa.gov/lawsregs/guidance/wetlands/section402.cfm

For more information about CWA section 316, please visit the following link:
http://water.epa.gov/lawsregs/lawsguidance/cwa/316b/

6.2 Porter-Cologne Authority over Seawater Intakes

Porter-Cologne directly addresses new or expanded facilities' industrial use of seawater for cooling, heating, or industrial processing, which includes desalination. 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."*

Section 13142.5(b) gives the State Water Board authority to regulate intakes from new or expanded desalination facilities, in order to ensure that marine life mortality is minimized. The Porter-Cologne provision is both broader and narrower than CWA section 316(b), which governs cooling water intake structures. Section 13142.5(b) addresses only new or expanded facilities, unlike CWA section 316(b), which does not differentiate between new or existing intakes. The inclusion of mitigation measures as a method to minimize the intake and mortality of all forms of marine life contrasts with existing case law related to CWA regulation of cooling water intakes, which does not allow restoration measures as a substitute for best technology available for minimizing adverse environmental impacts. (Riverkeeper 2007) However, the Water Code provision specifically cites mitigation as a tool to minimize impacts to all forms of marine life resulting from industrial intakes. For the purposes of this amendment, staff defines "all forms of marine life" as including all life stages of all species present in ocean waters.

Additionally, Water Code section 13142.5, subdivision (d) (hereafter Water Code section 13142.5(d)) states:

> *"Independent baseline studies of the existing marine system should be conducted in the area that could be affected by a new or expanded industrial facility using seawater in advance of the carrying out of the development."*

This provision provides the Water Boards the authority to require baseline biological studies for new or expanded desalination facilities prior to development. These studies could include, but are not limited to, characterizing the abundance and diversity of marine species prior to using a screened surface intake or characterizing the benthic community prior to installing a subsurface intake.

6.3 Porter-Cologne Authority over Discharges

The State has broad authority under Porter-Cologne to regulate waste discharges that could affect water quality. In 1972, the California Legislature amended Porter-Cologne to provide the state the necessary authority to implement an NPDES permit program in lieu of a U.S. EPA-administered program under the CWA. Consequently, the state is authorized by the U.S. EPA to issue NPDES permits within California to point source dischargers of pollutants to navigable waters. Porter-Cologne requires that the Water Boards issue and administer NPDES permits such that all applicable CWA requirements are met to ensure consistency with the CWA requirements. Additional requirements set forth in Porter-Cologne must be at least as stringent as those required by the CWA. Section 13160 states that the State Water Board is designated as the State Water Pollution Control Agency for all purposes stated in the CWA and is authorized to exercise any powers accordingly delegated to the State. Under section 13263, Porter-Cologne authorizes the Water Boards to prescribe requirements for the discharge wastes into waters of the state, including brine waste from existing, expanded, and new desalination facilities.

In California, all discharges of waste are regulated under WDRs, which in California may also serve as NPDES permits (§ 13374). The regional water boards may also issue WDR permits for desalination facilities that dispose of brine in locations outside of jurisdictional waters covered by the CWA. The WDR Program regulates point discharges that are exempt pursuant to sub-section 20090 of title 27 and not subject to the Federal Water Pollution Control Act. WDRs are issued for waste discharges to land, including percolation basins, injection wells, or other discharges where groundwater quality could be impacted.

As stated in section 6.3 above, the Water Boards may require an owner or operator to conduct studies on the marine system prior to development. These studies may include but are not limited to characterizing abiotic factors such as salinity and temperature, and biotic factors such as species richness, abundance, and diversity. The data from the studies can be used to evaluate the impacts of a discharge from a new or expanded desalination facility.

6.4 State Water Quality Plans and Policies

6.4.1 Ocean Plan and Desalination

The Ocean Plan focuses on the protection of beneficial uses and meeting water quality objectives by addressing the discharge of pollutants. The Ocean Plan includes water quality objectives for bacterial, physical, biological and chemical characteristics; of these objectives, the most relevant objective is the biological characteristics water quality objective, which requires that marine communities, including vertebrate, invertebrate, and plant species, shall not be degraded. However, the Ocean Plan does not include provisions that adequately implement this objective with regard to desalination activities. The only implementation provision for desalination facilities is that “Salinity must also be monitored by all point sources discharging desalination brine as part of their core monitoring program.”

The Ocean Plan can be found at the following link:
http://www.swrcb.ca.gov/water_issues/programs/ocean/docs/cop2012.pdf

6.4.2 Once-through Cooling Water Policy

On May 4, 2010, the State Water Board adopted the OTC Policy. (SWRCB 2013) This Policy establishes technology-based standards to implement federal CWA section 316(b) in order to minimize adverse environmental impacts associated with cooling water intake structures on marine and estuarine life. The Policy currently applies to 13 existing power plants (including one nuclear plant) that use once-through cooling and have the ability to withdraw nearly 15 billion gallons per day from the State’s coastal and estuarine waters. The Policy identifies closed-cycle wet cooling as best available technology, and requires existing permit holders to either reduce intake flow and velocity or reduce impacts to aquatic life comparably by other means. The Policy is implemented through both NPDES permits and an adaptive management strategy by which a multi-agency advisory committee evaluates compliance dates under the Policy in order to ensure that the standards can be achieved without disrupting the critical needs of the State’s electrical generation and transmission system. Though the OTC Policy does not directly apply to desalination facilities, it may impact existing, co-located facilities’ ability to use once-through cooling water as source water or to commingle desalination brine with existing power plant cooling water discharges as those plants move to closed-cycle wet cooling systems. Much of the information relied upon during the development of the OTC Policy was used to guide the development of the Desalination Amendment described in this document.

More information about the OTC Policy can be found at:
http://www.swrcb.ca.gov/water_issues/programs/ocean/cwa316/

6.5 California Coastal Act

The California Coastal Act of 1976 (Coastal Act; Pub. Resources Code §§ 30000 et seq.) sets forth specific policies that address the protection of marine habitat, commercial fisheries, and water quality. Section 30230 of the Coastal Act states:

> *"Marine resources shall be maintained, enhanced, and, where feasible, restored. Special protection shall be given to areas and 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."*

Coastal Act section 30231 provides that the biological productivity and the quality of coastal waters, wetlands, and estuaries should be maintained to sustain or restore populations of marine organisms and for the protection of human health. Coastal Act section 30231 also requires that, where feasible, the biological productivity and quality of coastal waters shall be restored through encouraging waste water reclamation, and minimizing adverse effects of waste water discharges and entrainment, among other means. Coastal Act section 30231 was adopted as part of the Coastal Act, which otherwise establishes requirements and policies to be carried out when applicable agencies issue any Coastal Development Permit. Any new desalination facility proposed to be located in the coastal zone will require a Coastal Development Permit.

The Coastal Act can be found at the following link: http://www.coastal.ca.gov/coastact.pdf

7 ENVIRONMENTAL SETTING

California's ocean environment contains some of the most biologically rich and diverse habitats and natural communities in the world, a function of the inter-relationship of onshore and offshore physical processes. Modifications in one location may strongly influence biological processes in more distal locations. For example, colder subarctic waters of the California Current merge with warmer temperate waters from the south, which creates two distinct biogeographic regions. These two distinct regions typically contain distinct species compositions and communities. For example temperate fishes like rockfish, lingcod, Pacific salmon, and Pacific halibut typically inhabit cooler waters north of Point Conception, whereas species adapted to warmer subtropical conditions like barracuda, sand basses, and bat rays inhabit waters south of Point Conception. Cold water species are also found in southern California waters at greater depths where the water is cooler. (Allen and Horn 2006)

As biological and oceanographic conditions change seasonally and on longer time scales, so do the distribution and abundance of coastal fauna. For example, migratory pelagic fish such as tunas and swordfish may be found offshore in summer months and El Niño Southern Oscillation events may drive fish adapted to warmer subtropical conditions northward. Coastal areas are influenced by the California Current, which brings cool, North Pacific Ocean water south along the California coast. Coastal areas are also influenced by coastal upwelling of cold, nutrient-rich waters that support diverse species and ecosystems. There, coastal waters can be separated into two general zones, the nearshore zone and the offshore zone, each having unique characteristics. (Resources Agency 1995)

The nearshore ocean zone, where sunlight penetrates to the bottom, extends out to an ocean floor depth of about 100 meters (330 feet) in transparent waters. This zone has pronounced light and temperature gradients that vary seasonally and influence the temporal and spatial distribution of marine organisms. Nearshore waters support an abundance of habitats and organisms and offer many economic and recreational opportunities. (Resources Agency 1995) The nearshore environment supports a complex food web that includes diverse invertebrates, numerous bird species, sea turtles, sea otters, harbor seals, sea lions, elephant seals, and occasionally whales, that feeds in productive nearshore waters. (Resources Agency 1995)

The offshore ocean zone of California begins at a depth of about 100 meters and extends 200 miles offshore. Much of the offshore ocean zone lies beyond the continental shelf. Deep submarine canyons split the shelf in some areas and bring the deep ocean environment in close proximity to shore (e.g., the Monterey Submarine Canyon). (Resources Agency 1995) The offshore ocean zone supports important fishery stocks typically restricted to deeper waters, including tuna, swordfish, rockfish, sablefish, Pacific hake, and flatfishes. Several birds, such as albatrosses, travel many miles from shore into the offshore ocean zone to feed on crustaceans and small fishes. Gray and humpback whales and several species of dolphins and porpoises are marine mammals commonly found in California's offshore waters. (Resources Agency 1995)

7.1 Marine Ecosystems in California and Sensitive Habitats

California's marine ecosystem is diverse and contains sensitive habitats that may require special consideration of protection. Sensitive habitats are ecosystems that support high-value organisms, species diversity, and ecosystem complexity. Sensitive marine habitats that should be considered prior to siting a desalination facility include: kelp beds, eelgrass beds, surfgrass beds, rocky reefs, oyster beds, market squid nurseries, and foraging grounds and reproductive habitat for state and federally managed species. These biologically diverse habitats provide habitat for larval recruitment, settlement, and development. (Moyle and Cech 2004; Allen and Horn 2006) Sensitive habitats are also important areas for feeding, reproduction, and protection from predation.

7.1.1 Kelp beds

Kelp beds are common in areas with rocky substrates because kelp often attaches to hard substrates. Kelp reproduces by releasing spores into the water column that are carried by currents before the spores settle to the bottom and geminate. Giant kelp, *Macrocystis pyrifera*, releases spores continuously from spring to fall in California's coastal waters. The spores differentiate into sperm and eggs and fertilization occurs in the water column. Many of the spores, sperm, and eggs become food for other organisms in the marine food web. The planktonic reproductive life stages of kelp are at risk of entrainment in surface water systems. Fertilized eggs that avoid predation and entrainment, and settle on suitable substrate develop into the adult organisms that make up kelp beds.

Kelp beds can extend for miles along the coastline and form habitats that function similar to terrestrial rainforests in terms of their biological productivity and support of species diversity. Kelp beds are aggregations of marine algae of the order Laminariales, including species in the genera *Macrocystis, Nereocystis*, and *Pelagophycus*. Kelp beds include the total foliage canopy throughout the water column and provide vertical stratification similar to trees in a rainforest. Kelp beds provide structurally complex habitat that supports a diversity and abundance of invertebrates, fish, and mammals. Invertebrates and fish differentially utilize the holdfast (attaches kelp to substrate), thallus (body of the kelp), and kelp canopy (upper fronds) as shelter. For example, kelp perch (*Brachyistyus frenatus*) will often hide in the kelp fronds or canopy to feed on crustaceans and avoid predation, whereas the holdfast typically shelters crabs, brittle stars, worms and other invertebrates. (Moyle and Cech 2004) Disturbances to kelp beds, including complete or partial removal, can result in reductions in fish abundance and community composition in temperate regions. (O'Connor and Anderson 2010)

Kelp beds also provide habitat for rare and endangered species including white abalone, black abalone, giant black sea bass, and the Southern sea otter. The Southern sea otter and fish such as the California sheephead (*Semicossyphus pulcher*) are critical to the health of the kelp beds because they feed on purple urchins (*Stronglyocentrotus purpuratus*) that graze on the holdfasts of kelp. In the absence of predation by species like the California sheephead, urchin populations can increase to the point where they can graze an entire kelp bed to the point of creating urchin barrens, or areas where there are numerous urchins but no kelp. (Tegner et al. 1995)

In addition to the ecological function of kelp beds, aggregations of kelp have been shown to reduce wave energy, trap sediment, and reduce coastal erosion. The kelp canopy is also valuable from an economic standpoint because it can be harvested for algin or direct human consumption. Algin is an emulsifying and thickening agent that is used in a wide range of products including: cosmetics, shampoo, food additives (e.g. in ice cream, jelly, and salad dressing), medicine tablets, toothpaste, dental molds, paint, and textile dyes. (Bedolfe 2012; Reish 1995)

7.1.2 Surfgrass and Eelgrass Beds

Surfgrass and eelgrass beds are home to a diverse invertebrate ecosystem and provide habitat for larval and juvenile fish and crustacean species, as well as octopuses. Eelgrass and surfgrass beds provide foraging habitat and shelter from predation for many species including, California spiny lobster, halibut, and rockfish and other commercially and recreationally valuable fish. (Jones et al. 2013) The size and quality of a seagrass bed has been linked to species abundance, species density, individual growth, and mortality. (Gorman et al. 2009) Seagrass beds are critical near shore habitats for a variety of species because the beds serve as nursery grounds for many invertebrates and fishes. (Larkum et al. 2006) Additionally, the sea grasses are highly productive and may reduce greenhouse gasses (GHGs) by serving as a carbon dioxide (CO_2) sink. (NOAA 2011)

7.1.3 Rocky Reef Habitat

Rocky reefs sustain high levels of biodiversity because of the high level of habitat complexity. Rocky reef habitats support kelp beds and provide protection for an abundance and diversity of other algae, invertebrate species (e.g. clams, crustaceans), fish, and other organisms. Rocky reefs also serve as rearing grounds for many species including larval and juvenile fish (Allen and Horn 2006) and support a number of commercially valuable species including: abalone, sea urchin, spiny lobster, California halibut, Pacific mackerel, rockfish, and several species of crab. Protecting and maintaining these sensitive rocky habitats promotes continued biological productivity of the species that rely on the habitat.

Rocky reef habitats are economically important in California because the biodiversity at the reefs attracts recreational fishermen, divers, and snorkelers. These recreational activities are an important revenue generator for many coastal communities as millions of people participate in these activities each year. (Pendleton and Rooke 2010) Beyond the aesthetic and recreational value of rocky reef habitats, organisms found in these habitats can be beneficial to humans in other ways. For example, recent studies discovered proteins found in the blood of keyhole limpets, a rocky reef inhabitant, have been used to treat certain types of bladder cancer. (Aarntzen et al. 2012)

7.1.4 Shellfish Beds

Shellfish of many varieties are abundant along the coast of California. Oysters, mussels, clams, abalone and scallops are popular types of shellfish eaten by many Californians. During spawning events, bivalves release eggs and sperm into the water column. Spawning events can be triggered by a variety of environmental conditions. (Helm et al. 2004) These zygotes (fertilized eggs) develop into larvae and eventually settle on a suitable substrate. Mussels generally settle on hard rocky surfaces and secrete long byssal threads for attachment. (Wilker 2010) Mussels are a food source for marine animals and have historically served as a food source to coastal communities. They also provide shelter for smaller organisms in rocky intertidal zones. (Singh et al. 2013) For the past several decades, however, natural mussel beds have been in decline and the direct causes are not yet understood. (California Department of Fish and Game 2010)

Demand for these bivalves as a food source in California has led to studies evaluating the necessary conditions and habitat for oyster growth. Much of the research has been driven by the mariculture industry (ocean farming) which raises oysters, and other types of marine animals, for human consumption. There are five species of oyster that currently grow in California, although *Ostrea lurida* is the only native species. (Status of the Fisheries Report 2008) Generally, oysters live in more brackish environments than mussels, such as estuaries, but can tolerate a wide range of saline conditions compared to other shellfish. (Status of the Fisheries Report 2008) They live on soft mud or fine grain sandy bottoms and interestingly, temperature has been found to be an important determinate for oyster reproduction and feeding. (Barrett 1963) Natural oyster beds have been steadily declining for decades, most likely because of their sensitivity to pollutants and other changed to natural environmental conditions. (Barrett 1963)

7.1.5 Soft-bottom Habitats, Wetlands, Estuaries, and Nursery Grounds

Soft-bottom habitats are the most extensive benthic habitats of the continental shelf and slope in California. Soft bottom habitats often contain an abundance of infaunal invertebrates like clams, snails, and worms that burrow into the benthic sediment. The fish that inhabit the soft bottom habitats typically have flat bodies (e.g. flatfish, skates, rays) or may also bury themselves or burrow in benthic sediments. Some non-flat bodied fish species like sculpins, rockfishes, and surfperches can also be found in soft-bottom habitats. Soft-bottom fish typically feed on pelagic and benthic invertebrates and other soft-bottom fish species. In addition to the ecological importance of soft-bottom habitats, the resident fish species are important to commercial and recreational fisheries. (Allen and Horn 2006)

Inland waterways provide habitat for various marine species, as well as freshwater and nutrient inputs to estuaries and the ocean. Bays and estuaries contain emergent coastal wetlands, mudflats, and seagrass meadows, which are subject to tidal fluctuations and changing salinity conditions. Enclosed bays and estuaries support an extensive food chain and provide refuge, spawning, and rearing habitat for many marine species, including commercially valuable California halibut, white seabass, herring, and various salmonids. Clams, oysters, staghorn sculpin, starry flounder, leopard shark, and California skate are found in mudflats. Many common coastal birds, such as the long-billed curlew, marbled godwit, black-necked stilt, oyster catcher, and gulls forage and nest in these areas, in addition to endangered and threatened birds like the western snowy plover, Belding's savannah sparrow, California least tern, and light-footed clapper rail. Estuaries and bays are economically, environmentally, and recreationally important areas in California, yet more than 90 percent of the original areas have been degraded or eliminated. (Resources Agency 1995) Habitat degradation and habitat loss are some of the primary factors that influence population declines and species extinction. (Tilman et al. 1994)

Nursery grounds are habitats where juvenile invertebrates or fish are present at higher densities, grow faster, and avoid predation more successfully than in different habitats. (Beck et al. 2003) Productive nursery grounds contribute more total biomass of individuals to adult populations and are critical to sustain adult populations. (Beck et al. 2003) Some species will spawn their young at the nursery grounds, like the Pacific herring that spawn their eggs directly on the seagrass beds (Allen and Horn 2006) and market squid that deposit fertilized egg cases along the ocean floor in sandy, flat bottom habitats. (Zeidberg et al. 2011; Zeidberg et al. 2012;) Other species, such as the California grunion, deposit their young in beach sand where the young will hatch and then move into juvenile habitats. (Allen and Horn 2006) Some of these species serve as an important part of the marine food web. For example, market squid serve as a major food source for species like salmon, swordfish, tuna, and certain sea birds and marine mammals. (Morjohn et al. 1978; Vojkovich 1998; CalCOFI 2013)

Organisms use nursery grounds to forage and avoid predation until they are able to grow and transition into the adult habitats. Species that use nursery grounds have at least some disjunction between the adult and juvenile habitat. (Beck et al. 2003) Species like bay scallops, and killifish do not have nurseries; however, species like northern anchovy and kelp bass do have nursery grounds. (Allen and Horn 2006) Critical nursery habitats for fish and some shellfish species include seagrass beds, wetlands, bays, estuaries, and coastal lagoons. While these highly productive habitats are not exclusively utilized by juvenile organisms, they are habitats where larvae metamorphose, develop into sub-adult stages, and then move to adult habitats. (Beck et al. 2003)

The value of a nursery may be site specific and is dependent on the following factors: larval supply, structural complexity, predation, competition, food availability, water depth, physical and chemical characteristics and water quality, disturbance patterns, tidal flows, spatial pattern (size, shape, fragmentation, connectivity), relative location (to larval supply, other juvenile habitats, or adult habitats). (Beck et al. 2003) These factors should be examined in addition to the nursery characteristics described above when determining whether or not a habitat serves as nursery grounds and the relative value of those nursery grounds. (Beck et al. 2003)

7.1.6 The Need for Special Considerations or Protections of Sensitive Habitats

Marine ecosystems in California support many marine organisms and serve numerous ecological functions. (Beck et al. 2003) Siting a desalination intake in or near these sensitive habitats could have deleterious effects on marine organisms that utilize the habitats, particularly for the planktonic and juvenile life stages. Eggs, larval organisms, and juvenile organisms are at the highest risk of entrainment at surface intakes. Most larval and juvenile organisms are not developed enough to swim and avoid entrainment and may be susceptible to entrainment through even small slot sized or small mesh intake screens.

Additionally, brine discharges from seawater desalination facilities can pose significant risks to sensitive habitats. Many of the organisms live in or on the seafloor in soft-bottom habitats and have the potential to be exposed to non-buoyant, hypoxic brine waste plumes. Studies reported brine discharges from seawater desalination facilities have been associated with reduced growth, reduced biomass, and the disappearance of seagrasses. (Gacia et al. 2007; Latorre 2005; Sanchez-Lizaso et al. 2008; Talavera and Ruiz 2001) Studies have also shown that sea grass communities are sensitive to salinity changes of only 1 to 2 ppt. (Roberts et al. 2012) Special consideration or limitations may be necessary to protect surfgrass beds and eelgrass beds in order to preserve their presence and key ecological functions (e.g. protection for juvenile organisms) in the marine environment. Unlike seagrasses, giant kelp were found to be fairly tolerant of salinity changes in recent salinity toxicity studies. (Phillips et al. 2012) However, special protections or considerations are still needed for kelp beds because the organisms that live within the kelp can be more sensitive to salinity changes (e.g. red abalone). Additionally, larval and juvenile organisms utilize the kelp, and developing organisms are typically more sensitive to salinity changes than adults. (Iso et al. 1994)

7.2 Marine Biodiversity in California and Sensitive Species

California’s diverse habitats support complex ecosystems with high species diversity. These biologically diverse species are extremely valuable from an ecosystem standpoint as well as being a key contributor to California’s economy (discussed further in section 7.2.2). A sample of the algal, invertebrate, and fish diversity is provided in Appendix C,some of which may be sensitive species (see also section 8.5.4). The presence of sensitive species can be used as an indicator of a healthy ecosystem and the absence may be an indicator of environmental changes. The types of sensitive species will vary among biogeographic regions in California and with habitats. Section 12 discusses state and federally listed threatened or endangered species that are also of interest when siting and designing a desalination facility.

One group of species that may require special consideration is abalone. Abalone have historically been overfished in California and there has been inadequate protection of their natural habitat. These factors have led to the collapse of the abalone fishery and near extinction of certain species. (Hobday 2001) White abalone (*Haliotis sorenseni*) and black abalone (*Haliotis cracherodii*) are both federally listed as endangered. Abalone are primarily found in crevices along rocky shorelines that provide both shelter from predators and attached algae as a food source. (Hobday 2001) Black abalone are generally found at shallower depths from zero to six meters (Morris 1980), and white abalone live at depths between 25 to 50 meters. (Lafferty 2004) In 2011, the National Marine Fisheries Service designated coastal areas along the California coast as critical habitat for endangered abalone to protection reproductive habitats.

Abalone are broadcast spawners, meaning they release eggs and sperm into the water column to be fertilized. Abalone larvae float in the water column for 3-10 days and are about 0.2 millimeters in size. (McShane 1992) During this time period, the planktonic larvae are particularly vulnerable to predation. Larvae that avoid predation settle in benthic rocky environments where they grow and mature into adults. Abalone reach sexual maturity after four to seven years at which point they spawn. (Tutschulte and Connell 1988) Abalone face an additional challenge because they are broadcast spawners, and thus the gametes must be within a certain distance of each other for fertilization to occur. In some areas, abalone populations are unsuccessful at reproducing because the adults are too far from each other for the eggs to be fertilized.

In 1995, coho salmon was listed by the California Fish and Game Commission as an endangered species within ocean waters south of San Francisco Bay, In 2002 this listing was expanded to include the northern coast of California to Oregon. Both chinook and steelhead are also state and federally listed as threatened species. In addition to salmon, there are other threatened and endangered species that inhabit coastal areas and waters of California including the tidewater goby, sea turtles (green, loggerhead, olive ridley, and leatherback), and a variety of bird species (e.g. western snowy plover and least tern). (CDFW Biogeographic Data Branch State and Federally Listed Endangered and Threatened Animals of California –January 2013) The presence of these species should be evaluated and considered when siting and designing a desalination facility to avoid negative effects on the sensitive species.

7.2.1 Broadcast Spawners and Larval Recruitment

In addition to threatened and endangered species, there is an abundance of other species of economic or ecologic importance in California. Many marine species are broadcast spawners or live at least part of their life history as plankton (see Appendix C). Broadcast spawning is a reproductive strategy where organisms release large numbers of sperm or eggs (gametes) into the water column where fertilization occurs. Many of the gametes are eaten by other marine organisms, but the zygotes (fertilized eggs) that avoid predation remain in the water column as plankton as they develop into larvae. Dispersal of larvae from spawning grounds occurs via ocean currents and the planktonic stage can be as short as a few days or just over a month depending on the species, meaning larvae can travel many miles away from where they were originally spawned. (Strathmann 1993; Swearer et al. 1999)

During the planktonic larval stage, many species will continue to feed and develop to allow more time to find suitable settling or recruitment habitat. (Strathmann 1985) Some larvae (e.g. mussels or abalone) will settle on hard substrate or benthic environments and develop into adults while other larvae (e.g. many fish species) will remain in the water column or seek protection in kelp beds, estuaries, or eelgrass beds as discussed above. Marine larvae survivorship is typically very low because organisms must avoid predation and obtain enough nutrients until they can find suitable habitat to settle. Even then, many young organisms are susceptible to predation and other causes of natural mortality. (Rago 1984)
Open water intakes and brine discharges have the potential to increase mortality of larval marine organisms. (Steinbeck 2007) As mentioned above, gametes, and larval and juvenile organisms are at the highest risk of entrainment because few have developed sufficiently to swim and avoid entrainment, even when the intake is protected with small slot sized intake or mesh screens. (Tenera 2013a and b) Additionally, studies have shown that species are most sensitive to elevated salinity during developmental life stages and become more tolerant to changes as adults. (Philips et al. 2012; Iso et al. 1994)

7.2.2 Fisheries in California

In 2012, the California Cooperative Oceanic Fisheries Investigations (CalCOFI) estimated 162,290 metric tons of invertebrates and fish were landed by commercial fisheries in California. Even though this is a 12 percent decrease from 2011 landing, the preliminary economic estimates for commercial landings in 2012 is $236.1 million, which is an increase from the almost $198 million generated in 2011. The top five commercially landed species by volume are: market squid, pacific sardine, Dungeness crab, red sea urchin, and pacific mackerel. Dungeness crab and market squid were the first and second highest valued fisheries in 2012 valued at $85.6 million and $68.3 million respectively. (CalCOFI 2013)

Market squid (*Doryteuthis opalescens*) have been the largest fishery by volume in California since 1990. (Zeidberg et al. 2011; Zeidberg et al. 2006, Vojkovich 1998) The fishery targets spawning grounds because market squid are group spawners and the exact area of the spawning grounds may change on an annual basis, but occurs in the same general location. (Young et al. 2011) Spawning aggregations of market squid are predictable enough in California that fishing fleets can target spawning adults in limited geographic areas. (CDFG 2006) Female market squid lay egg capsules that each contains approximately 200 developing embryos and the capsules are attached in clusters or mops to sandy substrate in nearshore waters. (Hixon 1983; Young et al. 2011) The market squid fishery has a high potential of being sustainable if the adults have the opportunity to spawn and the developing embryos survive to adulthood; however, it is critical that their spawning habitat and nurseries are protected.

Squid larvae are highly sensitive to elevated salinity. Brine discharge associated with desalination facilities has the potential to significantly impact the viability and survivorship of squid offspring. (Reeb 2013; Reeb 2011) Data from a preliminary study showed a decrease in percent hatching when salinity reached 45 ppt relative to ambient seawater (34 ppt) and that less than 20 percent of squid larvae hatched when exposed to 50 ppt ($p<0.001$ Holm-Sidak method). (Reeb 2011) A study on the hatching rates of a related species of squid, *Loligo vulgaris*, when incubated in salinities of 32 to 42 g/L (ppt). (Sen 2005) The goal of the study was to identify optimal salinity conditions for rearing the squid. But the study results demonstrated a significant reduction in the total hatching (TH=[number of hatching eggs (premature and swimming paralarvae at nearly the water surface)/number of incubated eggs] x 100), and hatching success (HS=[number of healthy and swimming paralarvae at nearly water surface/number of incubated eggs] x 100) of squid when incubated in 42 ppt water. The total hatching was between 92 and 100 percent for treatments from 32 to 40 ppt, but dropped to only 3 percent when salinity was 42 ppt. Hatching success ranged from 87 to 96.7 percent for treatments between 32 and 38 ppt, but dropped to 65.3 percent when salinity was 40 ppt. Hatching success dropped to zero percent for squid incubated in 42 ppt. (Sen 2005)

In addition to salinity sensitivity, squid larvae have a high probability of entrainment through screened surface intakes due to their small size. Consequently, squid nurseries should be protected from unnecessary environmental disturbances to ensure the sustainability of the market squid fishery. Other key fisheries in California include northern anchovy, jack mackerel, pacific herring, white seabass, pacific halibut, sea cucumbers, and bottom-dwelling marine finfish or ground fish. There are more than 90 federally managed species in the ground-fish fishery. They include all rockfishes, flatfishes, roundfishes (e.g. lingcod), and sharks and skates. (CalCOFI 2013)

Rockfish diversity in California is incredibly high; over 55 species from the genus *Sebastes* can be found along the coast. (Love et al. 1990) Rockfish are long-lived and some species can live over 70 years. (Boehlert and Yolavich 1984) Consequently, rockfish can take many years to reach sexual maturity (in some cases 25-30 years). Love et al. (1990) reported that recruitment for rockfish species is very low in part because adult fish are being caught before they have the opportunity to spawn. CDFW has limited harvest limits for yelloweye and canary rockfishes because they have been overfished. CDFW issued the Nearshore Fishery Management Plan that uses the Marine Life Management Act as a framework to set forth a plan for maintaining sustainable fisheries. The plan suggests a whole ecosystem approach is necessary to successfully manage the nearshore rocky reef habitats. Similar protections of economically valuable species may be needed when considering siting and design options for desalination facility intakes and discharges.

8 ISSUES CONSIDERED IN THE DEVELOPMENT OF THE DESALINATION AMENDMENT

8.1 What types of facilities should the Amendment cover?

There are numerous types of facilities in California that withdraw ocean water for industrial uses. Industrial facilities, such as oil and gas refineries, iron and steel manufacturers, pulp and paper mills, OTC facilities, and desalination facilities all use ocean water for various processes. Oil and gas refineries, pulp and paper mills, iron and steel manufacturers, and OTC facilities are well established in California and the number of these industrial facilities is not expected to increase dramatically in coming years. However, the number of desalination facilities in California is expected to more than double in the near future.

Desalination is becoming an important water supply alternative for areas where water sources are limited. There are currently 10 small, intermittently operated desalination facilities located along the California coastline, with as many as 15 desalination plants proposed for development (See Tables and Figures 2-1 and 2-1). One large desalination facility is currently under construction in Carlsbad, with more underway soon. In addition to permanent desalination facilities, there are also portable desalination units that are used for training military personnel in California for tactical deployment overseas or for research purposes to advance desalination technology. Government-operated portable desalination units can also be used to provide water during natural disaster events and other emergencies. These portable units have relatively low production capacities (up to 0.05 MGD), are used infrequently and/or intermittently, and have relatively insignificant environmental impacts compared to large permanent facilities with surface intakes.

The following issue addresses:

- The scope of the proposed Amendment. Should the Amendment apply broadly to all industrial facilities or only to desalination facilities?

8.1.1 Regulatory Considerations

In California, seawater discharges and intakes are regulated under different authorities. U.S. EPA has granted authority to the Water Boards to administer the NPDES permitting program within the state of California (the state statutory authority is found in chapter 5.5, division 2 of the Water Code). An NPDES permit authorizes point source discharges of pollutants to navigable waters, consistent with requirements that ensure compliance with all applicable provisions of the CWA, together with any more stringent limitations necessary to implement water quality control plans (§ 13377). Additional requirements may be required under state law, as long as the requirements are as stringent as those required by federal laws and regulations. The statute does not differentiate among new, expanded, or existing industrial facilities. The regional water boards issue NPDES permits for brine discharges into ocean waters.

The Water Boards' authority to prescribe discharge requirements extends to all federally owned and operated facilities discharging into waters of the State. Federally owned and operated facilities are subject to state laws and requirements governing discharges pursuant to state law authority to control and abate water pollution. (§ 13260 et seq.) However, the Water Boards' authority to regulate intakes at federally owned or operated facilities in California is limited to the extent that the CWA waiver of sovereign immunity covers only those requirements regarding control and abatement of water pollution (See, 33 U.S.C. § 1323).

For non-federally owned and operated facilities, the intakes are regulated based on the type of facility. The OTC Policy was developed pursuant to CWA section 316(b) in order to address impacts from facilities within California that intake seawater for the purposes of cooling. However, by its terms, this statute does not apply to industrial facilities that use seawater for purposes other than cooling (e.g. desalination facilities). The Water Boards are currently authorized to make determinations regarding factors set forth in section 13142.5(b) for new or expanded industrial facilities that are proposing to use seawater for heating, cooling, or industrial use. 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."*

Section 13142.5(b) applies to new or expanded industrial installations like oil and gas refineries, iron and steel manufacturers, pulp and paper mills, and desalination facilities. Each of these facilities withdraws seawater and uses it for industrial purposes or processing. Currently, the regional water boards will make a 13142.5(b) determination for these types of industrial facilities on a case-by-case basis, which has resulted in regulatory inconsistencies among projects and regions.

During the 2011-2013 Triennial Review of the Ocean Plan, the State Water Board identified a need to address desalination facilities and brine discharges in a statewide plan. As desalination expands in California, the number of studies that have examined the environmental impacts of desalination facilities have increased. Some of the desalination activities result in impaired water quality and negative effects to aquatic beneficial uses. (Foster et al. 2012 and 2013; Cooley and Donnelly 2012; Ruso et al. 2007; Dupavillion and Gillanders 2009) The environmental impacts resulting from the intakes and discharges associated with iron and steel processing plants, paper mills, and oil and gas refineries are not well characterized. Additionally, the 2011-2013 Triennial Review of the Ocean Plan did not identify the need to address intakes at industrial facilities other than desalination facilities. (SWRCB 2011)

8.1.2 Options

- **Option 1:** **No action. Do not amend the Ocean Plan to address any of these types of industrial facilities.** The regional water boards will continue to make 13142.5(b) determinations for industrial facilities on a case-by-case basis. Under Option 1, the State Water Board would not adopt regulatory provisions to direct how the regional water boards make determinations about the factors set forth in the statute on any of the types of facilities that may be covered by the statute. Each regional water board would continue to make section 13142.5(b) determinations on a case by case basis and regulate discharges under their existing NPDES authorities. Option 1 may result in continued inconsistencies among regions and projects and would not meet any of the project goals (section 4.3).

- **Option 2: Amend the Ocean Plan to address all industrial facilities using seawater for cooling, heating, or industrial processing.** Under Option 2, the State Water Board would amend the Ocean Plan to address seawater intakes for all new and expanded industrial facilities that are not covered under the OTC Policy. Additionally, the State Water Board would add provisions to the Ocean Plan to address brine discharges from all industrial facilities. The regional water boards would implement the provisions through an NPDES permit using their authority pursuant to section 13260 et seq.

  Option 2 would result in clear and consistent application of the Amendment among all regions and facilities. However, there is not enough information about the types of impacts from all industrial facilities using seawater for cooling, heating, or industrial processing. There is a risk that the Amendment provisions would be inappropriately applied to non-desalination facilities in a way that could lead to unintended consequences for facility operations or ineffective regulatory controls. The Amendment may restrict specific needs or prohibit necessary steps in a facility’s process. Given the currently available information, it would not be appropriate to broadly apply the Amendment to all facilities using seawater for cooling, heating, or industrial processing. The Ocean Plan may be amended at a future point in time when there is sufficient information to address impacts from specific industrial facilities.

- **Option 3: Amend the Ocean Plan to address desalination facilities.** The State Water Board would amend the Ocean Plan to address seawater intakes from new or expanded desalination facilities and discharges from all desalination facilities. The Amendment will provide direction on assessments to be made when evaluating the best available site, design, technology, and mitigation measures feasible, consistent with section 13142.5(b). Additional requirements will apply to minimizing marine life mortality resulting from discharges.

  Option 3 limits the scope of the Amendment so that they would apply only to desalination facilities, since there is insufficient information available for other industrial facilities to include them in a statewide plan at this time. The Amendment will not apply to intakes at federally owned or operated desalination facilities because the CWA waiver of sovereign immunity does not extend beyond requirements for the control and abatement of water pollution (33 U.S.C. §1323). Therefore, federally owned or operated desalination facilities withdrawing seawater will not require section 13142.5(b) determinations, although the regional water boards will continue to permit federal facilities for their discharges. Option 3 will provide exceptions for small, portable desalination facilities because the portable facilities have different logistical and operational constraints (e.g. infeasibility of digging a subsurface intake for a temporary portable unit), are used infrequently or intermittently, and are not thought to pose a significant threat to water quality relative to permanent desalination facilities.

8.1.3 Staff Recommendation:

Staff recommends Option 3. The scope of the Amendment, hereafter referred to as the Desalination Amendment, will cover desalination facilities and would provide section-specific exceptions for federally owned or operated facilities and small, portable desalination facilities. Adding guidance for making section 13142.5(b) determinations will promote consistency among regions and projects. Option 3 meets all of the project goals identified in section 4.3.

8.1.4 Amendment Section:

See chapter III.M.1 of Appendix A.

8.2 Should the Desalination Amendment include definitions for new, expanded and existing facilities?

As mentioned in issue 8.1, the Water Boards regulate intakes for desalination facilities using their authority under section 13142.5(b). Currently, the regional water boards make section 13142.5(b) determinations on a case-by-case basis for new and expanded facilities, but the statute does not include authority over existing seawater intakes. The statute does not define “new,” “expanded,” or “existing,” nor does the legislative history provide any additional context for defining these terms. The OTC Policy defines a “new power plant” as a “new facility” as defined in 40 C.F.R. section 125.83, which is the definition used in US EPA’s Phase I regulations implementing CWA section 316(b). The OTC Policy defines “existing power plant(s)” as any power plant that is not a “new power plant.” However, the OTC Policy definitions of new and existing are not suited for the Desalination Amendment. Since there are no definitions for “new,” “expanded,” or “existing,” facilities in the statute, the Ocean Plan, or the legislative history, the exclusion of definitions for the terms in the Desalination Amendment may result in discrepancies among the regional water boards’ applications of these terms.

The following issue addresses:

- Water Board’s authorities over intakes and discharges and how that relates to the applicability of the Desalination Amendment to new, expanded, and existing facilities

8.2.1 Options

- Option 1: **No action. Do not add definitions for new, expanded, and existing desalination facilities.** Instead, the regional water boards would continue to use their discretion as to whether a facility was new, expanded, or existing. Option 1 may result in inconsistencies among regions and projects and would not meet any of the project goals (section 4.3).

- Option 2: **Amend the Ocean Plan to include definitions for new, expanded, and existing desalination facilities.** The State Water Board would amend the Ocean Plan to include definitions for new, expanded, and existing desalination facilities in order to clarify which facilities are subject to a section 13142.5(b) determination. The addition of these definitions in the Ocean Plan will be applied only in chapter III.M of the Ocean Plan in order to avoid interfering with the intent and meaning in other sections.

8.2.2 Staff Recommendation:

Staff recommends Option 2. Add definitions for new, expanded, and existing desalination facilities to the Desalination Amendment to promote consistency among regions and projects. Option 2 meets project goals one and two identified in section 4.3.

8.2.3 Amendment Section:

See chapter III.M.1 of Appendix A.

8.3 Should the State Water Board identify a preferred method of seawater intake?

In 2005, coastal facilities in California withdrew approximately 12.5 billion gallons of seawater per day. More than 95 percent of that water was used for power plant cooling purposes, with the remainder used by other industrial sources such as desalination facilities. (Kenny et al. 2009) The State Water Board adopted the OTC Policy on May 4, 2010 (SWRCB 2013) to address impingement and entrainment impacts that occur during surface water intake operations of coastal power plants that withdraw marine and estuarine water for cooling purposes. The OTC Policy establishes a technology-based standard for power plants, allows for reduced impingement, and requires a 93 percent reduction of the intake flow rate. Although the OTC Policy does not apply to desalination facilities, the examples and findings in the OTC Policy are relevant in creating provisions for desalination intakes. Even though the volume of water withdrawn from desalination facilities is typically significantly lower than the water withdrawn by OTC facilities, the amount of seawater used for desalination will increase as the number of operating desalination facilities grows. The type and design of the intake structures used at desalination facilities could significantly impact aquatic life beneficial uses and the intake and mortality of all forms of marine life.

The following issue addresses:

- Intake technology considerations for minimizing intake and mortality of all forms of marine life
- Surface vs. subsurface seawater intakes

8.3.1 Surface Intakes

Surface water intakes draw from waters above the seafloor. Onshore surface water intake structures withdraw water from a bay, canal, or beach. Offshore surface water intake structures typically have submerged intake pipes or tunnels for withdrawal of seawater using a shoreline pump, and are sufficiently deep to avoid wave disturbances and surface ship traffic. There are instances that occur where surface intakes have to be temporarily shut down because animals (e.g. sea jelly swarms) or other debris clog the intake and prevent source water from entering the facility. Normally, source water for desalination facilities is easily accessible through surface water intakes.

Source water withdrawn through a surface water intake requires pretreatment to remove suspended solids and biological material that can otherwise clog or reduce the efficiency of the RO membranes. RO membranes can scale and corrode if minerals precipitate from the source water. For this reason, many desalination facilities acidify source water or add chemical antiscalants to prevent scaling and corrosion. Following a media filtration, chemicals are also added to enhance the coagulation of suspended solids in order to easily remove the sediment from the source water. Pretreatment increases costs and energy requirements, and is an additional step that is often not necessary when using subsurface intakes. The natural filtration process of a subsurface intake significantly reduces or eliminates the need for pretreatment requirements. (National Research Council 2008; SDCWA 2009))

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. The higher quality of feed water with a subsurface intake reduces capital costs for construction of pretreatment processes. (SDCWA 2009) Operational costs include screen operation/maintenance, disposal of solid waste, chemical usage, and electrical and maintenance pretreatment costs. (Missimer et al. 2013)

8.3.1.1 Effects of surface water intakes on the intake and mortality of marine life

8.3.1.1.1 Construction-related mortality

Construction-related intake and mortality of all forms of marine life is relatively limited, and can be minimized if construction occurs away from sensitive habitats and areas of high habitat productivity. The duration of construction will vary from project to project based on the design and configuration of the surface intake. Some facilities may use existing infrastructure or modify existing infrastructure to eliminate or reduce construction impacts. Numerous factors can be taken into consideration to assist in avoiding construction related impacts and are further explained in sections 12.1, 12.2, and 12.3. Potential environmental effects and related technologies to help avoid the intake and mortality of marine life during construction of intakes are described in greater detail in the sections below. For a detailed discussion of these issues and the determination of impacts under CEQA, please see section 12 of this staff report.

8.3.1.1.2 Operational impacts

Operation of surface water intakes can result in significant intake and mortality of all forms of marine life. Consequently, intakes should be sited and designed to avoid sensitive habitats and species. In addition to construction-related mortality, intake and mortality of marine life occurs through two primary mechanisms. Organisms may become trapped against surface water intake screens by the suction power of the surface water intakes, referred to as impingement. Smaller organisms in the water column such as algae, plankton, fish larvae, and eggs, that pass through surface water intake screens are drawn into the facility and will perish when exposed to the high pressure and heat of a cooling water or desalination system. This process is referred to as entrainment.

Overall, impingement and entrainment result in the loss of biological productivity. Impingement typically involves the loss of adult aquatic organisms, which reduces the reproductive population of an affected species. Entrainment of eggs and larvae will reduce the recruitment of juveniles to parent populations, and reduces available food for fish and wildlife dependent on the aquatic organisms lost to impingement and entrainment. The severity of the impacts of impingement and entrainment on the sustainability of a specific species and health of an ecosystem depends on a number of factors that are difficult to quantify such as reproduction rates, natural mortality rates, and the percentage and ages of affected populations. Recreational and commercial fishing may also be affected if breeding stocks of economically valuable fishes and invertebrates drop below sustainable rates.

Although there are few studies of the biological effects of desalination facility surface intakes, there are extensive studies at OTC power plant facilities that investigated the biological impacts of their source water intakes. Mortality entrained organisms is generally assumed to be 100 percent in the absence of site-specific studies. (U.S. EPA 2004a; Pankratz 2004) During 2000 to 2005, power plants in California annually entrained on average 19.4 billion fish larvae with estimated intakes of 78-2,670 MGD. (SWRCB 2010) No direct estimates exist for the amount of invertebrate larvae, zooplankton, or phytoplankton entrained within this same period, although the numbers are likely orders of magnitude larger based on the relative abundance of plankton in seawater compared to fish larvae. During the same time period, approximately 2.7 million fish (84,250 pounds) annually were impinged at power plants, along with a number of marine mammals and sea turtles. (SWRCB 2010)

8.3.1.2 Approaches to Reduce Impingement and Entrainment at Surface Water Intakes

There are numerous technologies that can help reduce or avoid impingement and entrainment of marine life, including intake structure design, configuration of screening systems, passive intake systems, and fish diversion and avoidance technologies. (U.S. EPA 1976; U.S. EPA 2004b) The following are approaches that facilities use to avoid impingement and entrainment.

8.3.1.2.1 Reducing Intake Flow Volume

Desalination facilities using RO typically withdraw seawater to serve as source water, backwash water for the pretreatment system, and to dilute brine wastes and other effluent generated during the process. (WateReuse 2011) Decreasing the volume of seawater required for any of these three purposes will reduce the volume of water withdrawn through a surface intake, and will consequently reduce impingement and entrainment.

A desalination facility can lower the volume of source water needed by increasing the recovery rate of the desalination process. The recovery rate is the amount of product water a facility generates over the amount of water it takes in. Designing a facility to operate at a higher recovery rate will reduce pretreatment costs because there is less source water that needs to undergo pretreated; although, energy demands may be increased to support the additional production efficiency. An additional four to ten percent of the total intake for RO systems is used to backwash the pretreatment filtration systems. The amount of water required for backwashing filters can be significantly reduced by treating and reusing the backwash water. While treating backwash water adds costs to the overall desalination process, the procedure reduces the intake volume and associated impingement and entrainment. (WateReuse 2011a)

Withdrawing additional seawater through surface intakes for the purpose of diluting brine effluent to meet water quality standards (referred to as “flow augmentation”) can significantly increase entrainment and impingement. Additional mortality may occur through brine exposure in the mixing process and through predation in conveyance pipes. The alternative to flow augmentation for reducing impingement and entrainment impacts is to discharge the brine concentrate through high-velocity multiport diffusers, or by mixing the brine with effluent, such as from power plants or WWTPs, prior to discharge to the ocean. These discharge methods are further discussed in subsequent sections below.

8.3.1.2.2 Reducing Through-Screen Intake Flow Velocity

The velocity at which seawater is withdrawn through an intake has a significant influence on the potential for impingement because a higher intake velocity results in greater net force towards the intake. Impingement occurs when an intake velocity is sufficiently high that fish or other organisms cannot swim away and are trapped against intake screens. A maximum intake velocity of 0.5 feet per second (ft/s; 0.15 meters per second) has been shown to protect most small fish (U.S. EPA 1973) and is an appropriate value to preclude most impingement of fish large enough to be unable to pass through the screen. (EPRI 2000) U.S. EPA CWA section 316(b) Phase I Rule is based on the determination, for new facilities, that the best technology available performance standard is achieved by reduced flows equivalent to that of a closed-cycle wet cooling system. To reduce impingement impacts, the Phase I Rule also requires that intake structures be designed to limit intake flow velocity to a maximum of 0.5 ft/s (0.15 m/s). (U.S. EPA 1973) The State Water Board’s OTC Policy also requires that through-screen velocities must be limited to 0.5 ft/s (0.15 m/s) or less for existing power plant seawater or estuarine water intakes in order to reduce impingement mortality.

8.3.1.2.3 Installing Intake Screens

Surface water intake structures can be screened to preclude as much debris, seaweed, fish, and other organisms as possible from entering the plant. Passive intake screens can be placed in areas of high local currents and wave-induced water motion to transport marine debris and organisms off and away from the screens. (Kennedy/Jenks Consultants, 2011) Active (self-cleaning) intake screens can be installed in areas with high or low local currents because the actively sweep debris and fouling organisms off the screen rather than relying on currents. Studies suggest that the type of screen, size of the screen slot opening, and the method of intake are all factors that influence reductions of marine life mortality.

Intake screens can be designed in a range of screen slot opening sizes. Studies described in sections below show that the smaller the slot opening, the more protective it is in reducing entrainment. (EPRI 2005; Weisberg et al. 1987; Tenera Environmental 2013b) There will be variable energy, operation, and maintenance requirements for screens with different slot opening sizes even if the screen type (wedgewire vs. fine mesh), intake capacity, and intake flow rate are constant. Screens with smaller slot or mesh sizes may require more energy to withdraw the same amount of water compared to screens with larger slot openings if the screen is not designed to compensate for the additional friction and drag as water moves through smaller screen slot openings. Increasing the screen surface area can reduce the friction and drag. Consequently, screens with smaller openings may need to be dimensionally larger, or a facility may need additional screens to facilitate the withdrawal of source water.

Passive intake screens are not self-cleaning and require manual cleaning either by divers or by retrieving the screen for cleaning and maintenance. Passive screens with smaller slot or mesh sizes in the ocean environment will most likely require more frequent maintenance than screens with larger slot or mesh sizes. Additionally, screens with smaller openings will require more maintenance because there will either be more screen surface area or a greater number of screens to clean. To reduce or eliminate manual cleaning and maintenance requirements, screens can be equipped with manual air burst cleaning systems or brushes to periodically clean the screens. (Intake Screens, Inc. 2014, Alden Labs 2014, Hidrostal 2014) There are also biofouling resistant screen materials, such as copper-nickel alloys, that can be used to prevent biological growth on the screens (Kennedy/Jenks Consultants, 2011); however, screen materials known to be deleterious to marine organisms or water quality should be avoided.

Below is a brief description of different types of screens and their effectiveness in reducing impingement and entrainment impacts.

Coarse bar screens, trash racks, and angled coarse screens. A shoreline surface water intake such as a concrete intake canal is typically equipped with a single row of stationary *coarse bar screens* or through a *trash or bar rack* where the water enters the intake. Coarse screens generally have openings of 0.37 to 5.9 in (9.5 to 150 mm) and approach velocities of up to 2 ft/s (0.6 m/s). (U.S. EPA 2011; EPRI 2005) The initial screens have coarsely-spaced vertical bars and are primarily used to exclude large debris. Floating booms can also be deployed in front of intake screens to keep out large floating debris, large marine animals, and boaters. Trash racks can be installed to capture trash and prevent it from entering the intake. Trash racks may be equipped with trash rakes that facilitate automated cleaning of the rack. (AldenLabs 2014) Fish with weak swimming abilities and compressed body shapes may get stuck between the bars of the coarse bar screens or may be harmed by the trash rack cleaning systems.

Angled coarse screens can be used within an intake to guide fish to a collection point. The marine life can then be returned to their natural environment. (AldenLabs 2014; Taft 2000) The success of angles screens relies heavily on constant hydraulic conditions. The efficiency of diversion varies by species, but is typically high. Survival following exposure to the angled screen also varies by species with more delicate species having survival rates around 70 percent and more robust species having survival rates approaching 100 percent. (Taft 2000) Angled coarse screens are effective at protecting juvenile and adult life stages, but are ineffective at protecting fish eggs, larvae, and small invertebrates. (Taft 2000)

Traveling screens (rotating vertical, modified vertical, inclined). *Traveling screens* are moving screen panels ("trays") mounted onto a moving belt that rotates the screen vertically through the water. Traveling water screens may be simple or sophisticated with coarse screens for removal of large floating debris or with finer screens capable of removing finer suspended materials. (U.S. EPA 2011) *Rotating vertical traveling screens* rotate around an axis, while *inclined traveling screens* utilize standard through-flow traveling screens set at an angle to the incoming flow. Angling the screens may improve fish protection since fish tend to avoid the screen face and will move toward the end of the screen, aided in part by the direction of current flow. (Taft 2000)

Modified vertical traveling screens ("Ristroph" screens) are conventional traveling screens fitted with a collection area for fish beneath the screen panel. Impinged fish are loosened from the screen with a gentle spray and flushed into a recovery trough. From the recovery trough, fish are returned to the source water body. The screen operates continuously to keep impingement time relatively short consequently modified traveling screens have been shown to substantially reduce impingement mortality. (U.S. EPA 2009; U.S. EPA 2011) The Dominion Power's Surry Station uses Ristroph screens with a fish wash and return system. Data from the facility , showed increased fish survival rates following impingement through use of the wash system and that the impinged fish had a 93.8 percent survival rate, although mortality varied by species. (EPRI 1999) Other generating stations (e.g. *Coarse bar screens, floating booms, and angled coarse screens.*) have employed the use of Ristroph screens with similar reports of reductions in fish losses due to impingement. (Taft 2000)

The US EPA and other NPDES permitting agencies have required some power plants to install traveling screens with fine mesh screens to reduce entrainment. US EPA Region IV and the Florida Department of Environmental Regulation required that the Tampa Bay Electric Company's newly constructed once-through cooling system Big Bend Unit 4 utilize traveling screens with a 0.5 mm mesh size, in addition to Unit 3. Each unit had an intake capacity of 540 cubic feet per second (cfs; 349 MGD) once the screens were installed. In some cases, the traveling screens were able to reduce entrainment by more than 80 percent. (Brueggemeyer et al. 1987)

Other studies have investigated the efficacy and use of fine-mesh traveling screens to reduce entrainment in conjunction with the functionality of the screens in terms of plant reliability. (Thompson 2000; Hogarth and Nichols 1981) The US EPA required that the Brunswick Steam Electric Plant in North Carolina install and use 1.0 mm mesh size with a fish return system on two of the four traveling screens in addition to implementing flow-minimization requirements and a 9.5 mm mesh size fish diversion device at the facility. There was an 82 percent decrease in the average density of entrained fish after the requirements were implemented. Hogarth and Nichols (1981) investigated the reliability of fine mesh intakes and reported that the fine mesh traveling screens significantly reduced entrainment without jeopardizing the plant reliability. After the flow minimization requirements were implemented, the intake volumes dropped from 1105 - 1205 cfs (714-778 MGD) intake volume varies seasonally at the plant) to 605 to 915 cfs (390-591 MGD). (Hogarth and Nichols 1981) It is important to note that even after the flow minimization requirements and the use of 1.0 mm mesh size intake screens were implemented, the OTC intakes were able to withdraw between 390 and 591 MGD, volumes which exceed the intake volume for even the largest proposed desalination facility in California.

Fine-meshed screens. Coarse screens are usually used in conjunction with *fine-meshed screens,* which can be either stationary (passive) or moving (rotating). Fine screens typically have mesh sizes of 3.0 mm (.12 inch) or smaller that filter out finer debris and most of the remaining adult and juvenile fish that passed through the coarse screens. (U.S. EPA 2011) Flow velocity through the screen can also be controlled to prevent juvenile fish from being impinged. While fine-meshed screens are primarily effective at reducing entrainment of adult and juvenile fish, they still allow all small phytoplankton and zooplankton, and the majority of eggs, and fish and invertebrate larvae to pass through. Efficacy of fine-meshed screens is highly dependent on species and life stage.

Wedgewire screens. Wedgewire screening technology have been installed and operated effectively at power plants and desalination facilities for decades. (Enercon 2010a) *Cylindrical wedgewire screens* have triangular or wedge shaped wires around a cylinder-shaped intake. The wedge shape helps prevent clogging of the screens because most particles or organisms will continue through the screen rather than being trapped between the wires. (Intake Screens Inc. 2014) The screens can be fine or coarse mesh. Wedgewire screens are passive screening systems that act as a physical barrier to prevent organisms from being entrained. Cylindrical wedgewire screens can reduce impingement and entrainment if the screen slot size is sufficiently small (0.5 to 1.0 mm) to physically block passage of an organism (EPRI 1999) Additionally, hydraulic factors can contribute to the reduction in impingement and entrainment at wedgewire screens. (EPRI 2003; Tomljanovich 1978; Weisburg 1987) The cylindrical shape of the wedgewire screen, combined with a very low through-slot velocity, is also necessary to allow juvenile and adult fish to escape the flow field. A relatively high ambient current cross-flow helps move organisms around and away from the screen. Additionally, high velocity cross-flow provided by ambient currents prevents buildup of debris on the screens. (Taft 2000; Weisberg et al. 1987) When these conditions are present, wedgewire screens are effective at reducing entrainment and impingement. (Taft 2000) In some cases, hydrodynamic forces can prevent impingement entirely by sweeping organisms past the screen, thus preventing contact with the screen. (Enercon 2010b)

Numerous studies have evaluated the effectiveness of wedgewire screens at reducing impingement and entrainment (Heuer and Tomljanovich 1978; Taft 2000; Weisberg et al. 1987; EPRI 2003; EPRI 1999; EPRI 2005) and some of those studies have shown wedgewire screens can significantly reduce entrainment of fish eggs and larvae at intake pipes. (Weisberg et al. 1987; EPRI 2003; EPRI 2005) Entrainment data for facilities using or testing small slot size screens are provided below and a summary table is provided in Appendix D (Table D) of the Staff Report with SED.

In addition to investigating the efficacy of wedgewire screens in reducing entrainment, facilities including West Basin Municipal Water District (WBMWD) tested different metal alloys for the screens and found that some of the screens dissolved over time when submersed in seawater. (Tenera Environmental 2013b) Marine life fouling on the screens is another issue with using wedgewire screens. Screen slot size, composition, design, and environmental setting are all factors that influence the rate and severity of biofouling. Taft (2000) reported concerns with biogrowth and the potential for clogging of screens with slot sizes as small as 0.5 mm. The fouling organisms may impede the structural integrity of the screens or prevent adequate intake flow.

McGroddy et al. (1981) measured the effects of biofouling and debris clogging hydraulic performance in order to determine cleaning frequencies that would be required if the screens were used at the Redondo Beach Generating Station. Debris clogging can occur in a relatively short timeframe whereas biofouling can take weeks to months before there is substantial mass to clog the screens. The cleaning frequency estimates were dependent on environmental conditions and varied from a few hours to a few weeks. To maintain intake flows, the screens had to be less than 50 percent clogged and the study noted frequent air bursts helped maintain flow. (McGroddy 1981)

McGroddy et al. (1981) also compared biofouling on 0.7 mm to 2.0 mm mesh size carbon steel, epoxy-coated steel, copper, and stainless steel screening materials. The study also investigated the effectiveness of applying heat treatments to the screen samples. The heat treatments were effective at eliminating the attached organisms and the study reported that the stainless steel screening material was the least susceptible to biofouling. However, the study compared stainless steel screens with larger mesh openings to other screening materials with smaller slot openings, so the study should be repeated with alloys with the same slot openings. (McGroddy et al. 1981)

Another study reported Z-alloy screens were the most effective at preventing corrosion or fouling in a one-year study. (Tenera Environmental 2013b) Whereas a study by Wiersema et al. found that stainless steel screens clogged quickly but copper alloy screens remained at least 50 percent un-clogged throughout the experiment. (Wiersema et al. 1979) A SCWD2 pilot-scale cylindrical wedgewire study also investigated biofouling potential of various screen materials. The results from their studies can be found here: http://www.scwd2desal.org/documents/Draft_EIR/Appendices/AppendixG.pdf. Emerging data from WBMWD reported no significant biofouling or reduction in performance capacity for screens with 1.0 mm slot sizes that had been deployed in waters off Redondo Beach, CA for 18 months. (WBMWD Comments at August 6, 2014 Public Workshop and August 19, 2014 Public Hearing).

The screen composition is a factor that should be investigated in the design process of a facility. It is imperative that the wedgewire screens are maintained so slot-size integrity is maintained, through-screen velocity does not exceed 0.5 ft/s (0.15 m/s), and the facility still has adequate intake flow. The 0.5 ft/s intake velocity standard is consistent with the CWA 316(b) rule, which further requires the assumption that the screen is under a 15 percent blocked condition. Consequently, an owner or operator would target a through-screen velocity of 0.43 ft/s to meet the 316 (b) requirements. This requirement helps to ensure that even if the screen is partially blocked or clogged, that the intake velocity is maintained at a safe rate in order to prevent impingement and reduce entrainment.

Importance of Screen Slot or Mesh Size. Both fine-mesh and wedgewire screens can be effective in reducing entrainment, and when combined with suitable velocity controls, can also reduce or eliminate impingement. However, the effectiveness of fine-mesh and wedgewire screens in reducing entrainment is largely a function of the size of the screen slot opening.

A 0.5 mm slot-sized and fine mesh screen has been shown to protect some larvae and eggs. Several examples are described below:

The 25 MGD Tampa Bay seawater desalination plant is co-located with the Big Bend Power Plant and uses the power plant's ocean-derived cooling water as the desalination source water. The Big Bend Power Plant withdraws 1.4 billion gallons per day through four intake units (approximately 350 MGD each). The intake pipe for the power plant's Units 3 and 4 is equipped with a 0.5 mm fine mesh screen that is used seasonally from March 15 to October 15. (AldenLabs 2014) The 0.5 mm traveling water screens used in conjunction with a fish return system reduced impingement and entrainment of fish eggs and larvae by over 80 percent. (AldenLabs 2014; WateReuse 2011a; U.S. EPA 2011)

- 0.5 mm fine mesh screens successfully reduced impingement mortality at the Barney Davis Seawater Cooling Station in Corpus Christi. No data is available for entrainment avoidance of 0.5 mm screens at this intake location. (Tetra Tech Inc. 2002) [Note that another source reports the power plant initially installed 0.7 mm screens that were replaced with 1.0 by 1.2 mm screens to improve intake capacity. (Poseidon Comment 15.69)

- According to Roberto Pagano in "Recent Developments in Techniques to Protect Aquatic Organisms at the Intakes Steam-Electric Power Plants," 0.5 mm sized screens have been used on traveling screen and single-entry, double exit screens. These systems are successful if the facilities apply safe return of impinged organisms. (U.S. EPA 2011) Additional studies have investigated entrainment reduction using 0.5 mm and 1.0 mm mesh size traveling screens and reported that entrainment was significantly reduced without jeopardizing the plant reliability. (Brueggemeyer et al. 1987; Hogarth and Nichols 1981; Thompson 2000; also see the section on traveling screens in section 8.3.1.2.3)

- The Tennessee Valley Authority conducted laboratory studies showed reductions in hatchery-reared striped bass larvae entrainment of up to 99 percent using 0.5 mm screens. A test at the John Sevier Power Plant showed that 0.5 mm intake screens reduced entrainment levels by more than half when compared to entrainment impacts of using 1.0 mm and 2.0 mm screens. (Tennessee Valley Authority 1976)

- 0.5 mm fine mesh screens were tested and used for limited periods of time on two of the four intakes at the Brunswick seawater cooling Power Plant in North Carolina. There was an 84 percent reduction in entrainment compared to conventional (9.5 mm screens). (Tetra Tech Inc. 2002) Similar results were shown at pilot studies at the Chalk Point Generating Station in Maryland, which also uses seawater for cooling, and the Kintigh Generating Station in New Jersey. (Tetra Tech Inc. 2002)

- An evaluation of cylindrical wedgewire screens at Beal Lake, Arizona looked at the efficacy of 0.5 mm screens for eggs and larvae of three size classes of fish (small, medium, and large). The screens did not significantly reduce entrainment of the small fish eggs or larvae (0.5 mm and 4.2 mm respectively). The 0.5 mm slot size screens did reduce entrainment of eggs (1.0 to 3.8 mm) and larvae (8.5 to 12.1 mm) for medium and large fish by 100 percent. (Bureau of Reclamation 2007)

The effectiveness of both fine-mesh screens and wedgewire screens in reducing entrainment is a function of the screen slot size. Entrainment decreases as the screen slot size decreases and the size of the fish increases. (EPRI 2005; Weisberg et al. 1987; Tenera Environmental 2013b) However, the potential for entrainment of fish larvae is largely dependent on their head capsule dimensions. (Tenera Environmental 2013b) Laterally compressed fish like anchovies and flatfish typically will have higher entrainment rates than fish like sculpins or rockfishes of the same length because the anchovies and flatfish have smaller head capsule dimensions. Mesh screen slot sizes of 0.5 mm to 1.0 mm are required for effective screening for many species at early life stages. Many fish mesh screen installations have been evaluated for effectiveness and have proven to be reliable in operation:

- An entrainment study on 1, 2, and 3 mm slot-size wedgewire screens at an electrical generating station in Maryland showed that anchovy and goby larvae less than 5 mm long were entrained regardless of the screen slot size. However, the 1 mm screen excluded more than 90 percent of ichthyoplankton 10 mm or larger when entrainment was compared to an open intake. (Weisberg et al. 1987) Another study performed at AldenLabs demonstrated that almost 100 percent of larvae over 10 mm were excluded from entrainment by a 1 mm wedgewire screen (AldenLabs 2014; EPRI 2003), whereas the 1 mm screen only prevented 53 percent of 5 to 10 mm ichthyoplankton from being entrained. (Weisberg et al. 1987)

- A study on wedgewire screens at Logan Generating Station in New Jersey reported a 90 percent decrease in fish larvae and egg entrainment through installation of a 1 mm wedgewire screen relative to conventional screens (9.5 mm). (EPRI 1999) A Laboratory study by Hanson (1979) reported screens with 1 mm slot size reduced entrainment of larvae with large head capsules, but did not reduce entrainment of eggs smaller than 2.3 mm in diameter. (EPRI 2005)

- Lifton (1979) evaluated entrainment and impingement for 1 mm and 2 mm wedgewire screens on intakes at the Seminole Generating Station in Florida. The study showed there was virtually no impingement of organisms after screens were installed, and that larvae entrainment was reduced by 66 and 62 percent for the 1 mm and 2 mm screens, respectively, when compared to larger (9.5 mm) screen systems. The densities of the fish entrained were not statistically different for the 1 mm and 2 mm screens. (Lifton 1979; EPRI 1999)

- A study in Narragansett Bay, Rhode Island (estuarine site), and Lake Erie, Ohio (freshwater site) measured entrainment of fish eggs and larvae through 0.5 and 1.0 mm wedgewire screens, both operating at through-slot velocities of 0.15 and 0.30 m/s. The 0.5 mm screen significantly reduced entrainment for all larval species and length classes by over 72 percent relative to open intakes at the estuarine site. The study also reported a 50 percent reduction in shad larvae entrainment using a 0.5 mm screen at the freshwater site, although entrainment was not significantly reduced with the 1.0 mm screen. There was a greater than 92 percent reduction in egg entrainment with a 0.5 mm screen, but the effects of a 1.0 mm screen on egg entrainment were not distinguishable from egg entrainment at an unscreened intake. Egg entrainment was unaffected by intake velocity, but larval entrainment significantly decreased as through-slot velocity decreased. (EPRI 2005)

- Per Hanson in, “A Practical Intake Screen Which Substantially Reduces the Entrainment and Impingement of Early Life Stages of Fish,” entrainment of 1.8 mm to 3.2 mm sized striped bass fish eggs could be eliminated with 0.5 mm screen slot openings. However, striped bass larvae measuring 5.2 to 9.2 mm were entrained through a 1 mm slot sized screen. Yellow perch less than 8 mm long were not excluded by a 1 mm screen, but exclusion reached 100 percent for yellow perch 13 mm long. (U.S. EPA 2011)

- A recent study modeled the theoretical reduction of fish larvae entrainment between 0.75 mm, 1 mm, 2 mm, 3 mm, 4 mm, and 6 mm wedgewire screens. (Tenera Environmental 2013a) The modeling was based on the statistical relationships between larval morphometrics (width and depth of head capsule and body length) and wedgewire slot-width. Tenera Environmental (2013a) measured head depth and width for several California marine fish species and modeled the probability of entrainment for a given species based on the species’ morphometrics. The study estimated a small proportion (3.3 percent) of 25 mm (0.98 in) long anchovies may be entrained through a 0.75 mm slot-size screen. However, 47.7 percent of 25 mm long anchovies were at risk of entrainment through a 2 mm screen, and 86.8 percent of 25 mm long anchovies were at risk for entrainment through a 3 mm screen. These data may represent conservative estimates since the model did not include ambient hydrodynamics and fish behavior. (AldenLabs 2014)

- Data for two of the most prevalent larva in California waters showed that all northern anchovy larva less than 8 mm in length and all CIQ gobies (a group of goby species comprised of *Clevelandia*, *Ilypnus*, and *Quietula*) less than 6 mm would be entrained using a 1 mm wedgewire screen. Of the entire larval populations for these species, 74.5

> percent of northern anchovy larvae are less than 8 mm in length and 92.2 percent of CIQ gobies are less than 6 mm in length. (Foster et al. 2012) According to a study that modeled entrainment based on head capsule size, slot sizes over 3 mm will not significantly reduce population-level mortality for the majority of California fish species at risk of entrainment (e.g. gobies, anchovies, croaker). (Tenera Environmental 2013a) The report demonstrated that it is feasible to model entrainment based on various screen slot sizes and that estimates of entrainment can be generated, and that modeling using a 1 mm wedgewire-screened intake resulted in a net reduction in entrainment of approximately 10 percent.

A summary table with a sub-sample of entrainment studies is provided in Appendix D.

The general estimates for slot size may be valuable for designing an intake screen; however, discretion should be applied when applying results for one species to multiple species because entrainment is related to a species' morphometric. Caution should be used when extrapolating entrainment result to morphologically dissimilar taxa to ensure that screen slot size will be adequately protective for all species in the affected habitat. For example, the Tenera (2013a) study showed that 1 mm screens reduced entrainment of sculpin larvae by 81.1 percent, but only 45.1 percent for anchovies (Table 8-1; Appendix D). Three-quarters millimeter slot size screens moderately increased protection of sculpin larvae by reducing entrainment by an additional 4.8 percent over 1.0 mm slot size screens; however, anchovy entrainment was reduced by an additional ten percent, which may have a significant impact on the anchovy population. The EPRI 2005 study shows similar differences among species in terms of screen efficacy. Some species were adequately protected by the 0.5 mm screen while many others did not show significant reduction in entrainment (Table 8-1; Appendix D).

Additionally, even though wedgewire screens can reduce entrainment mortality of juvenile and adult fish and essentially eliminate impingement mortality, intake-related mortality will be site and species-specific. Empirical studies on wedgewire screen efficacy may be required to test the models that have been designed to estimate entrainment. There also may be a need to empirically measure entrainment at individual desalination facilities. For example, a modeling study by Tenera Environmental (2013b) investigated reduction in entrainment at the Diablo Canyon Power Plant intake when using a 1 mm wedgewire screen. The study showed entrainment reductions ranging from 4.6-15.8 percent relative to open water intakes (Appendix D). There were also differences in entrainment from year to year due to variation in local larval size and abundance.

Some studies on screen efficacy are contradictory. The majority of studies that examine the efficacy of wedgewire screens only looked at impacts on ichthyoplankton; yet there are many other organisms that are abundant in the water. Pilot studies on wedgewire screens have indicated that the *total* number of aquatic organisms that are entrained at screened intakes is not statistically different compared to entrainment at an uncontrolled intake. (Kennedy/Jenks Consultants 2011; Foster et al. 2012) Modeling data demonstrates that even though screens may preclude a small portion of the larval population from entrainment, a significant percentage of the population (e.g., all of the smaller sized organisms) can still pass through the screen slots. (Tenera Environmental 2013a) The portion of organisms that are not entrained because of the wedgewire screen is relatively small compared to the number of organisms in the water. (Foster et al. 2012) Consequently, there is only an approximate one percent reduction in entrainment mortality between screened and unscreened intakes. (Foster et al. 2013)

Section 13142.5(b) requires that the Ocean Plan consider *all* forms of marine life, regardless of size. Subsurface intakes are more protective of marine life than surface water intakes. However, when subsurface intakes are infeasible for a particular location, small slot-sized screens will protect larger juvenile and adult organisms (particularly fishes) from entrainment.

Other passive and active screens. There are many other types of passive and active screening technology. Examples of other types of passive intake screens include *perforated pipe inlets, porous dikes, leaky dams, artificial breakwaters, artificial filter barriers, Gunderbooms®,* and *fish barrier nets.* Additional examples of active intake screens include *dual flow travelling screens*, *modified revolving disc screens,* and *modified Geiger MultiDisc® Screens*.

8.3.1.2.4 Velocity Caps

A velocity cap is a partial cover added to an open intake pipe that changes the direction of the intake flow. A velocity cap creates a flow field that juvenile and adult fish can detect and avoid if the intake velocity is high enough to detect but low enough so that the fish can swim away. Most fish have sensory receptors that can detect horizontal water currents. However, these receptors do not sense vertical currents very well since vertical currents are largely unnatural in the marine environment. Velocity caps are classified as impingement reduction technology because they discourage impingeable fish from entering the system. The OTC Policy requires that the coarsely spaced bars on velocity caps be no further than 9 inches apart to prevent large organisms like seals, sea lions, and sea turtles from being entrapped in the intake systems. Velocity caps can be used in conjunction with other technologies to reduce impingement and entrainment.

Velocity caps have shown to be an effective way of reducing impingement at offshore facilities. (U.S. EPA 2000) Based on a U.S. EPA technology efficacy assessment, velocity caps can reduce impingement by more than 50 percent, and minimize entrainment and entrapment of larger marine species between inlet structures and screens onshore. (WateReuse 2011a) One of the first facilities to employ a velocity cap was the Huntington Beach Generating Station (approximately 240 MGD average/514 maximum intake capacity), after study results showed that small fishes could swim away to avoid being pulled into the intake pipe when a velocity cap was in place. The Los Angeles Department of Water and Power (2007) released a detailed report that assessed the velocity cap effectiveness at reducing fish impingement at the Scattergood Generating Station (SGS) cooling water intake structure. The velocity cap reduced the abundance of impinged fishes by 97.6 and the biomass of impinged fished by 95.3 percent. (LADWP 2007)

Velocity caps in southern California were originally designed with intake velocities between 2 and 3.5 ft/s. (Weight 1958) The San Onofre Nuclear Generating Station (SONGS) was the largest seawater intake in California (2,384 MGD intake capacity) prior to decommission/shutdown in 2013, and had twin, 18-ft (5.5 m) diameter offshore intake pipes fitted with 45 ft (13.7 m) diameter velocity caps. Water entered the velocity caps at an average velocity of 1.8 ft/s (0.55 m/s), which is a high enough velocity for impingeable fish to detect but low enough to be able to avoid the intake. Full-scale impingement studies were conducted at El Segundo from July 1956 through June 1958. The study compared impingement prior to installing velocity cap to impingement following velocity cap installation. Total impingement was reduced 95 percent from 272.2 tons to 14.95 tons following installation of a velocity cap. (Tenera 2006)

EPA recently provided the following clarification regarding velocity caps:

> *"EPA is aware that low intake velocity is sometimes confused with velocity cap technologies, and EPA would like to clarify that these concepts are not the same. Most velocity caps do not operate as a fish diversion technology at low velocities, and in fact are often designed for an intake velocity exceeding one foot per second. Thus a velocity cap will not typically meet the low intake velocity impingement mortality limitation. The velocity cap is located offshore and under the water's surface, and uses the intake velocity to create variations in horizontal flow which are recognizable by fish. The change in flow pattern created by the velocity cap triggers an avoidance response mechanism in fish, thereby avoiding impingement." (Federal Register/Val. 77, No. 112, Monday, June 11, 2012/Proposed Rules, page 34320)*

8.3.1.2.5 Other Surface Intake Reduction Techniques

Some industrial facilities rely upon active processes that remove or guide fish away from intakes and return fish back to the environment. In some instances, fish can be collected and returned to the environment following impingement. Louver systems consist of a series of vertical panels placed at an angle to current flow direction, and have been successful at diverting adult and juvenile fish away from intakes. (U.S. EPA 2009; U.S. EPA 2011) Fish elevators consist of large trays located in front of traveling screens that can be raised via a belt to collect fish in the water column in front of a screen. The tray is emptied to move fish and other organisms into a return system. (SCE 2008)

Behavioral barriers take advantage of natural fish behavior to prevent entrainment. (U.S. EPA 2003; Taft 2000) Velocity caps, slanted screens, and louvers are examples of behavioral barriers. Acoustic barriers, underwater strobe lights, air bubble curtains, and electrical barriers are other types of behavioral barriers. Unfortunately, laboratory and field studies show that while some species of fish respond to these devices, others do not and some species are even attracted to them. (Hocutt 1980) There is also concern that some of this technology could have adverse impacts to marine mammals.

Intake operations can be modified to reduce the time, duration, or frequency of withdrawals during certain biologically important time periods, such as spawning season, to reduce impacts on aquatic life, and significantly reduce entrainment and impingement. For example, a study at SONGS showed that larval entrainment was reduced by half by changing the timing of high volume water withdrawals. (U.S. EPA 2001)

8.3.2 Subsurface Intakes

Subsurface intakes extract marine water from beneath the ground, filtering the seawater through the geological features of the seafloor. Because the water is naturally filtered as it moves through sediments, it generally contains lower levels of contaminants such as suspended solids, silts, organic contaminants, oil, and grease. Similarly, subsurface intakes provide a natural barrier to suspended sediments, algal toxins, pathogens, dissolved or suspended organic compounds, harmful algal blooms, kelp, sea jellies, debris, or oil or chemical spills, and adult and juvenile marine organisms. (Missimer et al. 2013; MWDOC 2010; Lattemann and Hopner 2008; Kreshman 1985) Subsurface intakes collect water through sand sediment, which acts as a natural barrier to organisms and thus eliminates impingement and entrainment. (MWDOC 2010; Missimer et al. 2013; Hogan 2008; Pankratz 2004; Water Research Foundation 2011) 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.

Subsurface intakes are often limited to locations with favorable geological conditions, since aquifer characteristics vary with the geology, structure, and topography of the substrate in which they occur. Detailed hydrogeological and geophysical surveys and mapping are needed to determine the feasibility of installing subsurface intakes. Local geologic conditions will determine the necessary intake design, size, and flow capacity.

Overall, subsurface intakes can lower desalination operational plant costs and minimize associated environmental impacts. 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. (Pacific Institute 2013a; National Research Council 2008; Bartak et al. 2012; SDCWA 2009) The total lifetime costs for subsurface intakes over a 10- to-30 year operational time frame are often equivalent to or less than surface intakes due to reduced pre-treatment needs. (Missimer et al. 2013)

Subsurface intakes can be carefully sited to determine the least environmentally disruptive location and avoid areas with sensitive habitat and species. In addition, the construction period should be as short as possible. Construction of onshore subsurface intakes have the potential to disrupt breeding habitat, foraging grounds, or vegetation (Water Research Foundation 2011), and offshore construction of subsurface intakes has the potential to disrupt benthic communities for the duration of the construction, although the community structure is expected to return after the construction is completed. The most significant environmental impacts associated with subsurface intakes are related to construction and maintenance, although the magnitude and nature of those environmental impacts will vary depending on the type of subsurface intake. For example, vertical beach well intakes will disturb relatively little surface area and require minimal maintenance, whereas offshore infiltration galleries can require complete substrate replacement and continuous maintenance in order to ensure continued longevity. However, construction can be planned around breeding seasons to minimize impacts to sensitive species or habitat.

Subsurface intakes may not be suitable in all locations due to the desired intake volume or site geology (Ecosystems Management Associates 2010). For example, beach wells are not as suitable for larger intakes, and the site geology needs to be suitable to support a number of individual wells to yield the required raw water supply. Beach wells can support small to intermediate capacity intakes, but to support larger intakes, a greater number of individual beach wells can raise the issue of undesirable aesthetic impact. However, it is possible to install multiple subsurface intakes to withdraw the amount of water desired and the well heads can be buried to reduce or eliminate aesthetic impacts. Beach galleries specifically have design potential for large scale facilities, and have been demonstrated to be able handle large volumes of water. (Missimer et al. 2013) Different types of subsurface intakes, the combination of different subsurface intakes, and the number of wells required can all be factored into the assessment of subsurface intake feasibility. In addition, a well's "cone of influence" must be accurately sized so that production is not affected in nearby or adjacent wells. (Kennedy/Jenks 2011)

Drilled wells (either vertical, slanted, or horizontal), infiltration galleries, or seabed filtration systems are the most typical types of subsurface intakes, each of which has its own advantages, disadvantages, capabilities, suitability, and cost-effectiveness. A brief description of the most common types of subsurface intakes is included below, along with a discussion of potential environmental advantages and marine life mortality associated with these intakes.

8.3.2.1 Types of Subsurface Intakes

8.3.2.1.1 Vertical Intake Wells

Vertical intake wells are drilled vertically into a source water aquifer and are relatively inexpensive to construct and maintain. Vertical intake wells have a well casing and submersible pump, and each well can generally extract between 0.1 and 1 MGD source water. (Pankratz 2004) For practical reasons, such as ease of access, vertical wells are usually located onshore. Wellheads must be protected from beach erosion, and beach wellheads are often buried in a vault near the shoreline to maintain beach aesthetics. Examples of vertical well desalination plants are described below:

- The 0.3 MGD Sand City Brackish Water Reverse Osmosis (BWRO) (#4 Figure 2-1) desalination facility in Sand City, California, operating since 2010, has installed four, 60 ft (18.3 m) deep, vertical beach wellheads to extract brackish water. The intakes provide up to approximately 0.7 MGD of brackish groundwater and seawater to the desalination plant, which produces approximately 0.3 MGD of product water to serve the drinking water needs for the community. (Sand City 2013)

- The Sur plant, in the country of Oman, is one of the largest desalination plants in the world with a pumping capacity of up to 21.2 MGD. The plant is supplied by 33 beach

> wells that draw water from fractured karstic carbonate aquifers. The wells are 262 ft deep and spaced about 130 ft apart. The Sur plant is an example of a facility that uses subsurface intakes to successfully provide large volumes of water for desalination. (David et al. 2009)

Impacts from construction of vertical beach wells may include habitat displacement, nesting/breeding interruption, discharge of boring spoils, mechanized equipment, and hydrocarbons into the nearshore marine environment, and temporary increases in local sediment loading. Intake wells should be sited to prevent saltwater intrusion and depletion of freshwater sources of drinking water. A detailed discussion of the impacts of all types of subsurface intakes for CEQA is in sections 12.1.4, 12.1.9, 12.2, and 12.4 of this Staff Report.

8.3.2.1.2 Slant Wells

Slant wells are similar to vertical wells, but are drilled into source water aquifers at an angle using directional drilling methods. Like vertical intake wells, the wellheads of slant wells are generally buried in a vault beneath the ground to maintain shoreline aesthetics. Slant wells can either be connected to a common centralized collector, or submersible well pumps can be used in each shaft. Although slant wells are more expensive to construct than vertical beach wells, slant wells can minimize above-ground shoreline structures. In addition, slanted or angled wells can provide a substantially greater length of well screen in the target aquifer, an important advantage when there is limited aquifer thickness.

The Municipal Water District of Orange County investigated the use of various subsurface intake systems at Doheny State Beach in Dana Point, CA. A 350-foot long 12-inch diameter (casing and screen) test slant well was constructed on the beach and out under the ocean in the May 2006. The test slant well yielded 2,100 gallons per minute (3.0 MGD) and was tested in the Phase 3 Extended Pumping and Pilot Plant Test (Phase 3) from June 2010 to May 2012. Phase 3 determined the pumped water quality over time and hydraulic connectivity to the ocean. Drawdown impacts, performance of the well and aquifer, filtration capability of the aquifer, biofouling potential, and mineral scaling potential were evaluated in Phase 3. Materials corrosion testing was also performed to determine the most suitable stainless steel for the full scale slant wells. Effectiveness of the aquifer to provide pretreatment was evaluating using suspended solids and silt density index data. Additionally, the raw source water was run directly through RO membranes, which showed no fouling or deterioration over the test period. An initial groundwater flow model for San Juan Creek was also developed to evaluate the potential impacts on upstream users and appropriate mitigation approaches. (MWDOC 2014)

The Cartagena Plant in Spain uses horizontal drain intakes specifically designed to address marine environmental conditions unique to the site, where the presence of a protected seagrass species placed constraints on location, construction method, and length of the intake pipe. Directional drilling, guided by a global positioning system, achieved a radial pattern of horizontal drains that generated a larger water capacity than vertical wells, thus requiring fewer water intake points. (Wiesner 2012)

8.3.2.1.3 Horizontal Beach Wells/Radial Collector Systems

Radial or horizontal collector wells (sometimes referred to as Ranney Collectors, after a prominent manufacturer) typically consist of a central caisson or pumping station extending into the ground, with horizontal lateral well screens that fan out from the caisson into the surrounding aquifer. Individual horizontal wells can be drilled or well screens can be hydraulically jacked out from the bottom of the caisson using a direct-jack or pull-back process. The maximum horizontal well screen length of a radial collector well is approximately 300 feet. (Pankratz 2004) Since the laterals are placed horizontally, the surface area from which water is drawn is greater than that of a standard vertical well, leading to higher pumping capacities. The caisson may be buried in beach sand to maintain the aesthetics of the shoreline.

8.3.2.1.4 Infiltration Galleries

Infiltration galleries consist of an excavated trench that is then lined with a collector system and covered by filtration media. An infiltration gallery is similar to a radial collection system and is generally used where sediment deposits are relatively impermeable, or are of insufficient thickness and depth. (Pankratz 2004) In such locations, radial well arms and screens can be installed in a trench that is subsequently backfilled with a gravel pack and/or selected filter materials. Infiltration galleries consist of a group of well screens or perforated collection pipes that are buried horizontally within an engineered media (sorted sands or gravels with high porosity and permeability) that are designed to have favorable percolation rates. Infiltration galleries must be below the lowest-low tide level to allow continuous downward flow of water from the water body into the collection pipes. Installing an infiltration gallery may require the removal and disposal of extensive quantities of sediments and materials, resulting in potentially significant, albeit temporary, impacts to benthic biological resources.

Infiltration galleries offer a high level of pretreatment filtration, and are often designed to operate at low percolation rates (less than 0.1 gallon per minute per square ft of area). The infiltration gallery collector pipes may be buried approximately 10 to 15 feet below the top of the media. If the natural sediment is too fine, and not suitable for the percolation of water at a high enough rate, the existing sediment can be excavated and replaced by engineered, coarse-grained sand. The cost efficacy and usability of an engineered infiltration gallery will be site-specific. Loss of filtration rates as a result of fine sediments plugging an engineered infiltration gallery is a primary concern with an onshore and an offshore infiltration gallery located in water bodies with prevalent clay or silt. Storms may deposit fine sediment over the engineered media and clog the intake or reduce the flow, although higher wave energy may also work to dissipate and dislodge fine particles that may otherwise clog the media. The engineered media may also need to be dredged and replaced every few years in some regions, or may erode away altogether in others. In high-energy environments, the surface of the filtration media is continuously cleaned by wave action. High rates of infiltration are possible for sandy beaches with active wave energy.

The Fukuoka District Desalination Facility in Japan was constructed in 2005 and utilizes an infiltration gallery to withdraw source water. The facility has five supply lines that withdraw 27 MGD (103,000 m^3/d) of seawater. (Shimokawa 2005; SCWDA 2009) The plant uses an ultrafiltration membrane for source water pretreatment in conjunction with a high recovery (60 percent) RO module. These methods require less seawater and therefore, require a relatively small area of 211 feet by 1,030 feet (65 m by 314 m) on the seafloor. The first eight years showed excellent performance with no intake backwashing or cleaning required.

8.3.3 Regulatory Considerations

Porter-Cologne requires that new or expanded desalination facilities use the best available site, design, technology, and mitigation measures feasible to minimize intake and mortality of all forms of marine life (§13142.5(b)). Desalination facilities would be categorized as an "industrial installation" and any new or expanded desalination intake would be subject to requirements to minimize the intake and mortality of marine life. The regional water boards are currently responsible for addressing desalination intake impacts to ocean water biota, and are responsible for making section 13142.5(b) determinations.

The California Coastal Act also contains language regarding the marine environment and protection of marine resources, although the Water Boards lack direct authority to implement Coastal Act provisions. The California Coastal Commission will consider Coastal Act requirements in issuing a Coastal Development Permit. Coastal Act section 30230 provides that:

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

Furthermore, Coastal Act section 30231 states that the biological productivity and the quality of coastal waters, wetlands, and estuaries shall be maintained and restored if possible. Coastal Act section 30231 specifically states that the adverse effects of entrainment should be minimized.

8.3.4 Options

- **Option 1: No action. Do not recommend a preferred intake technology. Defer to the regional water boards to determine best available site, design, technology, and mitigation measures for seawater intakes.** Under Option 1, the State Water Board would not provide direction on preferable intake types, and would rely on regional water board determinations of compliance with section 13142.5(b) requirements. The regional water boards would be responsible for determining whether the proposed facility site, design, or technology considers the minimization of intake and mortality of marine life and whether the facility's mode of withdrawing seawater would protect water quality and beneficial uses. The approach gives the regional water boards flexibility to evaluate the merits of proposed intake alternatives, but could also result in inconsistencies among regions and projects within a region. Consequently, Option 1 does not meet the project goal of providing a consistent statewide approach for minimizing intake and mortality of marine life, protecting water quality, and related beneficial uses of ocean waters.

- Option 2: **Establish subsurface intakes as the preferred technology method for seawater intakes. Surface water intakes will be prohibited.** Under Option 2, the State Water Board would amend the Ocean Plan to only allow subsurface intakes as the means for desalination facilities to withdraw seawater. Subsurface intakes draw water from below the ground or seafloor using the sediment as a natural filter, resulting in null impingement and entrainment at the intake. Section 13142.5(b) restricts the Water Boards' intake jurisdiction to new and expanded facilities. Option 2 would require new facilities to site and design their facilities to meet subsurface feasibility requirements and require expanded facilities upgrade to subsurface intakes upon renewal of the facility's NPDES permit. The viability of subsurface intakes is highly dependent on site-specific conditions and hydrogeology. Consequently, requiring subsurface intakes as the only intake technology may result in overly-restrictive conditions that effectively eliminate desalination as an option for some communities. In addition, Porter-Cologne specifically allows mitigation to factor into site selection. A facility that can show that their siting, design, technology, *and* mitigation measures minimize marine life mortality should be able to proceed with alternative intake methods. Consequently, Option 2 does not meet the project goals because it restricts the potential locations of desalination facilities and could limit the feasibility of desalination as an alternative water supply option.

- Option 3: **Establish subsurface intakes as the preferred technology for seawater intakes. Surface water intakes will be allowed if subsurface intakes are shown to be infeasible. An owner or operator may apply to use an alternative method of preventing entrainment so long as the alternative method provides equivalent protection of eggs, larvae, and juvenile organisms as is provided by a 1.0 mm (0.04 in)] slot or mesh size screen.** Under Option 3, the State Water Board would amend the Ocean Plan to require subsurface intakes, but would acknowledge that subsurface intakes are not always feasible. Subsurface intakes would be established as the preferred intake technology because they are the best method for minimizing intake and mortality of all forms of marine life. Site- and facility-specific feasibility factors would be evaluated to determine the feasibility of a subsurface intake at all of the possible site locations. An owner or operator will need to consider a wide range of siting options to ensure that the possibility of using subsurface intakes is not eliminated because the siting options were too narrow. Additionally, California has a long history of moving water so the siting locations do not have to be in close proximity to the destination of the product water. Feasible for the purposes of Chapter III.M, is defined as capable of being accomplished in a successful manner within a reasonable period of time, taking into account economic, environmental, social, and technological factors. (Public Resources Code § 21061.1; § 30108). The factors in Chapter III.M.2.d.(1)(a)i. should also be considered by the regional water board when determining subsurface feasibility.

  After considering the feasibility of subsurface intakes, surface intakes could be permitted where subsurface intakes are demonstrated to be infeasible. A surface intake would need to be designed in a manner that would adequately minimize entrainment impacts.

Therefore, surface intakes should be placed in areas that would avoid impacts to sensitive habitats and species and should require screening technologies with a 1.0 mm or smaller slot size as it has demonstrated be effective in entrainment reduction while still feasible from an operational and maintenance standpoint. To address entrainment reductions for a surface water intake, the through-screen velocity should not exceed 0.5 ft/sec as it have been demonstrated to protect most small fish and is an appropriate value to preclude most impingement of adult fish.

If subsurface intakes are not feasible, an owner or operator may apply to the regional water boards to use an alternative intake technology. The alternative intake technology must provide equivalent protection of eggs, larvae, and juvenile organisms as a screen with a 1.0 mm slot size as demonstrated through studies. The study should be at least 12 months long, but the regional water board may determine a longer study period and/or additional data are needed if the data are incomplete or inconclusive, or if there were errors in the experimental design, sampling protocol, analysis, or conclusions. The study should evaluate instantaneous mortality as well as delayed mortality. Ideally the alternative intake technology would be built along with an intake using a screen with a 1.0 mm slot size and the technologies would be operated simultaneously for a side-by-side comparison. If there is an accurate method for assessing the technologies in a laboratory setting, the regional water boards may permit laboratories studies. However, the laboratory studies should be done using the same operating design and specifications that are representative of how the intake technology will function once installed and operational at a facility.

The regional water board should review the study design comparing the intake technologies before the study begins to ensure the experimental design will be able to effectively compare the technologies. The regional water board may permit the use of existing data at their discretion. But since there is a lack of entrainment data at California desalination facilities, it would be beneficial to require that studies are performed. This too will ensure that the data are comparable. It is not advisable to use data from one intake study and compare it to data for the alternative intake from a different study unless the methods are nearly identical.

8.3.5 Staff Recommendation

Staff recommends Option 3 for the means of addressing seawater intake in the Desalination Amendment. This option provides direction to the regional water boards on how to assess intake feasibility for new and expanded facilities, while providing flexibility for site-specific considerations and technological innovations. Option 3 would meet all of the project goals in set forth section 4.3.

8.3.6 Proposed Amendment Language

Please see chapter III.M.2.d.(1) of Appendix A

8.4 What siting considerations should the Desalination Amendment address?

One of the considerations in making a section 13142.5(b) determination is evaluating the best available site or location of a new or expanded desalination facility in order to minimize intake and mortality of all forms of marine life. There are numerous elements that should be considered when determining the best location for a desalination facility, including the feasibility of subsurface intakes, the general oceanographic and seafloor topographic conditions, the presence of sensitive species and sensitive habitats, the offshore abundance and diversity of marine life, the presence of existing infrastructure, the possible sources of dilution water, and anthropogenic influences (e.g. existing point-source discharges). Each of these elements should be considered individually in order to arrive at a comprehensive determination of whether the proposed desalination facility's location best minimizes marine life mortality.

The following issue addresses:

- Current rules for intakes
- Site and design considerations for minimizing intake and mortality of all forms of marine life
- Sensitive habitats and designated areas that require consideration for special protection from operational and construction related activities from a desalination facility
- Co-location options for desalination facilities and the associated pros and cons

8.4.1 Clean Water Act Section 316(b) U.S. EPA Phase I Rule

The Clean Water Act Section 316 (b) U.S. EPA Phase I Rule outlines a framework for intakes associated with new water-cooled power plants. While this rule does not apply to desalination facilities, the concepts considered are similar and can be used to inform board decisions about how to best address siting of desalination facilities. The Phase I rules vary depending on the siting of the intake, and impose more stringent "best technology available" requirements for facilities with intakes located less than 100 m (330 feet) outside the littoral zone. The littoral zone is defined as an "area where the physical, chemical, and biological attributes of aquatic systems promote the congregation, growth, and propagation of individual aquatic organisms, including egg, larvae, and juvenile stages." (U.S. EPA 2000) An intake structure located in the littoral zone requires more stringent intake capacity and velocity controls, and requires the use of an alternative design and construction technology. U.S. EPA has included a discussion of the advantages of extending seawater intake structures beyond the littoral zone and the impacts and costs related to this in their report called "Economic and Engineering Analyses of the Proposed section 316(b) New Facility Rule." (U.S. EPA 2000) These strategies to avoid impingement and entrainment can also be applied to desalination intakes.

Additional intake controls (e.g. screens, velocity caps, behavioral barriers, etc.) and intake velocity requirements for surface water desalination intakes help to minimize marine life mortality. Siting surface water intakes away from high productivity areas can significantly reduce impingement and entrainment and the related effects on the populations of the affected organisms. Sites should be evaluated so that relative productivity can be compared among site alternatives and the intake can be sited in areas with the lowest biological productivity or diversity. Site-specific studies that assess turbidity, photosynthetically active radiation (or available photosynthetic light), chlorophyll-a concentrations, species abundance (including meroplankton), species diversity, biomass per area, nutrient availability, or other studies may be necessary to determine productivity and species composition at desalination intake site alternatives.

8.4.2 Surface and Subsurface Considerations

Surface and subsurface intakes have distinct environmental impacts which ultimately factor into a facility's site selection. (David et al. 2009) Each type of intake has unique challenges in terms of cost, maintenance, construction, and operation. A key factor to consider in siting subsurface intakes is the potential for the subsurface well to contribute to or exacerbate seawater intrusion problems. Seawater intrusion can irreversibly contaminate freshwater supplies, negating the benefit of the desalination facility's ability to produce potable water.

Subsurface intakes typically have greater construction-related effects but negligible intake-related mortality. (Missimer et al. 2013; Hogan 2008; Pankratz 2004; Water Research Foundation 2011) The construction of infiltration galleries has the potential to displace or harm benthic marine organisms that are an important food source for certain foraging fish species. Construction of vertical beach wells typically do not disturb as much area as infiltration galleries, but they still may result in the mortality of infaunal marine organisms like mole crabs, clams, and worms that are food for marine birds.

In comparison to subsurface intakes, surface intakes do not contribute to seawater intrusion and typically have lower construction-related impacts. In some cases, existing infrastructure can be used, which can eliminate or greatly reduce construction-related effects for surface intakes. Although construction-related marine life mortality at surface intakes is relatively low, operational mortality (e.g. entrainment impacts) will be significantly higher at surface water intakes. Another consideration is the duration of the impact. The duration of construction is relatively small in relation to the life of a project. For example, construction may take two years, but the facility will be operational for 30 years and the marine life mortality associated with the construction of subsurface intakes will be for a short duration relative to intake-related mortality that would occur at surface intakes as long as a facility is operating.

8.4.3 Siting of Discharges

Dischargers can evaluate site-specific data to minimize the impact of brine discharges on marine life. Discharge at sites with high advection and ambient mixing will increase dilution, and may be more protective of the surrounding environment. Conversely, siting a brine discharge near a bathymetric depression can result in the formation of a dense anoxic or hypoxic layer that smothers marine life on the sea floor. (Roberts et al. 2012) Discharge impacts of desalination facilities are described further in section 8.6.

8.4.4 MPAs and SWQPAs

California's Marine Managed Areas (MMA) protect or restore water quality and marine resources. There are two main types of MMAs: Marine Protected Areas (MPAs) and SWQPAs. MPAs include: State Marine Reserves (SMR), State Marine Parks (SMP), and State Marine Conservation Areas (SMCA). SWQPAs include: ASBSs and General Protection areas. State Marine Cultural Presentation Area and State Marine Recreational Managed Areas (SMRMA) are also under the broad classification of a MMA but do not fall into the SWQPA or MPA category. MMAs have specific goals that include, but are not limited to:

- Protecting or restoring rare, threatened, or endangered native plants, animals, or habitats in marine areas
- Protecting or restoring outstanding, representative, or imperiled marine species, communities, habitats, and ecosystems
- Protecting or restoring diverse marine gene pools
- Protecting or restoring outstanding, representative, or imperiled marine species, communities, habitats, and ecosystems
- Contributing to the understanding and management of marine resources and ecosystems by providing the opportunity for scientific research in outstanding, representative, or imperiled marine habitats or ecosystems

SWQPAs are a subcategory of MMAs that are under the authority of the State Water Board, and are intended to support unique and valuable marine organisms by protecting and maintaining natural water quality. The California Public Resources Code (Cal. Pub. Res. Code §36700) defines a SWQPA as:

> "*A nonterrestrial marine or estuarine area designated to protect marine species or biological communities from an undesirable alteration in natural water quality, including, but not limited to, areas of special biological significance that have been designated by the State Water Resources Control Board…*"

The Public Resources Code (Cal. Pub. Res. Code §36710, subd., (f)) also states that:

> "*In a state water quality protection area, waste discharges shall be prohibited or limited by the imposition of special conditions in accordance with the Porter-Cologne Water Quality Control Act…"*

MPAs are primarily intended to protect or conserve marine life and habitat. There are 34 SMR and SWQPAs designated as ASBS that require special protections. The Ocean Plan requires protection of species or biological communities in ASBS, and prohibits waste discharge into in ASBS waters. All intakes and discharges to and from a SWQPA or MPA should be sited or designed to ensure the protection of marine species and biological communities.

Other special protections are given to State Marine Cultural Presentation Areas and SMRMAs. State Marine Cultural Presentation Areas are nonterrestrial marine or estuarine areas designated to preserve cultural objects or sites of historical, archaeological, or scientific interest in marine area (Cal. Pub. Res. Code §§ 36700-36900) and SMRMA's are nonterrestrial marine or estuarine area designated to provide, limit, or restrict recreational opportunities to meet other than exclusively local needs while preserving basic resource values for present and future generations (Cal. Pub. Res. Code §§ 36700-36900). SMRMAs and State Marine Cultural Presentation Areas are currently not addressed in the California Ocean Plan. These areas are protected for cultural preservation and recreational purposes and were not established as protected areas for water quality purposes.

Since subsurface intakes eliminate impingement and entrainment, they can be sited nearby the SWQPA or MPA without adverse operational impacts; however, construction of a facility or its components could lead to disturbances like increased turbidity or re-suspension of contaminants in sediments that may adversely affect a SWQPA or MPA. Surface intakes have a greater potential to impact marine resources and/or water quality within a SWQPA or MPA. Discharges within an MPA or SWQPA can impact marine resources, although facility design and siting may be able to locate the discharge a sufficient distance away from the SWQPA or MPA so as to avoid marine life mortality. Studies may be able to determine the source water body for new and expanded desalination facilities to demonstrate to the regional water boards that a surface intake will not impact a SWQPA or MPA.

8.4.5 Sensitive Species and Habitats

Sensitive species are organisms that can only survive within a narrow range of environmental conditions, are sensitive to anthropogenic stresses, or are in need of special protection. CDFW maintains the California Natural Diversity Database (http://www.dfg.ca.gov/biogeodata/cnddb/) that "provide[s] the most current information available on the state's most imperiled elements of natural diversity and to provide tools to analyze these data." (CDFW 2015) In January 2015, CDFW released a list of "special animals" that they determined are the species most at risk or most in need of conservation efforts. This list includes some marine species and can be used in conjunction with the California Natural Diversity Database to identify sensitive species. There may be sensitive species in a region that are not included on the CDFW list or in the California Natural Diversity Database. For example, the California Natural Diversity Database includes crustaceans and mollusks on their "Special Status Invertebrate Species Accounts," but does not include any echinoderms (http://www.dfg.ca.gov/biogeodata/cnddb/invertebrates.asp).

The absence of sensitive species in an area can be used an indicator of pollution or change from the "natural" environmental conditions. Sensitive habitats are ecosystems that support high-value organisms, have a high level of species diversity, and have a high ecosystem complexity. Sensitive species and habitats are discussed in detail in the environmental setting section (section 7). Sensitive marine habitats that may require special consideration and protection from desalination activities include: kelp beds, eelgrass beds, surfgrass beds, rocky reefs, oyster beds, market squid nurseries, and foraging grounds and reproductive habitat for state and federally managed species. In addition, there are species that require special consideration and protection from desalination activities. Protecting and maintaining these sensitive habitats will help preserve a high level of ecosystem productivity. The presence and location of sensitive species and sensitive habitats should be considered when choosing among siting and design alternatives for a facility to minimize intake and mortality of marine life.

8.4.6 Co-location

Some desalination facilities are co-located with existing power plants and often share intakes and discharge infrastructure. Co-location can be advantageous because using existing infrastructure can significantly reduce or eliminate construction cost and the associated effects to marine life. Marine life mortality can be reduced or eliminated at a desalination facility that uses the effluent cooling water from a power plant. The use of the power plant's cooling water discharge does not result in significant incremental marine life mortality because any organism in the cooling water is presumably already dead due to the use of the water within the power plant. Some studies have shown survival of organisms through cooling water intake systems, but survival of ichthyoplankton is generally very low. Some desalination facilities may require more water than can be provided by a power plant, especially when using flow augmentation to dilute brine, which can result in additional marine life mortality. The availability of the cooling water will also change as more power plants come into compliance with the OTC Policy and switch over to closed-cycle cooling. Once the desalination facilities are "stand-alone" operationally, the benefit of no additional mortality will cease and it may require a re-evaluation of the best available site, design, technology and mitigation measures feasible for the stand-alone desalination facility.

8.4.7 Regulatory Considerations

The regional water boards are responsible for assessing the effects of desalination intakes on marine biota and are responsible for making a section 13142.5(b) determination for each desalination facility required to utilize the best measures to minimize construction-, intake-, and discharge-related intake and mortality of marine life. The determinations are made on a facility-specific basis and vary among regions and projects. Current requirements applicable to MPAs and SWQPAs are specified in the Ocean Plan. For SWQPAs, the Ocean Plan includes some intake and discharge restrictions for ASBSs and SWQPA-General Protection. The State Water Board has authority to designate a State Marine Conservation Areas and a State Marine Parks, types of MPAs, as well as SWQPA-General Protections; and a SMR can be designated as an ASBS. No current provisions exist for SMRMAs and SMCMAs in the California Ocean Plan, as they are not considered to be areas that require special protection of biological resources of water quality.

8.4.8 Options

- **<u>Option 1:</u> No action. Do not address siting considerations in the Desalination Amendment and defer to the regional water boards to determine best available site for seawater intakes and discharges.** The regional water boards would continue to use best professional judgment to make determinations about the best available site requirements to comply with section 13142.5(b). This alternative does not support the project goals, as best siting determinations would be inconsistent among the regions and may not consider all factors essential to evaluating a facility's location.

<u>Option 2:</u> **Amend the Ocean Plan to permit desalination facilities only in locations where there is no new intake-related mortality. Desalination facilities must either be co-located with existing intake sources (e.g. once-through cooling power plants) or use subsurface intakes.** Under Option 2, any new intake-related mortality would not be allowed. Option 2 would be environmentally protective but may be overly restrictive and could prevent some communities from being able to use desalination to augment their water supply. Subsurface intakes are not feasible at all locations, and there are only 13 power plants operating in California, including Diablo Canyon Nuclear Power Plant.

Co-locating with a power plant was previously a wise approach to desalination since existing infrastructure reduced construction costs and co-location typically did not result in incremental intake or mortality of marine life. However, co-location is no longer a viable long-term option for desalination facilities since once-through cooling systems in California are reducing their intake volume or shutting down in compliance with the requirements of the OTC Policy. Per the OTC Policy, power plants that intake ocean or estuarine waters for cooling are required to transition to an alternate system of cooling that would reduce the intake flow rate by 93 percent, or provide a comparable level of protection. (SWRCB 2013) There are specific deadlines associated with each power plant, with the last plant scheduled to discontinue its use of once-through cooling by 2024.

With power plants transitioning from once-through cooling intake systems, a co-located desalination facility could still benefit from using the existing infrastructure, but that infrastructure is unlikely to be constructed, sited, or designed in a manner that best minimizes intake and mortality of all forms of marine life. To restrict all future desalination facilities to co-located intakes may be favorable in the short run because it doesn’t increase impingement and entrainment impacts and decreases construction related impacts; however, the site may not employ the best available site, design, or technology following shut-down of OTC facilities. New desalination facilities would have to be issued a conditional section 13142.5(b) determination by the regional water board based upon the co-located conditions, and then a new section 13142.5(b) determination would have to be made once the power plant shuts down.

In the long-term, Option 2 would restrict desalination facilities to only those locations where subsurface intakes are feasible or where power plants operated at one point in time. If facilities are required to co-locate with a power plant and the power plant shuts down, there is the potential for the stand-alone desalination facility to be sited in an area that is not the best available site location, all other factors being considered. Restricting desalination facilities to locations where subsurface intakes are feasible would also restrict available site alternatives. Restricting siting to this extent could lead to a facility that is less protective of marine life because it could preclude design, technology or mitigation alternatives. Even though Option 2 would provide statewide direction to the regional water boards, Option 2 would not meet the project goals to be environmentally protective and provide desalination as an alternative to traditional water supplies.

- Option 3: **Amend the Ocean Plan to establish statewide requirements, guidelines, and considerations for the regional water board to use when evaluating the best available site alternatives for desalination facility.** Option 3 would establish specific limits and factors that must be demonstrated or evaluated by an owner or operator and then assessed by the regional water boards in order to decide the best siting alternative. Option 3 would not limit a facility to a specific site or prohibit co-location with a power plant. Option 3 would provide a consistent statewide framework for siting determinations, and would help ensure that the regional water boards evaluate the provisions necessary for a section 13142.5(b) determination.

  Siting provisions would be included to address the best location to place intakes and discharges to minimize intake and mortality of all forms of marine life. The presence of existing infrastructure would be considered the best available site to reduce construction-related disturbances. Sites would be evaluated for the feasibility of subsurface intakes. All other things being equal, locations where subsurface intakes are feasible would be considered the best because subsurface intakes do not impinge or entrain marine life. Desalination facilities could be sited at locations where subsurface intakes are infeasible as long as the regional water board determines it is otherwise the best available site and in combination with the best available design, technology and mitigation measures feasible results in the least amount of marine life intake and mortality.

  Special protections would be added in the Ocean Plan for sensitive species, sensitive habitats, SWQPAs, MPAs, and any other species or habitats that the regional water boards determine need special protections from desalination activities. Siting requirements would include an analysis of the cumulative impacts of the desalination facility in combination with other anthropogenic effects to marine life. Meaning, if there are multiple facilities being planned within the same area or region, and the facilities are using the same source water body, each facility's section 13142.5(b) determination should also consider the fact that a shared ecosystem will be impacted.

  Another siting factor that would be considered is the availability of wastewater (e.g. agricultural, sewage effluent, power plants or other industrial sources) to be used for brine dilution. Siting a desalination facility in close proximity to a wastewater dilution source can prevent a facility from discharging toxic concentrations of brine into ocean waters and reduce the cost of constructing conveyance pipes to transport the brine to the wastewater facility or vice versa. As mentioned in Option 2, once-through cooling power plants can potentially provide adequate wastewater for brine dilution in addition to the benefits from a shared intake.

If a desalination facility were co-located with a once-through cooling power plant, then it would be issued a conditional section 13142.5(b) determination by the regional water board and a new determination would be needed for the stand-alone desalination facility once the power plant shuts down. Conditional section 13142.5(b) determinations could also be issued by the regional water boards for facilities that co-located with other wastewater treatment facilities if there were a potential for the dilution water to become unavailable at some future point in time.

8.4.9 Staff Recommendation

Staff recommends Option 3 as the best alternative to address siting considerations because it allows site-selection flexibility while meeting the project goals. The Desalination Amendment will establish guidelines on the types of limitations and factors that must be assessed for making a section 13142.5(b) determination for best available site for a desalination facility in order to protect marine life, water quality, and the beneficial uses of ocean waters as they relate to desalination facilities. Option 3 would also ensure regional water boards applied a consistent statewide approach to section 13142.5(b) determinations while providing flexibility for facility-specific considerations.

8.4.10 Amendment Section

See chapter III.M.2.b and L.2.c of Appendix A.

8.5 Should the State Water Board provide direction in the Ocean Plan on mitigating for desalination-related impacts?

Mitigation is the replacement of marine life and/or habitat that is lost due to the activity of a desalination facility after minimizing marine life mortality through site, design, and technology measures. Marine life mortality can occur as a result of construction or operation of a desalination facility. Construction-related mortality will only occur during the construction period, whereas intake and discharge-related mortality will occur throughout the operation of a facility. Desalination facilities with appropriately designed subsurface intakes can effectively eliminate impingement and entrainment of marine life, and consequently should not need to mitigate for intake-related mortality. However, subsurface intakes may not always be feasible.

Siting, design, and technology measures can eliminate impingement and reduce entrainment of organisms at surface intakes. Mitigation is required in order to compensate for all residual entrainment-related mortality. In addition to intake-related mortality, discharge-related mortality may occur if organisms are exposed to lethal levels of turbulence associated with brine waste diffuser outfalls, although the magnitude of discharge-related mortality is the subject of debate. Organisms at outfall locations may also be exposed to toxic conditions as the result of elevated salinity or anoxic or hypoxic zones associated with brine discharges. Section 13142.5(b) (see section 8.1.1 of this Staff Report) requires an owner or operator of a new or expanded facility to mitigate for intake and mortality of all forms of marine life after the best available site, design, and technology alternatives feasible are used. This includes mortality associated with facility's construction, intakes, and discharges.

The following issue addresses:

- How to assess marine life mortality at desalination facilities
- Adding buffer to mitigation projects to compensate for statistical uncertainty
- Types of projects that can mitigate for marine life mortality at desalination facilities
- Mitigation options: complete a mitigation project or provide funds to a fee-based mitigation program

8.5.1 Marine Life Mortality Assessment

In order to determine the amount of mitigation required, an owner or operator will need to estimate the marine life mortality associated with a facility's intake, discharge, and construction.

8.5.1.1 Intake-related mortality

State Water Board staff convened an Expert Review Panel (ERP) to provide options for calculating mitigation for intake-related mortality. (Foster et al. 2012; Foster et al. 2013) Foster et al. (2012 and 2013) reported there are multiple options for measuring impingement and entrainment, but certain methods are better for accurately determining the amount of mitigation required to ensure that direct and indirect environmental effects of desalination are fully compensated. Foster et al. (2012 and 2013) discussed models that can be used to estimate the number of organisms lost due to entrainment. The main models used for assessing entrainment at desalination facilities are Area of Production Foregone (APF) (also called Habitat Production Forgone) using an Empirical Transport Model (ETM/APF), Adult Equivalent Loss (AEL), and Fecundity Hindcasting (FH).

Adult Equivalent Loss and Fecundity Hindcasting

AEL and FH have been used to assess entrainment by cooling water intakes and related impacts to individual populations. (Strange 2012; Raimondi 2011, Steinbeck 2007; Stratus 2004) These methods can be used to determine the efficacy of screening technologies or by fishery managers when assessing fish populations. (Ehrler et al. 2002, Miller et al. 2008, Rago 1984) Studies have also used AEL and FH to measure impingement and entrainment at ocean intakes. (Ehrler et al. 2002, Tenera Environmental 2000, and Tenera Environmental 2010) The AEL and FH models are discussed further below, but supplemental information regarding the models is included in Appendix E.

The AEL model assesses entrainment mortality of larval and juvenile fish and translates these numbers into an equivalent number of adult fish that are presumed lost to the population. AEL assessments are specific to a single species and are best suited for characterizing how intake-related mortality will affect the number of future adult fish in a population. The method requires detailed life-history data, such as life-stage mortality ratios (Figure 8-1), for the species of interest. FH measures entrainment mortality of larval and juvenile fish and translates that mortality into a number of lost breeding females. In essence, FH is an estimate of the loss of reproductive capacity in a population. FH also relies on background information for a species of interest, including life stage mortality ratios, and is best suited for characterizing how intake-related mortality will affect the reproductive capacity of a specific fish population.

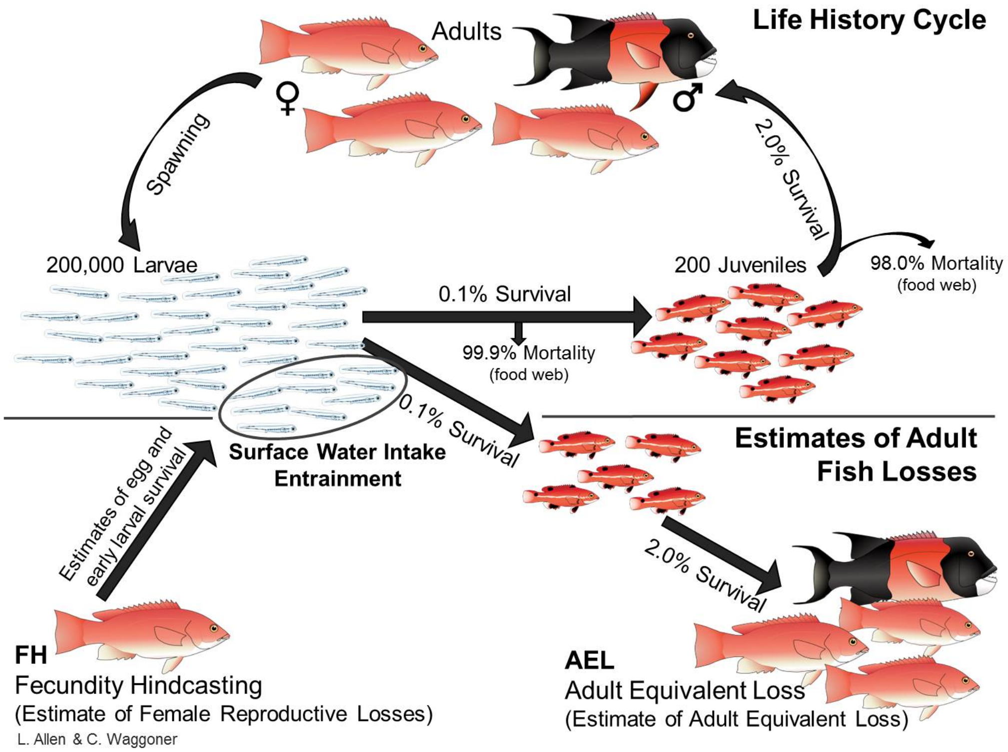


Figure 8-1 A visual comparison of two different loss rate model approaches, Fecundity Hindcasting (FH), Adult Equivalent Loss (AEL) using the life history cycle of the California sheephead. Fish illustrations are courtesy of Larry Allen.

Figure 8-1 displays the life history cycle of the California sheephead, *Semicossyphus pulcher*, with larval and juvenile fish production and life stage mortality ratios. The natural mortality of early life stages of fish is high because larval fish are food for other animals in the marine food web. AEL and FH forecast the effects of entrainment on fish populations. Consider a hypothetical desalination facility where 200,000 sheephead larvae are entrained each year. These larvae have an expected mortality ratio of 99.9 percent between life stages, meaning that under natural conditions only 200 of the original 200,000 larvae would survive to become juveniles. Additional mortality occurs between the juvenile stage and the adult stage. In the end, only four of the original 200,000 larvae would be expected to reach adulthood. In AEL terminology, the 200,000 larvae entrained by the desalination facility are the *equivalent* of four adults. A similar approach can be used to estimate entrainment impacts on the reproductive capacity of a fish population.

Foster et al. (2012 and 2013) suggested that while AEL and FH are useful methods for measuring impingement and entrainment, there are distinct disadvantages in using these methods to calculate the size of a mitigation project. The success of the AEL and FH methods depends on the reliability and availability of expected growth and survival rates for fish species' various life stages. (Tenera Environmental 2000) Unfortunately, growth and survivorship data are unavailable for many California species, making FH and AEL unreliable or unusable. (Ehrler et al. 2002) Although growth and survival data are available for some federally, state, or commercially managed species, there are many more species (including many of the most abundant species along the California coast) for which the required life history data are unavailable. (Miller et al. 2008; Tenera Environmental 2000) Table 8-1 (Raimondi 2013) shows that AEL and FH loss data were only available for 2 out of 10 species using the FH method and for 3 out of 10 species using AEL. There are a number of species that cannot be evaluated using AEL and FH simply due to lack of data. (Ehrler et al. 2002; Tenera Environmental 2010)

While AEL and FH are useful methods for assessing the effectiveness of screens or effects to individual populations and are helpful in fisheries management, they only assess direct effects of entrainment on individual populations. The AEL and FH methods use natural mortality rates to convert the losses of eggs, larvae, and juveniles into the number of equivalent adults or reproductive females. From a mitigation assessment perspective, AEL and FH place a higher value on larger and older fish because older individuals have lower mortality rates than younger fish and consequently a higher probability of reaching reproductive maturity and reproducing. Older fish are typically larger and reproductive output increases with size. Thus, older, larger fish can typically contribute more offspring to a population. AEL and FH evaluate the losses of the younger, smaller fish from a population standpoint; but the methods do not assess the indirect impacts of the entrained organisms. The loss of younger, smaller fish may seem inconsequential from a population standpoint because they have high natural mortality rates; however, these organisms serve as the base of the marine food web and organisms that are not consumed sink, and are degraded by microbes that recycle the nutrients. This process is an integral part of California’s seasonal coastal upwelling that delivers nutrient-rich waters to nearshore habitats. AEL and FH do not quantify the full extent of the loss of organisms from an ecosystem standpoint. Consequently, there is significant risk that using AEL and FH will underestimate the amount of mitigation needed to fully mitigate for intake-related mortality.

Area of Production Foregone Using an Empirical Transport Model (ETM/APF)

Production forgone is the biological productivity lost when marine life is killed by an industrial activity. The APF is the amount of area needed to be created in order to compensate for the lost productivity. APF is calculated by measuring the productivity forgone for a subset of species, then averaging those measurements together. A key assumption in how the APF method has been applied to date in California is that the production forgone for a subset of species is a representative sample of all species present at that location, even those that are not directly measured. If the habitat calculated using APF is created or restored, the habitat will support the species assessed in the analysis as well as other species in the ecosystem that were not assessed. This means that the average APF for a small subset of species (e.g., 15-20 species) is characteristic of the much larger community, even a community comprised of thousands of different types of organisms. The more species and diversity of species that are used in the APF analysis, the better the representation of the community will be. The ETM/APF model is discussed further below, but supplemental information regarding the model including guidance on conducting an ETM/APF analysis is included in Appendix E.

The first step in determining an APF is to develop an ETM that determines the spatial area containing the organisms at risk of intake entrainment. This area is defined as the **source water body** and is calculated using a combination of biological, hydrodynamic, and oceanographic data (Figure 8-2). The ETM also determines **proportional mortality (P_m)** (Figure 8-2), or the percentage of the larval organisms or propagules in the source water body that are expected to be entrained at a desalination facility's intake. The source water body (acreage) and the average annual P_m (percentage) are then multiplied together to calculate the APF.

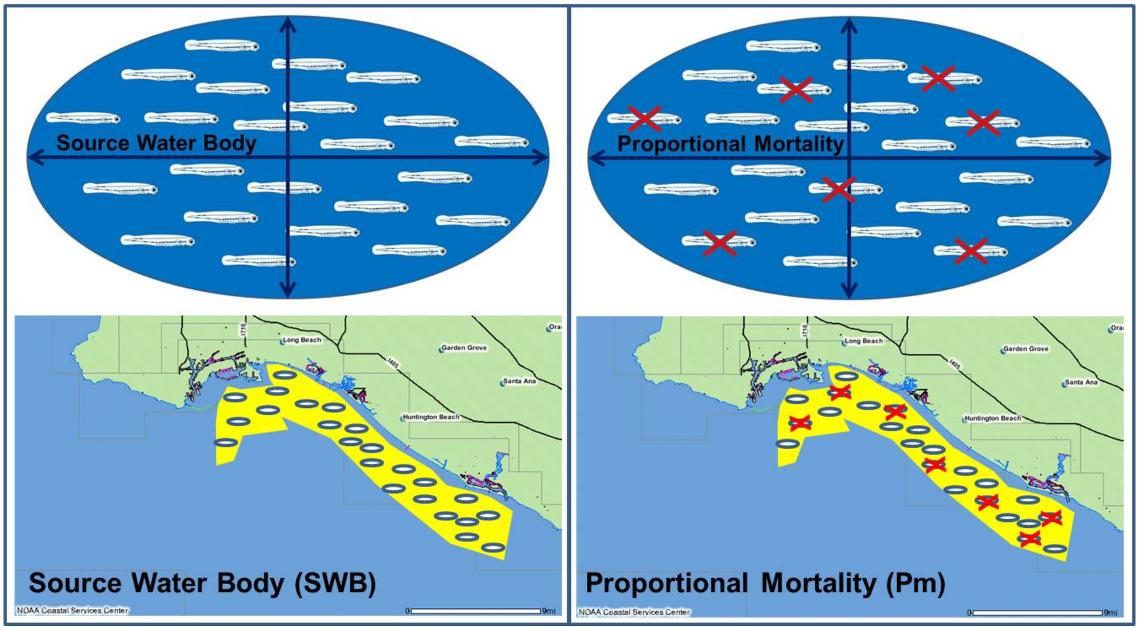


Figure 8-2. An empirical transport model can be used to estimate the source water body and proportional mortality for entrained species. The P_m can be multiplied by the source water body to determine the area of production foregone. Modified from Raimondi 2013. Larvae illustrations are courtesy of Larry Allen.

Combined with site-specific entrainment data, an ETM/APF approach can be used to translate the loss of organisms into the loss of biological productivity for all entrained species. The ETM/APF results compare the loss of ecosystem productivity to the amount of habitat (in acres) needed to produce the same amount of biological productivity that was removed from the ecosystem via entrainment; in other words, the APF determines the amount of acreage necessary to replace the production forgone due to facility operation. Although ETM/APF is based on species-specific data, the method assumes that the average ETM/APF is representative of all species in a community, not just the species that were directly measured, fish taxa, or commercially valuable species. (Marin Municipal Water District 2008)

Table 8-1 compares FH, AEL, and ETM/APF for entrainment data from Raimondi 2013. Both the FH and AEL data are highly dependent on the availability of life-stage mortality rates; when mortality rates are unavailable, the FH and AEL equivalents cannot be calculated (shown as NA in Table 8-1). However, the ETM/APF data does not rely on detailed life histories, and instead relies on simple oceanographic and biologic data. The ETM, in conjunction with site-specific entrainment data, is used to calculate a P_m; when multiplied by the source water body, the entrainment of a single species is translated into an acreage (e.g., the APF) required to fully compensate for the entrainment of that species. The average APF, amongst many species, is considered representative of the site as a whole.

Table 8-1. A comparison of three different loss rate model approaches, FH, AEL and an ETM, that can be used to estimate entrainment at desalination facilities. Proportional mortality (P_m) and the source water body (SWB, reported in km) are determined by an ETM (See Figure 8.4.2) and can be multiplied together to determine the APF. Not available (NA) indicates that data were unavailable. (Raimondi 2013)

Taxon	Estimated Annual Entrainment (# of individuals)	2xFH (Breeding Females)	AEL (Adult Equivalents)	ETM P_m (SWB in km)	APF in km^2 (acres)
CIQ goby complex	113,166,843	202,538	147,493	1.0% (60.9)	0.609 (150)
Northern anchovy	54,349,017	53,490	304,125	1.2% (72.0)	0.864 (213)
Spotfin croaker	69,701,589	NA	NA	0.3% (16.9)	0.051 (12.6)
Queenfish	17,809,864	NA	NA	0.6% (84.9)	0.509 (126)
White Croaker	17,625,263	NA	NA	0.7% (47.8)	0.335 (82.7)
Black Croaker	7,128,127	NA	NA	0.1% (19.4)	0.194 (47.9)
Salema	11,696,960	NA	NA	NA	NA
Blennies	7,165,513	6,466	NA	0.8% (12.8)	0.102 (25.2)
Diamond turbot	5,443,118	NA	NA	0.6% (16.9)	0.101 (25.0)
California halibut	5,021,168	NA	NA	0.3% (30.9)	0.093 (23.0)

The ERP III recommended the ETM/APF method to calculate desalination facilities' mitigation levels because ETM/APF:

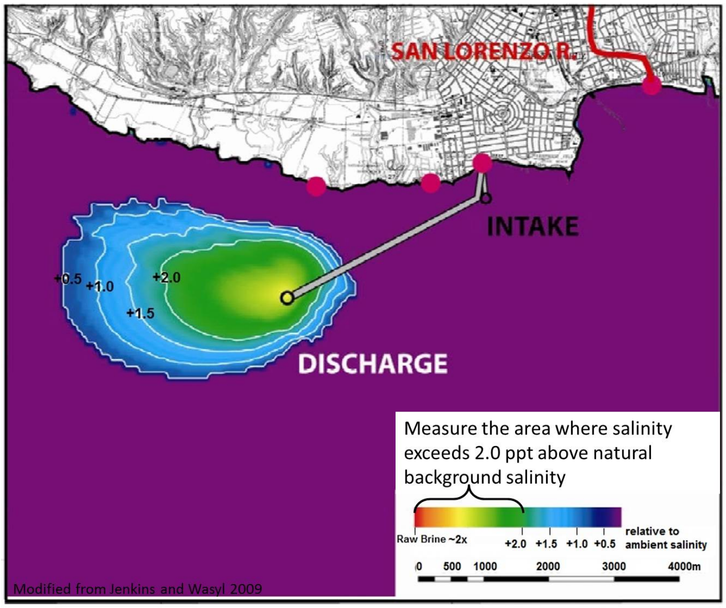
- Has historically been used in California to determine mitigation for entrainment at power plants and is widely accepted in the scientific community,
- Compensates for all entrained species and not just commercially valuable fish taxa,
- Requires less life history data for species compared to other methods (e.g., AEL and FH),
- Utilizes representative species that can be used as proxy species for rare, threatened, or endangered species, which may be challenging to acquire adequate data for. The creation or restoration of habitat benefits all species in the food web regardless of whether or not they were assessed in the ETM/APF model.

8.5.1.2 Discharge-related mortality

In addition to mortality that occurs at screened surface intakes, marine life mortality may occur where desalination brine waste is discharged. The mortality occurs as a result of exposure to toxic concentrations of brine, anoxic or hypoxic conditions, or shearing stress from turbulent mixing where brines are discharged.

Brine is a waste byproduct of the desalination process, and it is typically discharged back to the ocean at or near the desalination facility. Brine waste can exceed twice the salinity of natural open-ocean or coastal locations. Elevated salinity can have toxic effects on marine organisms if the salinity exceeds an organism's normal physiological range. Organisms may be exposed to concentrations of salinity that may result in either immediate or delayed mortality, including developmental abnormalities that prevent an organism from reaching maturation. (Dupavillion and Gillanders 2009, Iso et al. 1994)

In order to estimate the amount of mortality that occurs as a result of the discharge, an owner or operator can model the facility's discharge to determine the area where salinity exceeds an established level above natural background salinity and mitigate for that area. For example, Figure 8-3 presents modeling data showing isohaline zones where salinity exceeds certain thresholds around a discharge. In this hypothetical example, the facility would be required to mitigate for the area in yellow to green (where salinity exceeds 2.0 ppt above natural background salinity).



Measure the area where salinity exceeds 2.0 ppt above natural background salinity

Modified from Jenkins and Wasyl 2009

Figure 8-3 Brine discharge salinity concentrations ppt relative to ambient seawater. Modified from Jenkins and Wasyl 2009.

Some brine discharges may cause shear-related mortality. Shear stress is the measure of friction or force from the discharge on an organism in the path of the discharge. At certain velocities, the shear stress can be lethal to marine life. This is a concern for facilities that discharge their brine waste through multiport diffusers. Although this method rapidly dilutes the waste, the velocity of the brine waste at the point of discharge may result in marine life mortality. Typically, the level of shear stress will increase as the velocity of the discharge increases with the highest velocity occurring at the upward rising portion of the discharge and dissipating further from the point of discharge. (Roberts et al. 1997; see Figure 8-4)

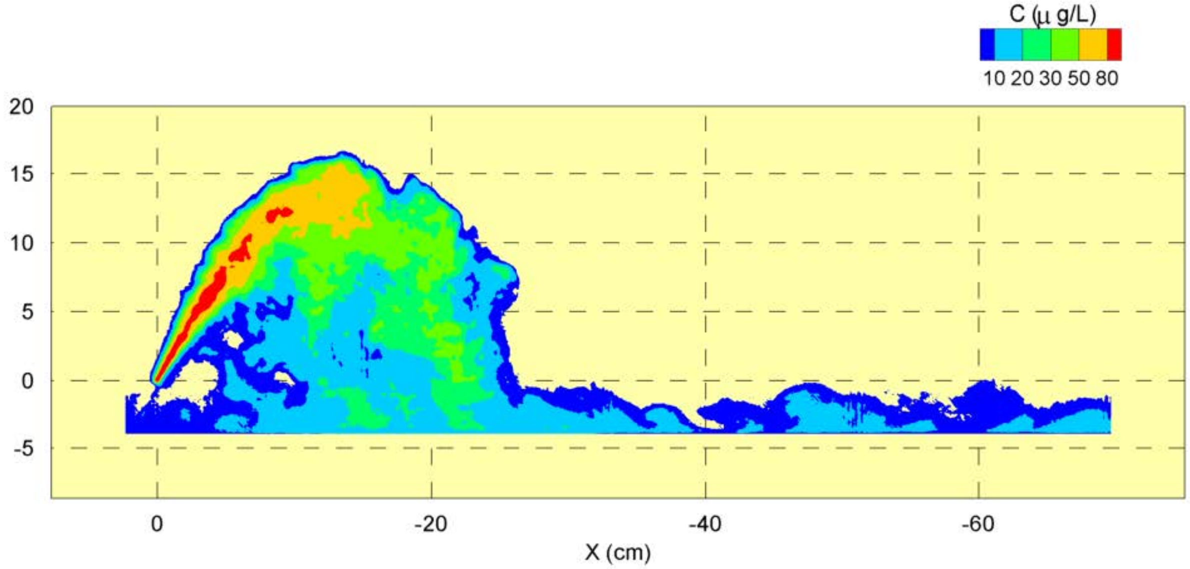


Figure 8-4. Laser-induced fluorescence animation image of a brine plume discharge from a diffuser. (From Roberts 2013)

The tracer chemical Rhodamine 6G was added to the brine plume to optically measure brine mixing in this laser-induced fluorescence image. C is the local instantaneous concentration of the tracer chemical in µg/l and this figure is a snapshot from the laser-induced fluorescence animation. The areas where the tracer chemical is the most concentrated (shown in red and orange) have the highest velocity and turbulent mixing. Consequently, these areas have greater shearing stress associated within that area relative to the green and blue areas.

There are few studies that estimate shearing-related mortality at brine multiport diffusers and other discharges. The entrained volume is the amount of water that is subject to high turbulence intensities and shear stresses from multiport diffusers. Foster et al. (2013) modeled shearing stress from multiport diffusers and reported that larvae in 23 percent of the total entrained volume of dilution water may be exposed to lethal turbulence for 10 to 50 seconds. Another study estimated entrainment mortality at multiport diffusers to be between 10.7 and 16.8 percent of the total entrained volume of dilution water (Jenkins and Wasyl 2013); however, it is unclear as to how those estimates were made. The total entrained volume of dilution water is the amount of ambient water that mixes with a discharge to dilute the brine to the receiving water limitation. If a facility has a 50 percent production efficiency, it takes approximately 20 parts ambient water to dilute 1 part brine to 5 percent above ambient salinity. For example, if a facility is discharging 50 MGD of 66 ppt brine, with a background salinity of 33 ppt, the facility would need approximately 950 MGD of diluent water to get their brine to 35 ppt. Of that 950 MG, organisms in 218 MG could potentially be exposed to lethal turbulence (23 percent of total dilution volume) using the modeling data from Foster et al. (2013).

To date, there is no empirical data showing the level of mortality caused by multiport diffusers. Foster et al. (2013) hypothesized that the actual level of mortality associated with multiport diffusers was very low, in part because the exposure time to organisms was very low. However, until additional data is available, we assume that larvae in 23 percent of the total entrained volume of diffuser dilution water are killed by exposure to lethal turbulence. The actual percentage of killed organisms will likely change as more desalination facilities are built and more studies emerge. Future revisions or updates to the Ocean Plan may reflect additional data that becomes available.

A potential way to address discharge-related mortality is to require mitigation for all organisms within a specific isohaline (e.g. the area that exceeds some level above natural background salinity). Organisms within a certain distance of the discharge will simultaneously be exposed to shearing stresses (when multiport diffusers are used) and toxic water conditions due to high salinity concentrations and/or other chemical constituents in the discharge. However, the volume of water susceptible to high shear stress should always be less than the volume of water where salinity exceeds 2.0 ppt above natural background salinity for undiluted brine discharges. Thus, shearing-related mortality would only occur within the area that exceeds 2.0 ppt above natural background salinity, and mitigating an area equivalent to the area that exceeds 2.0 ppt above natural background salinity would also compensate for shearing-related mortality.

Diluted brine discharges like discharges from flow augmentation systems and commingled discharges will have to use other methods for estimating discharge-related mortality. If the brine is adequately diluted, there will be no osmotic-related mortality but there may be shearing related mortality. The shearing mortality will be related to the velocity at which the effluent is discharged. Modeling and additional studies may need to be done in order to estimate shearing related mortality from diluted brine discharge systems. In some instances, the diluted discharged may be passively discharged; however if there is any turbulent mixing, an owner or operator will need to estimate the mortality associated with brine discharge.

For commingled discharges, there may be shearing that occurs as the result of the wastewater being discharged through diffusers. Historically, a wastewater treatment plant has not been required to mitigate for this shearing related mortality. It is not the intention of the Desalination Amendment to make the wastewater treatment plants mitigate for the shearing related mortality from their existing effluent volume. However, if an owner or operator of a desalination facility plans to commingle their brine with a wastewater treatment plant, they will need to estimate the shearing mortality from the addition of the brine. For example, if a wastewater treatment plant discharged 250 MGD of treated effluent and a desalination facility is planning on adding 50 MGD to the effluent, the owner or operator of the desalination facility would be responsible for estimating and mitigating for shearing mortality from the added 50 MGD.

In addition to shear-stress and salinity, brine waste discharges can also contain other chemical constituents that may have reasonable potential to exceed an Ocean Plan Water Quality Objective listed in chapter II, Water Quality Objectives Table 1. A facility’s mitigation plan should capture the effects of Table 1 constituents. Additionally, brine discharges can result in anoxic or hypoxic zones, resulting in additional marine life mortality. Although the Desalination Amendment requires consideration that brine discharges re designed to prevent the formation of dense outfalls that cause anoxia or hypoxia when feasible, careful monitoring should be done to determine whether such anoxic or hypoxic events occur; any deaths resulting from anoxia should be fully compensated for to comply with Water Code sections 13142.5(b) and 13142.5(d).

8.5.1.3 Construction-related mortality

The magnitude of marine life mortality that occurs as the result of the construction of a facility will be facility-specific. For example, the amount of benthic marine life that is disturbed during construction will differ for a facility that installs a subsurface infiltration gallery compared to a facility that installs screens on an existing intake pipe. The acres of disturbed habitat can be quantified and used as a way of estimating construction-related mortality by assuming 100 percent mortality of marine life in the area disturbed by construction.

8.5.2 Mitigation Projects

Mitigation is typically accomplished by an owner or operator either by creating a new mitigation project or by contributing funds to a mitigation bank or other steward to manage a mitigation project in lieu of the owner or operator completing a mitigation project themselves. The goal of mitigation is to replace the production forgone that results from construction or operation of a facility. Projects should have no net productivity loss once mitigation is taken into consideration. A Mitigation Plan can assist in achieving this goal. Mitigation Plans typically include project objectives, site selection, site protection instruments (the legal arrangement or instrument that will be used to ensure the long-term protection of the compensatory mitigation project site), baseline site conditions, a mitigation work plan, a maintenance plan, a long-term management plan, an adaptive management plan, performance standards and success criteria, and monitoring. (ECONW 2012) Each of these is a critical component to evaluate the success of a mitigation project. An important step is to identify the type and number of organisms at risk to address in the Mitigation Plan. Additionally, mitigation projects should be located close to the impacted area (Water Reuse 2011), but also at a sufficient distance from an open water intake so the mitigation project will replace the biological productivity that was lost instead of increasing entrainment at the intake. (Ambrose 1994)

Mitigation projects using screened surface intakes should site the mitigation project so that the production area from the project overlaps the source water body. The production area is the area where organisms originating at the mitigation site are dispersed to. The mitigation project should provide a source of organisms to replace those that were lost at a desalination facility. The best available mitigation measured feasible should be done to minimize intake and mortality of all forms of marine life. The goal of a mitigation project should be to compensate for losses of all forms of marine life and to ensure there is an increase in the populations of the lost species within the ecosystem. Another advantage to using subsurface intakes the mitigation project for any mitigation required for discharge or construction-related impacts can be sited without the concern of re-entraining organisms. Since subsurface intakes will not have a source water body, the mitigation project should be sited at a location that replaces the species that were lost at a desalination facility to the extent feasible.

In a mitigation project, replacing the same type of organisms that were lost is referred to as in-kind mitigation. (Ambrose 1994) Most in-kind mitigation involves the direct replacement of lost habitat, since creating or restoring additional functional habitat is the most direct way to replace organisms killed at intakes. For instance, if estuarine species are killed at an intake, then the best mitigation project will involve creating estuarine habitat. If reef species are killed, then the mitigation project should replace reef habitat. The creation or restoration of the habitat will provide ecological features like foraging and reproductive habitat that can promote productivity. An exception to this mitigation strategy occurs when a project creates or restores a habitat that is more productive than the habitat that is lost (e.g., creation of an estuary in lieu of open coastal soft-bottom habitats). (Foster et al. 2012 and 2013; Stratus 2004) Many soft-bottom species use estuaries during part of their life, so estuary mitigation is not entirely out-of-kind. In general, in-kind mitigation to replace the lost resources with the same type of resource is typically preferred over out-of-kind mitigation. (Ambrose 1994)

Out-of-kind mitigation methods replace lost resources with dissimilar resources (Stratus 2004; Ambrose 1994). Additionally, out-of-kind mitigation projects do not provide the same types of ‘whole-ecosystem’ benefits that in-kind mitigation projects provide. (Ambrose 1994) For example, purchasing commercial fishing capacity has been proposed as a potential mitigation strategy to assist in preventing overfishing or allow rebuilding of stocks of fish. Purchasing commercial fishing capacity may increase larval production because fish that are not removed through fishing would continue to reproduce and replenish larvae. (Stratus 2004) However, there is no guarantee the mitigation strategy will result in surplus production or increased productivity to compensate for losses. Furthermore, this out-of-kind mitigation strategy only compensates for commercially fished species, and does not mitigate for all organisms lost to entrainment. Similarly, mitigating environmental impacts by establishing or contributing to a fish hatchery can increase larval abundance for the managed species. (Stratus 2004) But, this mitigation strategy will only compensate for losses to one species, and does not mitigate for all other entrained species.

Other out-of-kind mitigation strategies may include habitat protection, habitat monitoring, improving water or sediment quality in a habitat, restoring upstream habitat, or storm water management. Habitat protection and monitoring projects cannot provide adequate mitigation for desalination impacts because they do not result in an increase in biological productivity. The preserved or monitored habitat already exists and there is no evidence that preservation of the habitat will result in additional biological productivity that replaces the entrained organisms. Improving water or sediment quality in a habitat, restoring upstream habitat, or storm water management may improve the quality of an environment that may lead to an increase in biological productivity; however, the productivity may be from dissimilar resources. (Stratus 2004; Ambrose 1994)

Appropriate mitigation options should be assessed on a facility-specific basis. Previous studies on facilities with similar impacts to a desalination facility indicated the restoration and creation of estuaries, coastal wetlands, intertidal mudflats, natural reefs, or kelp beds and other marine vegetation were all means to increase productivity in marine ecosystems. (Stratus 2004;

Ambrose 1994) Eelgrass, surfgrass, kelp and other algae, and rocky reefs provide habitat with structural complexity where larval and juvenile organisms can avoid predation. Additionally, eelgrass, surfgrass, kelp and other algae are primary producers, meaning that they aid in the production of plants, cyanobacteria and many other organisms and are able to perform a variety of beneficial ecosystem functions (e.g., prevent sediment erosion, carbon sequestration, flood mitigation). The newly created or restored habitat promotes replacement of the lost species through an increase in biological productivity and restored ecosystem functions. (Stratus 2004; Steinbeck 2011; WateReuse 2011b; DeMartini et al. 1994)

Another in-kind mitigation alternative for desalination facilities is for the owner or operator of the Desalination facility to contribute to California's MPA network. The Marine Life Protection Act (§2851(f)) states that marine life reserves "protect habitat and ecosystems, conserve biological diversity, [and] provide a sanctuary for fish and other sea life." MPAs, where commercial and recreational fishing are prohibited, protect species whose larvae will spill over the boundaries of the MPA and help replenish populations outside the MPA. (Gleason et al. 2012; Harrison et al. 2012; Wen et al. 2013) MPAs (particularly no-take or limited-take MPAs) have the potential to increase biological diversity and productivity of an ecosystem. Mitigation projects that expand the size of a MPA or increase the quality and productivity within a MPA may provide compensatory biological productivity for operational impacts associated with desalination. Enforcement of limitations imposed within MPAs may also help increase biological productivity through protection of larger breeding stock fish (and other commercial organisms). Contributing funds to enforce existing within MPAs may help to prevent poaching and consequently increase larval productivity. However, enforcement of MPA regulations at existing MPAs is logistically and economically challenging. MPAs span large areas of the ocean and staffing enforcement officers to monitor for illegal activities is resource intensive. (Marine Conservation Institute 2013)

8.5.3 Fee-based Mitigation

An alternative approach to an owner or operator creating a mitigation project is to pay a fee-based mitigation program to mitigate projects that would increase or enhance the viability and sustainability of marine life (Foster et al. 2012). Mitigation banks and fee-based mitigation are a means for an owner or operator of a facility to mitigate for the facility's impacts without having the burden of managing a mitigation project. Additionally, mitigation funds can be managed by organizations that are experienced in mitigation and have a history of successful mitigation projects. Funds can be pooled from multiple small projects and be put towards a large mitigation project that has a higher mitigative potential.

In California, fee-based mitigation programs or mitigation banks exist for wetlands, vernal pools, chaparral, coastal sage scrub, riparian forest, specific species (e.g. California tiger Salamander), and a few other habitats. (CDFW 2014) Conservation and mitigation banks are typically reviewed and approved by an interagency review team (e.g. CDFW or the Army Corps of Engineers). (U.S. EPA 2014) Typically, in order for a fee-based mitigation program to receive accreditation, it must meet all of the criteria listed below in addition to any other factors required by the overseeing agency the program:

- Has legal and budgetary authority to accept and spend funding
- Has a history of successful mitigation projects
- Has the physical acreage of successful mitigation projects restored, established, enhanced, or preserved
- Funds projects that will directly mitigate for the type of impacts occurring
- Is responsible for the long-term management and ecological success of the mitigation project
- Can provide financial assurances to ensure projects are funded in perpetuity

Currently in California, there is no established fee-based mitigation program for marine mitigation. However, in the future, a fee-based mitigation program could be developed for marine mitigation. Mitigation project costs depend on a number of variables and costs can vary widely. (ECONW 2012) At this time it would not be appropriate to determine a statewide mitigation fee for fee-based mitigation programs that will be established in the future because there is not enough information to establish a cost that would be appropriate for every facility impact. If such a program is developed, an owner or operator of a facility would pay a sum that is equivalent to the cost of the mitigation project, determined through a process established to assess marine life mortality associated with the project. If a project is designed to mitigate cumulative impacts from multiple desalination facilities or other developmental projects, the amount paid should be based on the desalination facility's fair share of the cost. A detailed discussion of the cost of existing and past mitigation projects for desalination facilities and OTC facilities is included in the Economic Analysis (Appendix G).

8.5.4 Adding Certainty to Mitigation Projects

It is important to ensure that marine life mortality is fully mitigated. Biological productivity created by a mitigation project should be sufficient to ensure there is no net loss in productivity from the operation of a desalination facility. When the size of a mitigation project is determined, there may be some statistical uncertainty associated with the calculations of productivity forgone versus mortality associated with the facility. The examples below describe how adding greater statistical confidence to the calculation or applying a mitigation ratio can help to ensure that the area affected by the desalination facility is fully mitigated.

8.5.4.1 Confidence Intervals

A facility's APF is calculated by measuring the productivity forgone for several species, then averaging those measurements for an "average APF." A key assumption in the ETM/APF approach is that the APF estimates for specific species are representative of all species present at that location, even those that were not directly measured. As with any technique for calculating mitigation habitat area, it is not possible to be 100 percent confident the calculated APF will fully compensate for impacts. The drawback of using an average APF lies in the degree of certainty, or confidence level, that the calculated APF will fully compensate for a desalination facility's impacts.

Using an average APF means that there is a 50 percent chance that a mitigation project will underestimate the mitigation area needed to fully compensate for a facility's impacts. We can increase our confidence in whether our APF acreage is fully compensatory by calculating confidence intervals from the available data, and adding the confidence intervals to the average APF. The resulting value will be greater than the average APF, but will have a greater degree of confidence (a higher confidence level) that the project will fully mitigate for impacts to the environment.

The Nth percent confidence level APF is the acreage required given an Nth level of certainty that a mitigation project will be fully compensatory. Confidence intervals and levels can be determined for any desired level of certainty (e.g., 70th percent, 80th percent, etc.). By using a higher confidence level, there will be a greater likelihood that a mitigation project will fully compensate for a facility's impacts. For example, using a 90th percentile confidence level means that we are 90 percent certain that the size of the mitigation project will fully compensate for entrainment impacts caused by a desalination facility.

Calculating confidence intervals from the available data, then adding those confidence intervals to the average APF, will shift the size of the required mitigation project upward, increasing the cost of a mitigation project, but ensuring the project is compensatory for impacts. (Raimondi 2011) In essence, using a higher percentile confidence level does the following:

1) Calculates the average APF from a subset of species in a community;

2) Develops confidence intervals around the average APF. The confidence interval is a function of the number of organisms used to calculate the average APF and the standard deviation of those APF calculations. The confidence interval is the 'extra' acreage needed to provide greater certainty that a mitigation project is fully compensatory;

3) Adds the confidence intervals to the average APF to determine a confidence level**.** The confidence level is the acreage required given a desired level of certainty (e.g., 90 percent confident) that a mitigation project will be fully compensatory.

There are numerous examples where the State Water Board or other state regulatory agencies have required greater statistical certainty for a regulatory action. The Instream Flow Policy shifted calculations of minimum bypass flow upwards by three standard errors (approximately equivalent to a 99 percent confidence level) in order to increase certainty that the minimum stream flow calculations were protective of salmonids. The required flow conditions are notably conservative, but the trade-off is that an owner or operator does not have to do site-specific assessments. Additionally, soil and groundwater cleanup standards at brownfield and underground storage tank contamination sites must meet a specified cleanup goal (typically a 95 percent confidence level) based on numerous soil/water samples and replicates. The Carlsbad Desalination Project is required to compare their constructed mitigation project with natural reference sites, and must meet an 80 percent level of certainty that the constructed mitigation wetland is functioning similarly to the natural reference site. (Poseidon Resources Channelside 2008) Wetlands are also frequently required to mitigate for a larger area than the impacted area, in order to ensure that productivity of the restored/constructed area is equivalent to the productivity lost by removal of the native habitat. (ECONW 2012) The use of confidence levels can increase the confidence that a project will completely mitigate for an impact. (Raimondi 2011)

The Ocean Plan also requires a 95 percent confidence level when determining significance (see definition of “significant” in the Ocean Plan) and for the Reasonable Potential Analysis Procedure for Determining Which Table 1 Objectives Require Effluent Limitations in Appendix VI of the Ocean Plan (see Step 9). Including a requirement that the APF be calculated using a one-sided, upper 95 percent confidence bound for the 95th percentile of the APF distribution is consistent with existing requirements in the Ocean Plan.

All of the examples listed above ask for greater statistical certainty that a proposed action will be successful. Although a 95th percentile confidence interval may appear to require a very high level of statistical certainty, the confidence level is less than other types of Board requirements (In-stream Flow Policy, cleanup standards). In practice, the amount of additional acreage needed for a 95th percentile confidence level is relatively low in comparison to the total size of a mitigation project. The amount of additional acreage needed will largely depend on how well the study was done.

Two example data sets are provided below to illustrate how a confidence level will impact the size of a required mitigation project based on the data collected. Data Set 1 and Data Set 2 are identical for the first ten species, but Data Set 2 includes data from an additional ten species. APF values have been measured for 10 species in Data Set 1. The ETM/APF analysis assumes the 10 species are diverse and are representative of all species in the ecosystem. The average APF is 77.4 acres, meaning that 77.4 acres is a representative mitigation area for *all species present in the ecosystem*; however, there is relatively low confidence (only 50 percent) that the calculated area is fully compensatory. To be more confident that the mitigation area fully compensates for a desalination facility’s surface intake, the confidence intervals can be set to a desired level of certainty. This can be done by calculating the confidence interval, and then adding that interval to the average APF.

The data in Data Set 1 shown in Table 8-2 and Figure 8-6 below, the 80th percentile confidence interval is 10.4, the 90th percentile confidence interval is 15.8, and the 95th percentile confidence interval is 20.3. The size of a mitigation area that we are 95 percent confident will be fully compensatory is calculated as the average APF plus the confidence interval of 20.3, yielding a total of 97.7 acres. The acreage difference between the 50th percentile confidence level and the 95th percentile is not exponential but rather 26 percent larger than the average APF.

Table 8-2. Data Set 1 includes the area of production forgone data for Species 1 to 10. The average APF is included along with the 80th, 90th, and 95th percent confidence levels using the one-sided upper confidence bound.

Species	APF
Species 1	30
Species 2	90
Species 3	140
Species 4	55
Species 5	50
Species 6	110
Species 7	86
Species 8	68
Species 9	122
Species 10	23
50th Percentile Confidence Level = Average APF	**77.4 Acres**
80th Percentile Confidence Level = Average APF + 10.4 acres	**87.8 Acres**
90th Percentile Confidence Level = Average APF + 15.8 acres	**93.2 Acres**
95th Percentile Confidence Level = Average APF + 20.3 acres	**97.7 Acres**

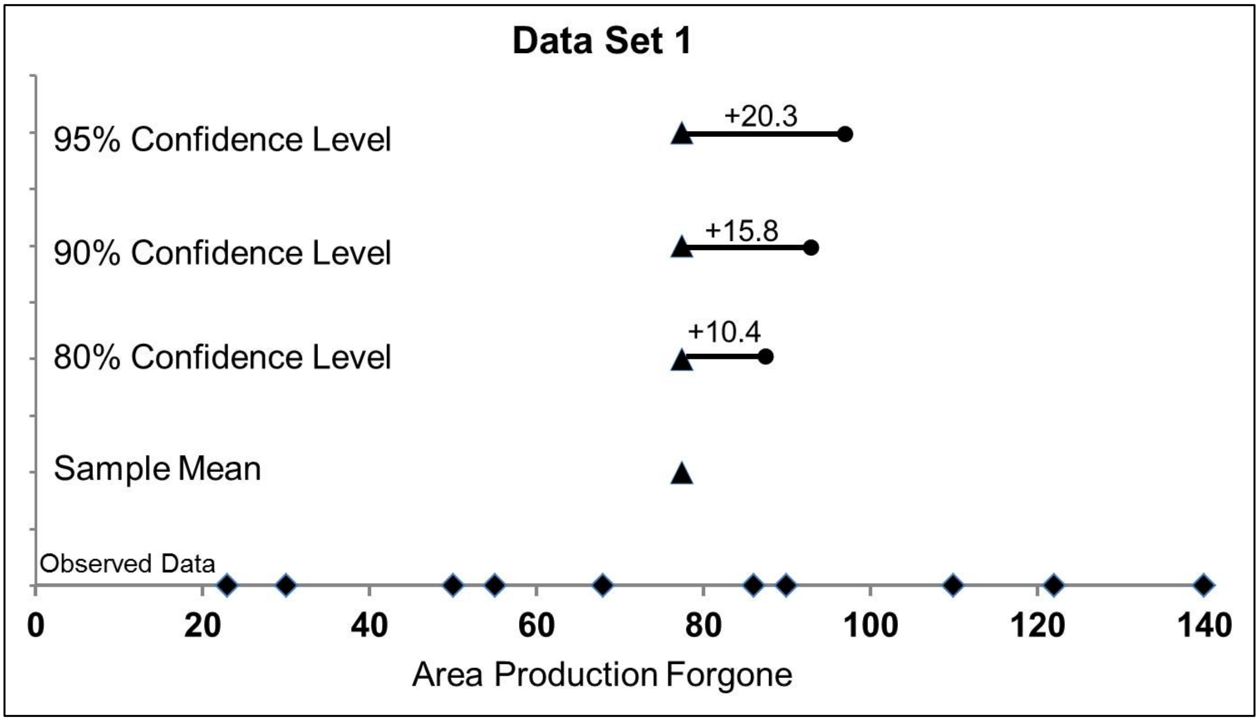


Figure 8-5: Visualization of the confidence interval data from Data Set 1. The observed data are plotted along the x axis. The average APF is included along with the 80th, 90th, and 95th percent confidence levels using the one-sided upper confidence bound. The circles to the right of the triangles show the acres required to mitigate once the upper bound confidence interval is applied.

The data in Data Set 2 shown in Table 8-3 and Figure 8-6 below, the average APF is 77.0 acres. APF values have been measured for 20 species. The 20 species are diverse and are assumed to be representative of all species in the ecosystem. The 80th percentile confidence interval is only 5.6, the 90th percentile confidence interval is 8.6, and the 95th percentile confidence interval is 11.0. The size of a mitigation area that we are 95 percent confident will be fully compensatory is calculated as the average APF plus the confidence interval of 11, yielding a total of 87.9 acres. For Data Set 2, the acreage difference between the 50th percentile confidence level and the 95th percentile is only 14 percent larger than the average APF. This is almost half as much as the added acres for Data Set 1. Since the variance is lower in Data Set 1, the confidence intervals are smaller. This example demonstrates the value in conducting a complete analysis so the variance in the sample is low. This will make the confidence interval smaller and result in fewer acres of mitigation required when using a 95 percent confidence level.

Table 8-3: Data Set 2 includes the area of production forgone data for Species 1 to 20. The average APF is included along with the 80th, 90th, and 95th percent confidence levels using the one-sided upper confidence bound.

Species	APF
Species 1	30
Species 2	90
Species 3	140
Species 4	55
Species 5	50
Species 6	110
Species 7	86
Species 8	68
Species 9	122
Species 10	23
Species 11	94
Species 12	99
Species 13	96
Species 14	79
Species 15	91
Species 16	80
Species 17	68
Species 18	55
Species 19	49
Species 20	54
50th percentile Confidence Level = Average APF	**77.0 Acres**
80th percentile Confidence Level = Average APF + 5.6 acres	**82.6 Acres**
90th percentile Confidence Level = Average APF + 8.6 acres	**85.5 Acres**
95th percentile Confidence Level = Average APF + 11.0 acres	**87.9 Acres**

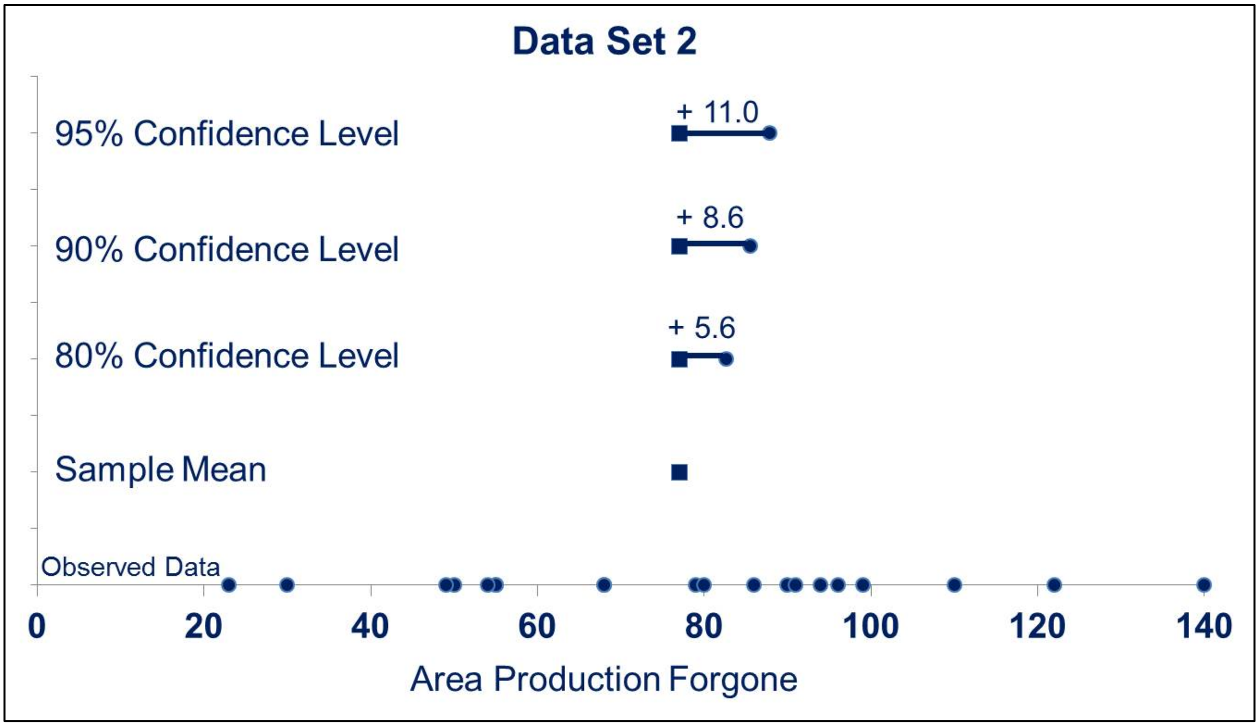


Figure 8-6 Visualization of the confidence interval data from Data Set 2. The observed data are plotted along the x axis. The average APF is included along with the 80th, 90th, and 95th percent confidence levels using the one-sided upper confidence bound. The circles to the right of the squares show the acres required to mitigate once the upper bound confidence interval is applied.

8.5.4.2 Mitigation Ratios

Another way to ensure there is no net loss of productivity is to use mitigation ratios expressed as the area required for compensation vs. the area of impact. (ECONW 2012) A mitigation ratio is calculated as the number of acres of created, restored, or enhanced mitigation habitat to each acre of natural habitat being impacted. For example a 3:1 mitigation ratio would mean that three acres of habitat would be created, restored, or enhanced through mitigation for every acre of impacted habitat. Mitigation ratios are commonly used when creating or restoring a habitat because the mitigation project is often not as successful as naturally functioning habitat in terms of ecosystem functions, including productivity. Adding mitigation acreage compensates for the disparity in productivity between the natural and created or restored habitat. Mitigation ratios can also be applied when doing out-of-kind mitigation for open water and soft-bottom habitats and the created, restored, or enhanced habitat is more productive than the open water and soft-bottom habitats.

<u>Mitigation Ratios Scenario 1: Impacts to Highly Productive Habitats</u>

The concept of applying a mitigation ratio stems from wetlands mitigation, where the restored, created, or enhanced habitat does not always provide “full, immediate, and riskless replacement of all services provided by each acre of impacted wetland.” (King and Price 2004) Often with wetlands mitigation projects, the restored or created habitat provides different habitat functions and services than the lost natural habitat. This could be from differences between the locations of the mitigation site and the natural habitat or because newly mitigated habitat takes time to develop ecosystem functions and services that occur in older, more established habitats (e.g. note the ecosystem differences between a newly planted redwood forest and a hundred year old redwood forest). A mitigation ratio can be applied to compensate for the differences between the impacted habitat and the habitat that will be restored, created, or enhanced.

A mitigation ratio is calculated as the number of acres of mitigated habitat (created, restored, or enhanced) to each acre of natural habitat being impacted. When there is a risk the mitigated habitat will not provide "full, immediate, and riskless replacement of all services provided by each acre of impacted wetland [or other habitat]," a higher mitigation ratio can be applied. For example, a mitigation ratio of 4:1 would mean that four acres of habitat would be created, restored, or enhanced as mitigation for every acre of natural habitat impacted by the project. Mitigation projects for impacts to highly productive marine habitats like wetlands, estuaries, kelp beds, surfgrass beds, eelgrass beds, and rocky reefs may require higher mitigation ratios because the impacts may be permanent. A higher mitigation ratio will help to ensure the project fully mitigates for all impacts.

When determining a mitigation ratio for wetlands mitigation, King and Price (2004) stated, "To account for differences in the ecosystem services provided per acre by impacted and replacement wetlands, a mitigation ratio should take into account the following five factors:

1. The existing level of wetland function at the site prior to the mitigation;
2. The resulting level of wetland function expected at the mitigation site after the project is fully successful;
3. The length of time before the mitigation is expected to be fully successful;
4. The risk that the mitigation project may not succeed; and
5. Differences in the location of the lost wetland and the mitigation wetland that affect the services and values they have the capacity and opportunity to generate."

These five factors could also be considered with other habitat types such as rock reefs, kelp beds, eelgrass beds, and surfgrass beds when determining an appropriate mitigation ratio. Replacement of these habitat types should be in-kind whenever possible. In-kind mitigation is when the habitat or species lost is the same as what is replaced through mitigation. (Ambrose 1994) In-kind mitigation may not be practical or feasible for impacts to open water or soft-bottom species. In this case, out-of-kind mitigation may be appropriate (see below).

Mitigation Ratios Scenario 2: Impacts to Open Water and Soft-Bottom Species and Habitats

A mitigation ratio can be also applied to out-of-kind mitigation for open water and soft-bottom habitats. Out-of-kind mitigation is when the habitat or species lost is different than what is replaced through mitigation. Normally when out-of-kind mitigation is performed, a higher mitigation ratio compensates for the fact that the mitigation will not provide a direct or complete replacement of the losses. However, for impacts to open water and soft-bottom habitats, a lower mitigation ratio may be appropriate for out-of-kind mitigation when the alternative habitat is more productive than the open water and soft-bottom habitats.

When a desalination facility entrains open water or soft-bottom species, creating, restoring, or enhancing a more productive habitat such as coastal estuarine habitat may result in a better overall mitigation project. It may not be possible, practical, or feasible to conduct mitigation project of open water or soft-bottom habitats. Even though the organisms replaced would not necessarily be the same species as the organisms that were entrained, this approach would result in no net loss of biological productivity if the mitigation project is successful.

Figure 8-7 below to help illustrate how biological productivity can vary between two habitats. In this example, there is four times as much biomass, or biological productivity, in the estuarine habitat than in the open coastal or soft-bottom habitats. If an owner or operator was allowed out-of-kind mitigation, but required to use a 1:1 mitigation ratio, the mitigated habitat may produce up to four times as much biomass as the amount of biomass that was lost. For this reason, Poseidon requested a mitigation ratio be applied that would compensate for the differences in biological productivities between the mitigated and impacted habitats, which would result in equivalent amounts of biomass lost and produced. In the example provided in Figure 8-7, one acre of estuarine habitat has the equivalent biomass as four acres of open coastal or soft-bottom habitat. Applying a mitigation ratio of 1:4, or one acre of estuarine habitat restored for every four acres of open water or soft-bottom habitat, would result in a balance of biological productivity lost and produced.

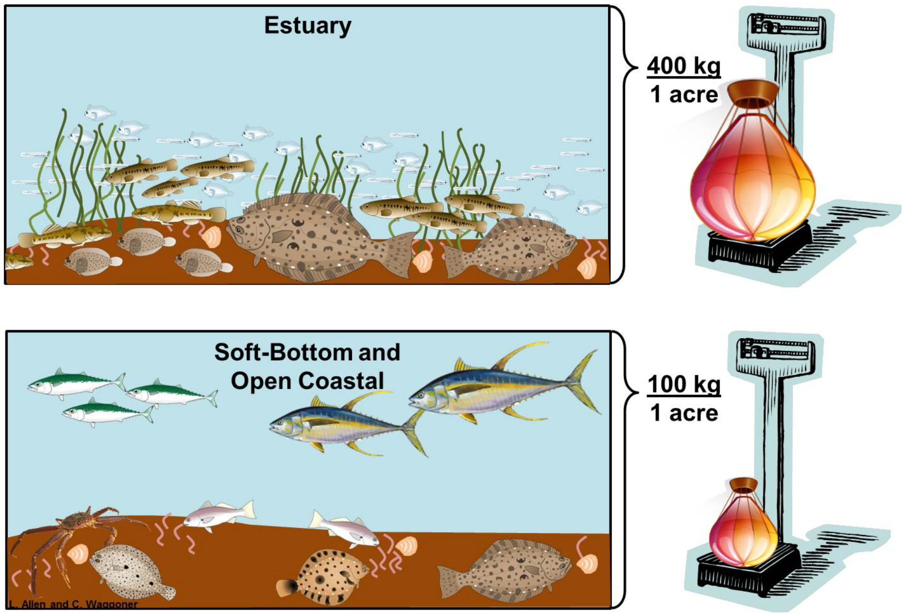
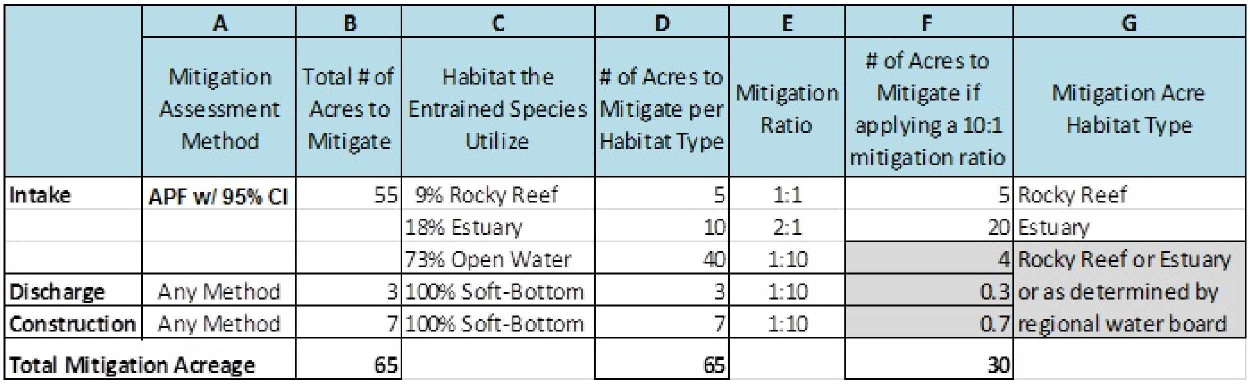


Figure 8-7. Marine inhabitants of an estuarine environment compared to a soft-bottom open coastal environment. Biological productivity can be compared using biomass, which is the weight of all of the organisms in a given area. Estuarine environments usually have higher biological productivity and biomass compared to open water and soft-bottom environments. In this example, the estuarine habitat is four times more productive than the soft-bottom open coastal habitat.

Example of Applying Mitigation Ratios

As described above, mitigation ratios are complicated and will vary on a project-by-project basis. Table 8-4 below includes an example of how mitigation ratios could be applied for the different impacts and habitat types. Column A includes the mitigation assessment method that will be used to determine the number of acres to mitigate. Column B is the number of acres initially calculated for mitigation using the assessment method in Column A. For intake-impacts, the number of acres to mitigate (as determined by APF) will be broken down based on the habitat the impacted species utilize and is listed in Column C. In this example, 9 percent of the entrained species inhabited rocky reefs, 18 percent inhabited estuarine habitat, and 73 percent live in open water nearshore environment. Column D breaks down the numbers of acres to be mitigated per habitat type before consideration of a mitigation ratio. Column E includes an example mitigation ratio based on habitat type (e.g. Scenario 1 or Scenario 2 above). The regional water boards could require a mitigation ratio from 1:1 to 1:10 for impacts to open water and soft-bottom species and a mitigation ratio greater than 1:1 for more productive habitats. In this example, a 1:10 mitigation ratio is applied for open water and soft-bottom habitats, 2:1 for the estuarine habitat, and 1:1 for the rocky reef habitat. The regional water boards would determine an appropriate mitigation ratio based on the factors mentioned above. Column F includes the number of acres to mitigate after applying the mitigation ratio. Column G is the associated habitat to be mitigated for the acres in Column F.

Table 8-4. Example mitigation calculation and how mitigation ratios could be applied.



	A	B	C	D	E	F	G
	Mitigation Assessment Method	Total # of Acres to Mitigate	Habitat the Entrained Species Utilize	# of Acres to Mitigate per Habitat Type	Mitigation Ratio	# of Acres to Mitigate if applying a 10:1 mitigation ratio	Mitigation Acre Habitat Type
Intake	**APF w/ 95% CI**	55	9% Rocky Reef	5	1:1	5	Rocky Reef
			18% Estuary	10	2:1	20	Estuary
			73% Open Water	40	1:10	4	Rocky Reef or Estuary or as determined by regional water board
Discharge	Any Method	3	100% Soft-Bottom	3	1:10	0.3	
Construction	Any Method	7	100% Soft-Bottom	7	1:10	0.7	
Total Mitigation Acreage		**65**		**65**		**30**	

Mitigation Credit for Using Screens

The ETM/APF mitigation assessment method assumes an unscreened or uncontrolled intake. A mitigation credit could be applied to the acreage required to mitigate for intake-related impacts to account for the entrainment reduction the screens provide. The Expert Review Panel on Desalination Plant Entrainment Impacts and Mitigation (Foster et al. 2013) reported that intake screens reduce entrainment of all organisms present in seawater by no more than one percent. Therefore, the mitigation credit applied to the APF to account for entrainment reduction provided by a screen should be no more than one percent.

Subsurface intakes do not impinge or entrain marine life and consequently do not require mitigation for operational-related mortality; however, they are not feasible at all locations. Screens with small slot sizes (0.5 to 1.0 mm) can be installed at open seawater intakes to reduce entrainment of adult organisms and larger larvae. Smaller organisms like phytoplankton will still be entrained even if screens with very small (<0.5 mm) slot sizes are used. These small organisms are a critical component of the marine ecosystem because they form the base of the marine food web.

Per California Water Code section 13142.5(b) an owner or operator of a new or expanded desalination facility will be required to mitigate for any entrainment mortality that occurs at a screened intake. The Expert Review Panel on mitigation recommended using the empirical transport model coupled with the area of production forgone (ETM/APF) method to assess mitigation at desalination intakes. The ETM/APF model is based on an open pipe or unscreened intake. The ETM/APF model assumes that the species that are assessed in the model represent the species that are not assessed, including organisms that are too small to include in the ETM/APF model.

The Expert Review Panel was asked how to adjust the mitigation acreage for entrainment reduction devices like screens. The Expert Review Panel provided a clear method for how to appropriately apply the entrainment reduction to the APF calculation. Additionally, the Expert Review Panel reported that while screens can be an effective tool for reducing entrainment of larger larval organisms, when all organisms in seawater are considered, screens reduce entrainment mortality less than one percent. (Foster et al. 2013),

A regional water board could credit an owner or operator one percent of their mitigation acreage that would be required for the facility’s intake-related impacts when using a screened intake. An owner or operator should not be allowed to determine their own mitigation credit for their facility because the method used to calculate the mitigation credit can dramatically affect the mitigation credit. Staff is concerned that an owner or operator would incorrectly calculate and apply the entrainment credit to the ETM/APF calculation, which could result in insufficient mitigation for the facility’s impacts.

In 2013, West Basin Municipal Water District submitted a report called “Entrainment: Intake Entrainment 5 Step Calculation” to the State Water Board. The mitigation assessment method described in the report used a “whole-life cycle” approach and head capsule entrainment modeling data (to factor in the entrainment reduction from the screens) to come up with an entrainment ratio which they then applied to the acres required for mitigation. The State Water Board asked the Expert Review Panel to review West Basin’s mitigation credit method and their comments are in Appendix 4 of the Final Report for Desalination Plant Entrainment Impacts and Mitigation (http://www.swrcb.ca.gov/water_issues/programs/ocean/desalination/docs/erp_final.pdf).

In their review, the Expert Review Panel stated, “There are a number of questions/issues that need to be addressed prior to a substantive assessment of WBMWD (2013).” Some of the conclusions and assumptions in West Basin’s report were not adequately explained and their mitigation assessment method incorrectly applied the “credit” they calculated to the mitigation model, which significantly reduced the acres required for mitigation.

The ETM/APF mitigation model is complicated enough without having to do additional studies and calculations to determine and apply a mitigation credit. As mentioned earlier, the method used to determine the mitigation credit can significantly influence the end result. The figure below demonstrates how the entrainment credit can change depending on the size of organisms included in the calculation.

The ETM/APF study in the Desalination Amendment only requires the analysis of organisms 0.3 mm and larger. Organisms smaller than 0.3 mm should be factored in to the entrainment reduction calculation; however, we do not require an owner or operator to sample organisms smaller than 0.3 mm. In order to holistically assess entrainment, an owner or operator would be required to do additional studies to measure entrainment of organisms smaller than 0.3 mm. The regional water board may apply a one percent credit for the screens because it would 1) provide a consistent statewide standard for mitigation credit for screens, 2) prevent an owner or operator from having to perform additional studies, and 3) would prevent the risk of inadequate mitigation resulting from either the use of an inappropriate mitigation assessment model or an incorrect calculation in the ETM/APF model.

8.5.5 Regulatory Considerations

The regional water boards are responsible for making 13142.5(b) determinations as to whether a project minimizes marine life mortality through the application of best available siting, design, technology, and mitigation. The determination of whether mitigation measures are necessary is generally part of the design process of a facility, and is addressed directly as part of the CEQA process. At present, there are no statewide standards that can be used to calculate the amount of mitigation needed to compensate for a desalination facility’s entrainment impacts. The regional water board’s permitting process may happen before or after other local and state agencies have issued permits. The discussion below is specific to mitigation to compensate for marine life mortality caused by the operation (intake and discharge) of a facility, and does not include mitigation that may be required by other agencies.

Projects may also be subject to Coastal Act requirements. Coastal Act (§30230) requires that:

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

Furthermore, Coastal Act section 30231 states that biological productivity and the quality of coastal waters, wetlands, and estuaries shall be maintained and restored if possible, and that the adverse effects of entrainment should be minimized. The California Coastal Commission is authorized to implement these requirements found in the Coastal Act.

The OTC Policy requires interim mitigation to compensate for impacts that occur at power plants until those plants are fully compliant. At present, the Ocean Plan does not address the amount of mitigation that will be required for entrainment that occurs at long-term stand-alone desalination facilities. The lack of a statewide plan or policy for sizing mitigation projects could lead to inadequate mitigation for some projects, as well as inconsistencies among regions. The following issue examines approaches for calculating the amount of mitigation necessary to fully compensate for marine life mortality caused by desalination intakes and discharges.

8.5.6 Options

- **Option 1: No Action.** Under Option 1, the regional water boards would continue to make 13142.5(b) determinations for desalination facilities applying for NPDES permits without the direction provided by a statewide plan. Regional water boards would continue to determine mitigation requirements for facilities and review and approve plans, studies, and reports submitted by the owner or operator of the facility prior to issuing a NPDES permit. Under Option 1, regional water boards may use variable methods for determining how much mitigation will be needed for a mitigation project; the plans, studies, and reports submitted to the regional water board would be disordered and inconsistent among the regions and projects. Option 1 does not provide a consistent statewide approach for minimizing intake and mortality of marine life, protecting water quality, and related beneficial uses of ocean waters.

- **Option 2: Amend the Ocean Plan to allow an owner or operator to independently determine the amount of mitigation required to compensate for their facility's impacts using methods of the owner or operator's choice with oversight by the Water Boards.** Under this option, the State Water Board would amend the Ocean Plan to address mitigation calculations and mitigation options for new or expanded desalination facilities. Regional water boards in consultation with State Water Board staff would use the provisions in the Ocean Plan as guidelines for making section 13142.5(b) determinations in regards to mitigation.

  Under Option 2, the Desalination Amendment would allow intake-, discharge-, and construction-related mortality to be calculated using a method of the owner or operator's choice. The choice of confidence level would be determined by the owner or operator with oversight by the regional water board. Intake-related mortality could be assessed using methods including but not limited to ETM/APF, FH, and AEL. An owner or operator could complete a mitigation project or pay in-lieu funding to an accredited fee-based mitigation program to be approved by the Water Boards. If the owner or operator chose to pay an in-lieu fee, the fee would be based on a calculation of the average cost per acre of expansion, restoration, or creating of kelp beds, estuaries, coastal wetlands, natural reefs, MPAs, or other projects approved by the regional water board.

  Option 2 would provide flexibility for an owner or operator in the method they use to assess impacts from their facility. However, the ETM/APF approach is the most appropriate method for assessing how much mitigation will be needed for intake-related impacts. (Foster et al. 2013) In addition, there is significant risk that mitigating an area equivalent to the average APF would result in inadequate mitigation. (Raimondi 2011) Finally, if each owner or operator of a facility calculates the average cost per acre of expanding, restoring, or creating of kelp beds, estuaries, coastal wetlands, natural reefs, MPAs, or other projects, there will be inconsistencies between the different methods of assessing impacts from their facility. Option 2 does provide a consistent statewide approach for minimizing intake and mortality of all forms of marine life, protecting water quality, and related beneficial uses of ocean waters, and the benefits of the flexibility do not outweigh the risks involved with moving forward with this option.

- **Option 3: Amend the Ocean Plan to require an owner or operator to determine the amount of mitigation required to compensate for their facility's impacts using methods prescribed in the Ocean Plan with oversight by the Water Boards.** Under this option, the State Water Board would amend the Ocean Plan to address mitigation calculations and mitigation options for new and expanded desalination facilities. Regional water boards in consultation with State Water Board staff would use the provisions in the Ocean Plan as direction for making section 13142.5(b) determinations in regards to mitigation.

  The Desalination Amendment would require that an owner or operator submit a Marine Life Mortality Report to the regional water board as part of their request for a section 13142.5(b) determination. The Marine Life Mortality Report would identify the type and number of organisms at risk so that the Mitigation Plan can be tailored to address those organisms and larger mitigation project goals. For example, previous open water intake studies have identified that juvenile and larval marine organisms suffer the most significant impacts from operational mortality; consequently, wetlands or rocky reef restoration projects were used to compensate for the losses. A Mitigation Plan for desalination-related mortality would focus on increasing survivorship or replacement of the larval and juvenile life stages of affected species as identified in the Marine Life Mortality Report.

  The Marine Life Mortality Report would include a calculation of the number of acres needed to mitigate for marine life mortality that results from the intakes, discharges, or construction of the facility:

  1. Intake-related impacts would be assessed using an ETM/APF approach and the final APF would be calculated using the one-sided upper95 percent confidence bound for the 95th percentile of the APF distribution. Although a 95th percentile confidence interval may appear to require a very high level of statistical certainty, the confidence level is less than other types of current Board requirements (e.g. Ocean Pln, Instream Flow Policy, cleanup standards). In practice, the amount of additional acreage needed for a 95th percentile confidence level is relatively low in comparison to the total size of a mitigation project. Guidance for conducting an ETM/APF analysis is provided in Appendix E.

2. Discharge-related impacts would be estimated by determining the area or volume in which salinity exceeds 2.0 ppt above natural background salinity (or an alternative facility-specific alternative receiving water limitation).

3. An owner or operator would also estimate the area disturbed by construction of the facility that results in marine life mortality. The regional water board may determine the construction-related disturbance does not require mitigation because the disturbance is temporary and the habitat is naturally restored.

4. The regional water boards will need to evaluate the Marine Life Mortality Reports and Mitigation Plans on a project-specific basis and establish an appropriate mitigation ratio for each of the habitat types that would be mitigated to compensate for the lost species to ensure the impacts from desalination facilities are fully mitigated.

5. The regional water board may permit out-of-kind mitigation for mitigation of open water or soft-bottom species. But, in-kind mitigation should be done for all other species whenever feasible.

   For both in-kind and out-of-kind mitigation, the regional water boards may increase the required mitigation ratio for any species and impacted natural habitat calculated in the Marine Life Mortality Report when appropriate to account for imprecisions associated with mitigation, including but not limited to, the likelihood of success, temporal delays in productivity, and the difficulty of restoring or establishing the desired productivity functions.

Under Option 3, the Desalination Amendment would include a requirement that an owner or operator provide the regional water boards with the necessary information to establish mitigation ratios. A standard mitigation ratio (e.g. 1:10) could be applied for impacts to soft-bottom or open coastal habitats. But this could be problematic since in some instances, a 1:10 mitigation ratio will be too high. For example, in some locations soft-bottom habitat serves as an essential fish habitat or a market squid nursery. When the soft-bottom or open water habitats are more productive, the mitigation ratio should be adjusted accordingly. Furthermore, coastal wetlands, estuaries, kelp beds, rocky reefs, eelgrass, and surfgrass beds are all habitats that are usually more productive than soft-bottom and open coastal habitats. Each of these more productive habitat types may be an appropriate alternative mitigation option for impacts to soft-bottom and open coastal habitats Under Option 3, this would be determined on a case-by-case basis since the productivity of each of these habitats will vary among habitat types and locations.

Since the type of alternative habitat selected for mitigation and the productivity of that habitat will vary, an owner or operator will need to evaluate the relative productivity of the impacted natural habitat to the estimated productivity of the replacement habitat on a case-by case basis. The information should be provided to the regional water board to establish an appropriate mitigation ratio. For mitigation of impacts to open ocean or soft bottom habitats, the regional water board may determine that a mitigation ratio less than 1:10 (e.g. 1:5, 2:1) is more appropriate, but the regional water board should not use a mitigation ratio exceeding 1:10 (e.g. 1:20). As mentioned in Mitigation Ratios Scenario 1: Impacts to Highly Productive Habitats, a mitigation ratio of at least 1:1 (e.g. 2:1, 3:2) should be used for all other habitat types (estuarine, wetland, kelp, surfgrass, and rocky reef habitats). The rationale for the mitigation ratios should be documented in the administrative record for the permit action.

An owner or operator would be required to mitigate for the area affected by the intakes, discharges, and construction by doing one of the following mitigation options:

1. Complete a mitigation project that is equivalent in size to the total impacted area calculated in the Marine Life Mortality Report. The mitigation project would need to expand, restore, or create of one or more of the following habitats: kelp beds, estuaries, coastal wetlands, natural reefs, MPAs, or other projects approved by the regional water board, or;

2. Provide funding to an appropriate fee-based mitigation program approved by the regional water boards. An appropriate fee-based mitigation program should have a history of successful mitigation projects documented by having set and met performance standards for past projects, and stable financial backing in order to manage mitigation sites for the operational life of the facility. The amount of the fee should be based on the cost of the mitigation project, or if the project is designed to mitigate cumulative impacts from multiple desalination facilities or other development projects, the amount of the fee should be based on the desalination facility’s fair share of the cost of the mitigation project.

Option 3 will ensure impacts from desalination facilities are measured and mitigated. Providing guidance on the types of mitigation projects that should be done for a facility will ensure the resources lost are replaced with similar resources. Requiring a statewide method for calculating impacts and providing mitigation guidelines will meet project goals by eliminating inconsistencies among projects and regions.

8.5.7 Staff Recommendation

Staff recommends Option 3, updating the Ocean Plan to provide statewide guidance on the appropriate methods for determining the nature and size of a mitigation project to ensure all desalination-related mortality is mitigated for a facility.

8.5.8 Proposed Amendment Language

See chapter III.M.2.e of Appendix A.

8.6 How should the State Water Board regulate brine discharges?

As discussed in section 2, future innovations in desalination technologies may significantly reduce or eliminate brine discharges. However, the proposed seawater desalination facilities in California will use systems where brine is continuously produced when the facility is operating, and these facilities will discharge brine into coastal waters through either a brine-specific outfall or as part of a larger effluent stream (e.g., that of a WWTP or power generating facility). Brine discharges behave differently than traditional effluent because they are denser than the ambient receiving waters and have a tendency to sink to the seafloor. Consequently, brine plumes can form a physical barrier that prevents adequate mixing of dissolved brine and can result in anoxia or hypoxia in the benthic organisms, in addition to toxicity associated with elevated salinity. (Hodges et al. 2011; Roberts et al. 2012) Multiport diffusers can be used to prevent the formation of dense brine plumes and the associated environmental consequences; however, as discussed in section 8.5, there is shearing stress associated with these types of discharges that may result in marine life mortality. This section will expand upon this issue by reviewing the environmental costs and benefits of discharging brine through multiport diffusers as compared to other discharge methods. For a detailed assessment of the impacts associated with the various brine discharge technologies, please see sections 12.1.4, 12.2, and 12.4.3 of this Staff Report (CEQA).

The following issue addresses:

- Environmental effects of brine discharges
- Methods of discharging brine and the pros and cons associated with each method

8.6.1 Effects of Brine

Waste discharges from desalination facilities have the potential to form dense, non-buoyant plumes that settle, spread along the seafloor, and have negative impacts on marine life. Passive discharge of raw or undiluted brine is highly discouraged because of how slowly it will mix in the receiving waters, if at all. (Roberts et al. 2012) Studies have shown exposure to the brine and other potentially toxic constituents in the desalination effluent can have deleterious effects on bottom-dwelling marine life. (Crockett 1997, Talavera and Ruiz 2001; Gacia et al. 2007; Latorre 2005; Del Pilar Ruso et al. 2007; Riera et al. 2012; Roberts et al 2010) These effects include: osmotic stress or shock, the potential formation of hypoxic or anoxic zones, endocrine disruption, compromised immune function, acute or chronic toxicity, and in extreme conditions, death. Some organisms may move away from areas with high salinity or hypoxia, which will change the structure of the local community (Roberts et al. 2010), but sessile organisms will not be able to move away from the impaired water body and may experience more severe effects.

Other organisms have physiological or behavioral changes that occur as a result of environmental cues like changes in salinity. Migratory fish like anadromous salmonids begin their lifecycle in freshwater and move into seawater as juveniles. Increases in salinity concentrations trigger morphological, biochemical, physiological, and behavioral changes in the fish to prepare them for their pelagic life stage. (Björnsson et al. 2011) These fish also rely on lower salinity concentrations as a cue to adapt to freshwater conditions when returning to their nascent spawning habitat. Brine discharges into salmonid habitat have the potential to interfere with the normal salinity adaptations that occur in the fish. (Roberts et al. 2012) Another study showed that flatfish generally avoided hypoxic environments and would only utilize habitats within a restricted range of suitable temperatures and salinities. (Switzer et al. 2009)

Monitoring studies have found that salinity can have a range of localized environmental effects, particularly when brine is discharged into poorly flushed areas like coastal lagoons or embayments. However, there is a need for additional field and laboratory data to measure the environmental effects associated with brine discharges. Most laboratory studies have focused on short-term chronic salinity toxicity associated with Whole Effluent Toxicity testing (WET), for which there is limited information on sub-lethal endpoints associated with reproduction, endocrine disruption, development, and behavior of benthic invertebrates and vertebrates. Additionally, existing WET studies have focused on the salinity of brine discharges, but have not addressed acute and chronic effects from different types of concentrates and mixtures of membrane treatment chemicals (antiscalants) associated with RO. (Roberts et al. 2012; Phillips et al. 2012) Antiscalants are typically used in desalinating seawater; however, chlorine or other chemicals may also be used at facilities to reduce biofouling. (Roberts et al. 2012)

8.6.2 Methods for Discharging Brine

Desalination facilities must dispose brine, which requires disposal in a manner that minimizes intake and mortality of all forms of marine life.[4] When discharging brine into ocean waters, it is important to dilute the waste stream as quickly as possible and as close to the point of discharge as possible to minimize the effects of the brine on marine life. There are several different methods of discharging brine and each method has its benefits and trade-offs. For example, diluting brine prior to discharge by taking in additional source water from a surface intake may reduce discharge mortality; however, there would be increased intake mortality that might offset any benefit of diluting the brine prior to discharge. A facility should consider the feasibility of each discharge method and determine the method that best minimizes intake and mortality of all forms of marine life. Brine disposal options and the associated pros and cons for each method are described below. A detailed discussion of the impacts associated with the various brine disposal technologies are discussed in detail in sections 12.1.4, 12.2, and 12.4.3 of this Staff Report (CEQA).

8.6.2.1 Commingling Brine with an Existing Wastewater Stream

Wastewater sources for brine dilution include effluent from agriculture, sewage treatment facilities, industrial facilities (e.g. oil and gas refineries), and power plant cooling water. To ensure the wastewater is being used for the highest purpose, wastewater used for brine dilution should be wastewater that would otherwise be discharged into the ocean. Wastewater streams from sewage treatment plants typically have lower salinity concentrations than raw (undiluted)

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[4] Water Code section 13142.5(b) requires that desalination facilities utilize "best available site, design, technology and mitigation measures feasible . . . to minimize the intake and mortality of all forms of marine life." Thus, the facility must use the relevant measures in combination to minimize both intake and mortality. See, *Surfrider Foundation v. California Regional Water Quality Control Board* (2012) 211 Cal.App.4th 557, 576.

brine and are positively buoyant when discharged into receiving seawater. Wastewater streams from power plants typically have similar salinity concentrations as the ambient seawater and can be used in excess to dilute raw brine so that the salinity of resulting plume is less than or equal to natural background salinity. Commingling brine with an adequate volume of a wastewater stream will generate a mixture that is close to a site's natural background salinity and is approximately neutrally buoyant or positively buoyant at the point of discharge. (Roberts et al. 2012) This method of discharge can prevent the formation of dense toxic brine plumes and consequently minimize intake and mortality of all forms of marine life.

In California, there are numerous WWTP effluent discharges to the ocean and currently 13 OTC facilities. WWTP effluents have very low salinity; mixing WWTP effluent and desalination brine could result in a waste stream with a salinity concentration similar to that of ambient seawater. OTC facilities withdraw seawater for cooling purposes and discharge it back into the ocean at the same salinity. Cooling water can also be used to dilute brine, but larger volumes of dilution water would be needed relative to using WWTP effluent to dilute the brine. However, both WWTP effluent and OTC cooling water can be used to dilute brine to near ambient concentrations and thereby reduce or eliminate the environmental effects caused by high-salinity discharges. The commingled discharges would be neutrally or positively buoyant and would prevent the formation of heavy, non-buoyant plumes capable of causing bottom water anoxia and toxicity to benthic communities.

Several factors may affect the viability of commingling brine with wastewater. First, there are questions regarding long-term sustainability with commingling brine because sufficient volumes of wastewater may not be available in the future to adequately dilute brine. Many of the coastal power plants are shutting down, reducing intake volumes, or upgrading to closed-cycle cooling in order to comply with the OTC Policy. The volume of WWTP effluent discharge may systematically decline over time as water conservation measures are more widely adopted, and as recycled water becomes a greater component of California's water portfolio. As wastewater effluent volume decreases, availability of the WWTP effluent for dilution purposes will also decrease and may potentially render commingling an ineffective brine disposal option. Long-term projections of effluent discharge volume and resultant commingled brine/wastewater effluent salinities will be necessary prior to relying on commingling as the primary method of brine disposal.

WWTPs that choose to accept and commingle brine with their wastewater will have to update their NPDES permit to reflect the physical and chemical changes in their commingled effluent plume (e.g., the size of the mixing zone or other modeled physical characteristics). Siting requirements for many desalination facilities will be highly specific, and may not coincide with the location of an existing wastewater discharge that is willing and able to accept the brine waste. The limited number of WWTPs, OTC power plants and other sources of wastewater dilution may restrict locations where desalination facilities are feasible. In some cases, commingling may require miles of pipeline construction and related infrastructure. Still, the prices associated with pipeline construction (approximately $1 to $2 million per mile) may be competitive with other types of discharge options when other brine discharge requirements are taken into consideration.

8.6.2.2 Discharging Brine through Multiport diffusers

When wastewater is unavailable or an infeasible option of brine disposal, brine can be rapidly mixed and dispersed in receiving water bodies though multiport diffusers. Multiport diffusers are an end-of-pipe system that can be installed on submerged marine outfalls to discharge effluent through numerous ports or openings. The ports increase the pressure at the discharge and assist in the mixing process that allows for rapid dilution and reduction of salinity. Multiport diffusers can be used at desalination facilities to enable rapid turbulent mixing that disperses and dilutes brine within a relatively small area. Studies have shown diffuser designs with jets inclined at a 60 degree angle result in the highest dilution and are the standard for diffuser designs. (Roberts et al. 1997) Multiport diffusers are the next best method for discharging brine when wastewater is unavailable for dilution and there are no live organisms in the effluent. Multiport diffusers are thought to have some marine life mortality associated with the centerline of the jet plumes. These impacts to organisms are discussed in further detail below.

8.6.2.2.1 Marine Life Entrainment at Multiport Diffusers

Multiport diffusers are one of the most widely-used wastewater effluent discharge technologies around the world and are currently used for discharges from desalination facilities in Australia, Spain, and the Middle East. (Roberts et al. 1997; WateReuse 2011) Multiport diffusers can rapidly dilute effluent brine to salinities near ambient background, often within only a few tens of meters of the outfall. Consequently, multiport diffusers may result in a smaller area of the ocean and benthic environment that is exposed to elevated salinities when compared to other brine disposal methods. However, multiport diffusers can cause marine life mortality as a result of shearing stress. Multiport diffusers are designed to increase turbulent mixing (Roberts et al. 1997) and as a result, organisms that are entrained into the brine discharge may experience high levels of shear stress for short durations, which is thought to cause some mortality. Entrainment in the brine discharge is the volume of water subject to the multiport diffuser jets. (Foster et al. 2013) The actual risk of shearing-related mortality will vary depending on the design aspects of a diffuser array and the production capacity and efficiency of a facility.

The size of the turbulent eddies in relation to the size of an organism is directly related to the risk of experiencing shear stress mortality. Large eddies (significantly greater than the size of the organism) are generally considered to be non-lethal, since the eddy current will move the entire organism as a whole. Large eddies may disorient an organism, but they rarely lead to mortality. (Foster et al. 2013) Eddies that are significantly smaller than the size of an organism are also considered to be of relatively low threat. However, eddies that are of approximately the same size as an organism may lead to potential damage. (Foster et al. 2013) Previous studies that have examined organism response to shear stress have typically examined exposure periods on the order of minutes to hours. It was difficult to draw direct comparisons between the findings in those studies and the potential impacts of shearing at multiport diffusers in situ because shearing at multiport diffusers impacts organism within a matter of seconds. There are no available data that have measured shearing-related mortality at multiport diffusers in a real world setting and more studies are needed to better characterize multiport diffuser related mortality. Mortality from shearing stress is discussed in section 8.5.1.2.

8.6.2.2.2 Turbidity Impacts from Multiport diffusers

Turbidity is a measure of the suspended particles in water. Turbidity of water is typically measured in Nephelometric Turbidity Units (NTU) using U.S. EPA Method 180.1, with possible values ranging from 0 to 1000 NTU. Typical turbidity off the California coast ranges from 3 to 4 NTU (Huang et al. 2013), although phytoplankton blooms and storm water runoff can increase turbidity in coastal waters. (U.S. EPA 1988; Foster et al. 2013) Turbidity can have both positive and negative impacts on marine life. Moderate turbidity may be beneficial to fish by protecting them from predation, and turbidity gradients can provide a means for fish to navigate into estuarine areas. (Bruton 1985) However, other studies have shown that turbidity can reduce the amount of available light for photosynthetic organisms like marine plants, algae, and phytoplankton, and can reduce primary productivity in an area. High turbidity can scour aquatic plants and algae, cause developmental and filtering problems in oysters (Loosanoff and Thomas 1948), damage fish gills. (Foster et al. 2013) and can reduce the ability for fish to perceive their prey. (Chesney 1989; Vinyard and O'Brien 1976)

U.S. EPA has stated that "settleable and suspended solids should not reduce the depth of the compensation point for photosynthetic activity by more than 10 percent from the seasonally established norm for aquatic life." (U.S. EPA 1988) The compensation point is the point at which the rate of photosynthesis equals the rate of respiration. Settleable solids and suspended solids can prevent light from penetrating to deeper depths and can reduce the area where photosynthesis can occur, which can result in a reduction in photosynthetic activity. The California Ocean Plan limits turbidity to less than 225 NTU at any time, less than 100 NTU for weekly averages, and less than 75 NTU for monthly averages. (Foster et al. 2012) Photosynthetically active radiation (or available photosynthetic light) is a more direct measurement of the amount of light available for photosynthesis and should also be measured when possible.

Jenkins and Wasyl (2013) claimed that in addition to marine life mortality associated with entrainment in diffuser jet streams, multiport diffusers increase suspension of fine-grained bottom sediments at discharge sites and that the increase may be detrimental to marine life. Jenkins and Wasyl further suggested that the environmental effects associated with multiport diffusers are significant and consequently, multiport diffusers should not be a preferred discharge technology. Jenkins and Wasyl highlighted one of the notable cases where turbidity has resulted in detrimental effects to marine life: turbidity has had adverse effects on marine life at SONGS, where the volume of discharge was 2,384 MGD. While the SONGS facility is an example where discharges can significantly increase turbidity, the effects seen at SONGS are unlikely to occur at desalination facility discharges because the SONGS discharge volume is significantly higher than even the largest planned desalination facility, which would discharge approximately 300 MGD. At these levels, the volume of the discharge alone can exacerbate effects of turbidity. In addition, the SONGS diffuser array was also designed to discharge cooling water from the facility and the diffuser design is not recommended for use at desalination facilities because the diffusers were designed to rapidly reduce the elevated discharge temperature and the diffuser heads were angled only at 20° above horizontal. (Foster et al. 2013) Consequently, the turbidity effects seen at SONGS are not expected to occur at desalination facility discharges.

There are numerous WWTPs along the California coastline that discharge through multiport diffusers at volumes greater than what is expected at the largest proposed desalination facility. The regional water boards regulate the turbidity discharges from WWTPs based on provisions in the Ocean Plan. The Orange County Sanitation District is permitted to discharge an average of 332 MGD during dry weather and up to 591 MGD in wet weather. (Santa Ana Regional Water Board 2012) The permit allows a monthly and weekly turbidity average of 75 and 100 NTU respectively with an instantaneous maximum of 225 NTU; from January 2009 to December 2011, the highest daily, monthly, and weekly average were all 38 NTU. Desalination facility discharges, even from the largest facilities, are expected to have minimal to no turbidity impacts on marine life. (Foster et al. 2013) Turbidity effects on marine life would be on a scale significantly lower than SONGS or the Orange County Sanitation District.

Typical RO brine or reject water is twice as turbid as the source water, and the ranges of turbidity in desalination discharges in California are expected to be low. (Foster et al. 2013) However, there are procedural methods and design elements that can help reduce turbidity at desalination discharges. The Perth Seawater Desalination Plant in Australia discharges its brine waste through a 40-port diffuser to reduce the effects of turbidity, and the solids that accumulate on the filters are backwashed and disposed of in a landfill instead of being discharged with the brine. In California, most existing desalination facilities discharge filter backwash into sanitary sewers for treatment prior to discharge, which can reduce turbidity and prevent harmful chemicals in the backwash from being discharged into the ocean. (WateReuse 2011b)

Brine discharge infrastructure can be sited and designed to help minimize re-suspension of benthic sediments and prevent the increase of local turbidity. Studies have shown that turbidity can be essentially eliminated by designing diffuser ports so they are at least 1 m off the seafloor with nozzle openings pointed at the sea surface and at a 60 degree angle from the horizontal axis. Site selection is also important to consider. Areas that have sediment with smaller grain sizes will be more susceptible to increased turbidity at discharge because smaller particles are more easily re-suspended than heavier particles like sand. An assessment of sediment grain size and particle distribution may help in designing and siting the multiport diffusers to better avoid turbidity-related issues.

Since concerns over increased turbidity resulting from desalination discharges were discussed at various stakeholder meetings, State Water Board staff reconvened the Expert Review Panel to investigate potential impacts. Foster et al. 2013 evaluated the potential for increased turbidity caused by diffuser discharges and found that effluent velocity is generally less than 2 cm/s at a distance of less than 1 m from the diffuser jet opening. Velocity continues to decrease as distance from the diffuser opening increases. Once the diffuser plume reaches the seafloor, it can create bottom currents with velocities on the order of 1 cm/s. Foster et al. (2013) determined that this velocity was too low to lead to significantly re-suspended benthic sediment and increased turbidity. Moreover, the study found that multiport diffusers can be properly designed and sited to prevent increases in turbidity. Regardless of the expected effects of turbidity on the marine environment, and in the absence of any requirements specific to desalination facility brine discharges, a regional water board would include provisions for turbidity in the desalination facility's NPDES permit. Limits imposed would be based on existing Ocean Plan limits.

8.6.2.3 Diluting Brine via Flow Augmentation

Flow augmentation is a type of in-plant dilution that occurs when a desalination facility withdraws additional source water for the specific purpose of diluting brine prior to discharge. One of the primary advantages to flow augmentation is that the salinity of the discharges can be reduced to near ambient levels and prevent adverse effects to benthic communities. (Roberts et al. 2012; Phillips et al. 2012) In flow augmented systems, the dilution water is separated from the desalination feed water at a point within the desalination facility, and is then mixed with desalination waste brine prior to discharge. Flow augmentation does not require the construction of diffuser systems, and systems are capable of discharging effluent close to natural background salinity. Flow augmentation has been advocated as a preferable brine disposal option in some locations. Jenkins (2013) has stated that flow augmentation is more environmentally protective than discharging through multiport diffusers if the system uses low-turbulence intakes. However, passage through traditional intake pumps results in significant marine life mortality. Studies have demonstrated that 100 percent of entrained organisms die (Pankratz 2004) and that entrainment impacts on individual populations and the ecosystem can be significant. (Raimondi 2011; Steinbeck et al. 2007; Strange 2012) Withdrawing additional source water with traditional pumps to dilute brine would result in significantly increased marine life mortality compared to discharging through multiport diffusers. (Foster et al. 2013)

Some advocates of flow augmentation have supplied modeling data to suggest that low-turbulence screw pumps (e.g. Archimedes screws pumps, screw centrifugal pumps, or axial flow pumps) are different from traditional pumps in that they can significantly reduce marine life mortality by lowering turbulence and through-pump mortality at the point of intake. (Jenkins, 2013) Proponents of flow augmentation have argued that flow augmentation can overall result in less marine life mortality compared to multiport diffusers even though the mechanisms to do so have not been clearly demonstrated. (Jenkins 2013; Foster et al. 2013) Studies have shown that Archimedes screws pumps, screw centrifugal pumps, and axial flow pumps are effective means of transporting juvenile and adult fish relatively unharmed and with low mortality rates (Department of Fish and Game 1984; FishFlow Innovations 2014; Hidrostal 2014; Intake Screens, Inc. 2014); however, the studies have only reported data for large fish that would likely be excluded from entrainment by screens at desalination facilities. To date, there are no empirical data that have estimated egg, larvae and small juvenile mortality at the low-turbulence pumps, even though such studies are technically feasible. (Alden Labs 2014)
Another consideration for flow augmentation systems is how to minimize marine life mortality at the point of brine mixing prior to discharge. Organisms entrained in the flow augmented dilution water may experience turbulence and shearing stress, osmotic stress or shock, or thermal stress as brine and dilution water are mixed prior to discharge. Osmotic stress or shock will

also occur when undiluted brine is discharged into the ocean. However, some organisms in the receiving water will be able to avoid the highly saline waters, whereas organisms entrained in the system are unable to avoid the osmotic stress or shock. Flow augmentation systems should be designed to minimize the effects of mixing the brine with the dilution water on marine life entrained in the flow augmentation system (e.g. reduce osmotic stress by slowly and gently mixing brine with dilution water). There are no case studies or engineering designs describing how best to re-introduce brine to the dilution water. Correspondingly, there are no data related to marine life mortality where dilution water and brine waters are mixed in an augmented intake flow system.

In summary, flow augmentation can successfully lower salinity of the brine prior to discharge and may be protective of organisms living at desalination outfalls. However, if the increased flows come from surface water intakes, increases in intake mortality may offset any benefit from reduced discharge mortality. Thus, any assessments of flow augmentation systems should include a whole-system estimate (intakes, water conveyance, augmented impacts, and ultimate disposal) of the intake and mortality of marine life. An owner or operator should carefully consider the effects each system component will have on the intake and mortality of all forms of marine life. Future studies may demonstrate that flow augmentation systems can be designed in a “fish-friendly” manner that considers and protects all forms and life-stages of marine life. If the process can be shown to be at least as protective of marine life as the effects of using multi-port diffusers, flow augmentation could be considered a viable option for desalination facilities. However, empirical data combined with modeling will be necessary in order to show the effectiveness of flow augmentation with regards to marine life protection.

8.6.3 Regulatory Considerations

The State has broad authority under Porter-Cologne to regulate waste discharges that could affect water quality. The State has been authorized by U.S. EPA to issue NPDES permits within California to point source discharges of pollutants to navigable waters. Additional requirements pursuant to Porter-Cologne must be at least as stringent as those set forth in the CWA. Under section13260 et seq., Porter-Cologne authorizes the Water Boards to prescribe requirements for the discharge of brine waste from all desalination facilities, whether existing, expanding, or new. In California, all discharges of waste are regulated under WDRs, which may also serve as NPDES permits.[5] WDRs are also issued for waste discharges to land, including percolation basins, injection wells, or other discharges where groundwater quality could be affected.

The State Water Board’s authority to regulate flow augmentation as a component of a facility’s discharge depends on whether the facility is new or expanded. Flow augmentation increases the volume of source water withdrawn via the intake, yet ultimately flow augmentation is considered a method of brine discharge. Section 13142.5(b) gives the State Water Board the authority to regulate intakes from new or expanded desalination facilities in order to ensure that marine life mortality is minimized. However, the State Water Board’s authority does not extend to existing intakes. To the extent that the use of flow augmentation results in discharge-related

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[55] Water Code section 13374.

impacts from effluent quality, the Water Boards have authority to regulate the impacts under their NPDES authority. However, the dilution water required for flow augmentation is considered part of the intake, and as such, the State Water Board's authority to regulate use of flow augmentation does not extend to existing intakes unless the facilities are conditionally permitted.

8.6.4 Options

- **Option 1: No Action. The regional water boards will continue to regulate brine discharges on a site-specific basis, without direction from the State Water Board.** Option 1 represents current conditions, where each regional water board evaluates brine disposal options on a facility-specific basis. The regional water boards would continue to be responsible for determining the means of compliance and how brine discharges are to be regulated. This approach allows the regional water boards greater flexibility to evaluate the merits of a proposed brine discharge method for a specific desalination facility, but could result in inconsistencies among regions and projects. Therefore, Option 1 does not meet the project goals of providing a consistent statewide approach for minimizing intake and mortality of marine life, protecting water quality, and related beneficial uses of ocean waters or promoting interagency collaboration.

- **Option 2: Amend the Ocean Plan to establish statewide requirements that require commingling with existing effluent streams as the only allowable brine discharge method.** Under this option, the regional water board would require brine dischargers to identify an existing WWTP or OTC plant effluent outfall and mix the desalination brine waste with the waste stream effluent. Desalination facilities would either be required to co-locate with a WWTP or OTC facility, or to transport the brine to one of these facilities. Option 2 would provide a consistent statewide approach to regulating desalination facilities; however, under this Option, the limited number of WWTPs, OTC power plants and other sources of wastewater dilution could restrict potential locations where desalination facilities are feasible. By significantly limiting the circumstances under which desalination facilities would be allowed, Option 2 fails to meet the project goal of supporting use of ocean water as a reliable supplement to traditional water supplies.

- **Option 3: Amend the Ocean Plan to establish statewide requirements for use of multiport diffusers as the only brine discharge method.** Under Option 3, the Ocean Plan would require all desalination facilities to discharge brine wastes through multiport diffusers. An owner or operator would be required to use diffusers to rapidly mix brine with seawater to minimize adverse impacts resulting from salinity.

  Multiport diffusers represent an ideal method for discharging undiluted brine. Multiport diffusers have been used for decades by numerous types of dischargers and are the most common type of open-ocean discharge. Multiport diffusers have been extensively modeled and the physical characteristics of plumes produced by multiport diffusers are well understood, and effluent plumes can be designed so that the does not create hypoxic or anoxic conditions at the seafloor. The Brine Panel report (Roberts et al.

2012) recommended multiport diffusers for discharge of raw brine, in part based on the ability of multiport diffusers to rapidly mix and disperse the waste brine. The Brine Panel cited literature and suggested that in most cases, the brine could be mixed to within 5 percent (1.7 ppt) of ambient seawater within only a few tens of meters (100 m) from the diffuser outfall.

Even though multiport diffusers can rapidly disperse brine, some marine life mortality may be associated with the multiport diffusers. In addition, multiport diffusers may be the best brine disposal method for some desalination discharges; however, there are some examples where commingling may be more environmentally protective. While Option 3 would meet the project goals by providing a consistent statewide approach to minimizing the intake and mortality of marine life, protecting water quality, and related beneficial uses of ocean waters and supporting the use of ocean water as a reliable supplement to traditional water supplies. However, Option 3 may not be the most environmentally protective if wastewater is available for commingling and should not be the only brine disposal method available.

- <u>Option 4:</u> **Amend the Ocean Plan to establish statewide requirements for flow augmentation as the only allowable brine discharge method.** Under Option 4, the Ocean Plan would require all desalination facilities to dilute brine via flow augmentation prior to discharging it into the ocean.

  Source water for flow augmentation may be withdrawn through a subsurface or surface intake. The intake capacity of subsurface intakes may be limited and unable to provide adequate volumes of dilution water. Therefore, Option 4 could potentially limit the possible locations where desalination is feasible if a subsurface intake is used for the facility. Facilities with surface intakes using flow augmentation would entrain additional organisms in their source water in order to dilute the brine prior to discharge. Because of lack of empirical data on viability of low-mortality flow augmentation systems used with surface water intakes, requiring flow augmentation could result in significant marine life mortality.

  Option 4 is not recommended because it may restrict desalination to locations where subsurface intakes are feasible, and where the subsurface intakes can provide adequate flow volumes to dilute brine prior to discharge. This option would not meet the second project goal that supports the statewide use of seawater for desalination. Option 4 is also not recommended because there are not enough data to demonstrate that use of flow augmentation at facilities using surface water intakes is a protective method of brine disposal. In the future, as more data become available and as technological innovations are made, flow augmentation using specially designed surface water intake systems may become a brine dilution option that is protective of marine life. At this time, however, flow augmentation should not be the only method available for brine disposal.

<u>Option 5:</u> **Amend the Ocean Plan to establish statewide requirements for use of the best available brine discharge method feasible after a facility-specific evaluation.** This option would require an owner or operator to first evaluate the availability and feasibility of diluting brine by commingling brine with wastewater. If wastewater is unavailable, then multiport diffusers are the next preferred method of brine disposal. The regional water board would then determine the best available methods of brine disposal feasible for a facility and consider it in combination with the best available site, other design elements, and technology feasible to use a combination of factors that results in the least amount of intake and mortality of all forms of marine life.

Option 5 would require that an owner or operator of a new, expanded, or conditionally permitted desalination facility evaluate the feasibility of commingling brine with wastewater first before considering discharging through multiport diffusers or using an alternative method for discharging brine. i Commingling with waste discharges would result in no additional intake of seawater to dilute brine and would result in a discharge that is close to natural background salinity. An owner or operating proposing to commingle brine with wastewater would have to assess any incremental shearing-related mortality that occurs as a result of adding the brine to existing effluent. This method of discharge is the most environmentally protective brine disposal method and should be used if feasible. In some cases, wastewater from a WWTP facility may be unavailable for brine dilution because it is being used for water recycling efforts. In this case, when the wastewater becomes unavailable, the facility would fall under the definition of an “expanded facility” since there would be changes in the design or operation of the facility. An owner or operator would have to install multiport diffusers or an equally protective brine discharge alternative and the regional water board would need to perform a new Water Code section 13142.5(b) determination.

Multiport diffusers are the next best brine discharge method because they rapidly dilute and disperse brine within a small area and result in minimal marine life mortality. Discharging brine through multiport diffusers does not require the additional intake of seawater to dilute brine as is the case with flow augmentation. Multiport diffusers are commonly used at ocean outfalls and can be installed at almost any location. The Desalination Amendment would require that they be sited and designed to minimize the impacts to marine life. For example, the regional water board should not permit multiport diffusers to be sited next to a highly productive kelp bed if the diffuser array could be sited in a less productive area.

Discharging through multiport diffusers would require an assessment of mortality that occurs as a result of the increased salinity at the discharge and any shearing-related mortality associated with the diffusers Even though the effects will likely be minimal from properly sited multiport diffusers. (Foster et al. 2013; Bothwell comment letter 2014) An owner or operator could use existing shearing data (see discussion in section 8.5.1.2 above) that has been approved by the regional water board or alternately, could elect to do their own diffuser entrainment modeling under the guidance and approval of the regional water board. Empirical studies of diffuser-related mortality are technically feasible and encouraged, but may be cost prohibitive. As more studies are done, there will be more information available on how to better estimate diffuser-related mortality in order to establish a performance standard for alternative brine disposal technologies.

For facilities proposing to use flow augmentation or other alternative brine discharge technologies, an owner or operator would be required to demonstrate to the regional water board in consultation with the State Water Board that their proposed method is at least as protective as commingling brine with wastewater if wastewater is available, or discharging through multiport diffusers if wastewater is unavailable for dilution. The analysis would need to include a whole-system (intakes, water conveyance, brine mixing, and ultimate disposal) estimate of intake and mortality of all forms of marine life. In the case of flow augmentation using power plant cooling water, any incremental mortality that occurs as a result of diversions for the desalination facility would be included in the analysis. Until demonstrated otherwise, organisms in water withdrawn through surface water intakes would be considered to have 100 percent mortality. Additionally, marine life mortality that occurs as a result of osmotic stress, turbulence and shearing stress in the water conveyance and brine mixing, and shearing stress at the discharge would be included in the overall mortality assessment of the discharge method.

All discharges should be designed to maximize dilution and minimize the contact of the plume with the seafloor. There may be dense, negatively buoyant plumes that meet the receiving water limitation for salinity. However, these should be avoided if feasible, and anoxic conditions and negative impacts to aquatic life associated with the plume outside of the brine mixing zone should be avoided, eliminated, or mitigated. Brine mixing zone modeling should be done to help identify the best available design configurations for brine discharges. Average vertical variation of salinity and temperature may be assessed from historical profiles when available and included in the mixing zone modeling. However, the conditions included in the model should represent the most conservative scenarios.

After independently considering the brine discharge alternatives in order of preference (i.e. commingling first, then multiport diffusers or an equally protective technology and determining the best discharge alternative, the regional water board would consider the brine discharge alternatives in conjunction with other determinations for best available site, design, technology, and mitigation measures that collectively minimize intake and mortality of all forms of marine life. The best combination of alternatives may not include the best method for minimizing intake and mortality of marine life in cases where the alternatives are mutually exclusive, redundant, or infeasible in combination.

8.6.5 Staff Recommendation

Staff recommends Option 5. An owner or operator of a seawater desalination facility must evaluate multiple brine disposal alternatives independently and then in combination with the best available site, design, technology, and mitigation alternatives, employ the discharge method that best minimizes intake and mortality of all forms of marine life. The Desalination Amendment will provide flexibility and accommodate for facility-specific constraints and considerations while establishing a statewide standard for determining the best brine discharge technology to minimize intake and mortality of all forms of marine life. Option 5 also allows for new or alternative brine discharge methods that may become available in the future as technological innovations are made, while ensuring that desalination facilities use the most protective means of discharging brine.

8.6.6 Amendment Language

See chapter III.M.2.d.(2) of Appendix A.

8.7 Should the State Water Board impose a receiving water limitation for salinity, and if so, what should the limit be?

Changes in salinity can cause physiological changes in aquatic organisms, reproductive harm, or even death. The salinity of brine discharges to the ocean is not currently subject to a formal receiving water limitation or water quality objective. The salinity of brine discharges can be regulated indirectly as part of required whole effluent toxicity testing requirements. The lack of a uniform requirement or receiving water limitation for salinity may result in inconsistencies among regional water boards and permitting uncertainty as the number of seawater desalination facilities increases throughout the State. The issue of a desalination-specific receiving water limitation or water quality objective for salinity is discussed below.

The following issue addresses:

- Effects of saline discharges on the marine environment
- Receiving water limitation point of compliance and mixing zones

8.7.1 Background: Effects of Saline Discharges on the Marine Environment

Studies have shown that changes in salinity can result in:

- Osmotic stress or shock,
- Endocrine disruption (Avella et al. 1991; Ayson et al. 1994; McCormick 1995),
- Changes in migratory behavior (McCormick 2001),
- Changes in reproductive behavior,
- Developmental abnormalities (Foster et al. 2013), and
- Changes in community structure (Del Pilar Ruso et al. 2007)

Sub-lethal effects of salinity, like growth and reproduction, are under-studied and poorly understood for most marine organisms. Marine organisms are adapted to tolerate a range of salinities; but when they are exposed to the upper limits of these ranges, organisms may experience hyperosmotic stress. If the exposure is prolonged, the hypersaline environment may cause cell and tissue damage, interfere with normal physiological systems (e.g., cell signaling, osmoregulation, endocrine, and renal), and can have long-term impacts on the organism. For example, salinity is an important trigger of osmoregulatory adaptations in salmonids (salmon and trout) that will initiate a cascade of endocrine signals to promote adaptations in the osmoregulatory and renal systems. (McCormick 1995; McCormick 2001) This is a key physiological pathway in salmonids that enables them to migrate from freshwater to saltwater and back again. (McCormick 2001) Alterations in natural salinity could interfere with natural migratory and developmental cues in these species, which could have deleterious impacts on a population level. Other studies have reported demersal flatfish are also sensitive to salinity fluctuations and undergo similar endocrine alterations. (Foster et al., 2013)

State Water Board staff commissioned a Science Advisory Panel (Roberts et al. 2012) to provide a review of elevated salinity studies and determine if there is a common salinity change where impacts to marine organisms are observed. The Panel also provided information on the management of brine discharges to coastal waters. The Panel reviewed scientific literature that addressed impacts of elevated salinity on marine organisms and found that most marine organisms started to show signs of stress when salinity was elevated by 2 to 3 ppt, and that the impacts of brine discharges will vary based on the organisms present at the outfall, the site location, the nature and concentration of the brine, and the extent to which the brine is dispersed in the receiving water body. (Roberts et al. 2012) A summary of this information is provided in Appendix F.

Chapter 2.1 of Roberts et al. (2012) discusses existing regulatory criteria for salinity from around the world and provides a summary table. Most of the regulations include salinity expressed as an increment of no more than 1 to 4 ppt above natural background salinity. A point of compliance is also included and was typically the boundary of the mixing zone of a fixed distance from the discharge from 50 to 300 m. The most conservative regulatory criteria were in Sydney, Australia where salinity can be no more than 1 ppt above ambient to be met within 50 to 75 meters of the outfall, and Okinawa, Japan where salinity can be no more than 1 ppt above ambient to be met at the boundary of the mixing zone. (Roberts et al. 2012)

Sea grasses and benthic communities are the most sensitive to changes in salinity and may be the most sensitive to brine discharges. Impacts to sea grasses have been observed at salinity increases of only 1 to 2 ppt. (Roberts et al. 2012) A before-after benthic community study was done at a desalination facility in Alicante, Spain that is discharging approximately 17 MGD of 39 practical salinity units (psu) brine. (Del Pilar Ruso et al. 2007; Missimer et al. 2013) Del Pilar Ruso et al. (2007) reported a change in benthic community structure that was seen by a significant reduction in abundance of polychaetes, nematodes and bivalves over the two-year study. Polychaete diversity also decreased and the surrounding area became primarily dominated by nematodes. The impacts were seen 400 m from the discharge. The health and success of California eelgrass and surfgrass beds is important because they support diverse food webs and provide a number of other ecosystem services. (NOAA 2011) A number of species in California feed on benthic invertebrates. Diversity of benthic invertebrates promotes species diversity overall. For example, if only nematodes are present in the sediment, then only the fish that eat nematodes will forage in that area; whereas if the benthic community is diverse, a number of different species will feed there.

Hyper-salinity toxicity studies were performed by University of California, Davis, Department of Environmental Toxicology (Philips et al. 2012) using U.S. EPA west coast methods (U.S. EPA 1995). Chronic, non-lethal endpoints like larval development were measured in bay mussels (*Mytilus galloprovincialis*), purple sea urchins (*Strongylocentrotus purpuratus*), sand dollars (*Dendraster excentricus*), and red abalone (*Haliotis rufescens*). The purple sea urchin and sand dollar were also tested using fertilization as the toxicity endpoint. Giant kelp (*Macrocystis pyrifera*) were tested using the germination and germ tube growth as the toxicity endpoints. Topsmelt (*Atherinops affinis*) were tested using biomass endpoints and mysid shrimp (*Americamysis bahia*) were tested using growth endpoints. Topsmelt (*Atherinops affinis*) and mysid shrimp (*Americamysis bahia*) were also tested for survival. Separate toxicity studies were done using laboratory generated water and brine effluent from the Monterey Bay Aquarium. The study showed red abalone, purple urchins, and sand dollars were most developmentally sensitive to brine. Developmental effects were seen in red abalone at salinities of just 35.6 ppt (Lowest Observed Effect Concentration [LOEC]). Euryhaline giant kelp and topsmelt were the least sensitive species to elevated brine concentrations. Results from the study are summarized in Appendix F.

For more information on the Granite Canyon toxicity study, please visit the link below.
http://www.swrcb.ca.gov/water_issues/programs/ocean/desalination/docs/saltoxfr08012.pdf

The Science Advisory Panel (Roberts et al. 2012) recommended, based on the studies of the effects of brine discharges, that the maximum salinity increase at the edge of the zone of initial dilution (also referred to as the mixing zone) should be no more than 5 percent above ambient background. Even though natural background salinity varies throughout California (see section 8.7.2 below), and by season, salinity is generally close to 34 ppt as a state-wide average. The Science Advisory Panel recommended that salinity vary by no more than five percent at the edge of the zone of initial dilution. For most California coastal waters, this translates to an increase of 1.7 ppt (rounded up, 2 ppt) above ambient background. (Roberts et al. 2012) Additional review of salinity effects on marine life (Foster et al. 2013) found that salinity increases less than 2 to 3 ppt were protective of most marine life.

The Science Advisory Panel further recommended that the salinity objective should be based on the most conservative species. The reports by Phillips et al. (2012) and Roberts et al. (2012) provide the basis to develop a receiving water limitation for California's ocean waters. The Granite Canyon report showed that red abalone was most sensitive to elevated salinity, with an LOEC at 35.6 ppt (1.6 ppt above background). Since salinity toxicity studies were not done for all organisms in the California marine environment, the 2 ppt limit may be overly conservative for some species, but not conservative enough for others. However, the majority of the studies on elevated salinity showed that effects were not seen below 2 to 3 ppt above natural salinity. (Roberts et al. 2012)

8.7.2 Natural Background Salinity

Another important component to establishing a receiving water limitation or water quality objective is determining what “normal” water quality for an area is. Ocean salinity varies both temporally and spatially in California. Surface salinity in the ocean will decrease during periods of heavy rainfall or snowmelt, while salinity in intertidal zones or shallow areas will increase if there is increased solar radiation and evaporation. In addition to seasonal and regional salinity variations, there are Pacific Decadal Oscillation and the El Niño/Southern Oscillation events that influence weather and decadal-scale climate patterns that should also be considered when determining natural background salinity. Salinity variation in California has been shown to vary 0.2 practical salinity units (PSU; 1 PSU ≃ 1 ppt) on a decadal timescale (Schneider et al. 2005). Lower salinity conditions were observed in the early 1950s, from 1966 to 1971, in 1978, and in the early 1990s; whereas salinity was high in the late 1930s, from 1956 to 1965, in the mid-1970s, and around 1990 (Schneider et al. 2005). These decadal timescale salinity fluctuations are not driven by the Pacific Decadal Oscillation or the El Niño/Southern Oscillation events, but instead are related to movement of the California Current (Schneider et al. 2005).

Figure 8-8 illustrates the variation in daily mean salinity in coastal waters off Huntington Beach (Southern California) from 1980 until mid-2000 (Roberts et al. 2012), and shows that natural ocean salinity varies by 10 percent between summer maximums and winter minimums, with a long term average value of 33.53 ppt (parts per thousand). This data is from NPDES monitoring reports for AES and Orange County Sanitation District outfalls in Huntington Beach. The Huntington Beach station salinity values are characteristic of salinities in coastal waters in the Southern California Bight, a coastal region in Southern California that spans from Point Conception to San Diego. Ocean salinity is more variable in Central and Northern California because of seasonal variations in freshwater influence from storm water runoff and precipitation. Figure 8-9 shows the long-term variability of the daily mean salinity at Crescent City (Northern California; Roberts et al. 2012). The long term mean variability is 71.7 percent, with a long term average salinity of 33.39 parts per thousand.

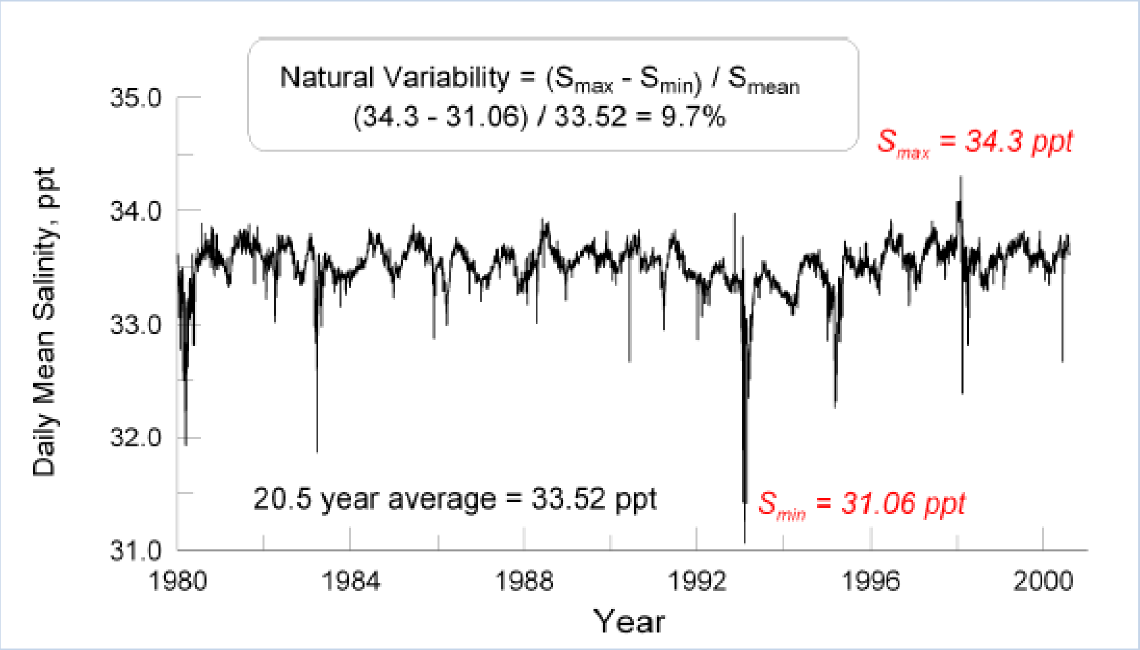

Figure 8-8. Long-term variation of the daily mean salinity in parts per thousand (ppt) from 1980 to 2000 measured in Huntington Beach coastal waters. Salinity data from Huntington Beach are representative of salinity concentrations in the Southern California Bight. (Roberts et al. 2012)

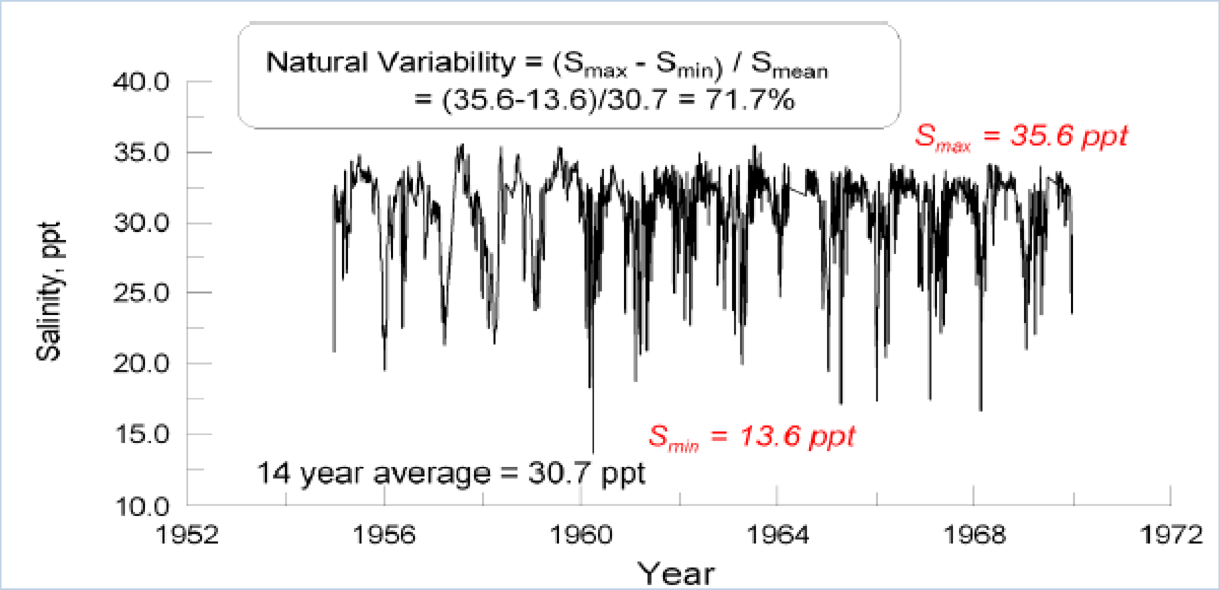

Figure 8-9. Long-term variation of the daily mean salinity in parts per thousand (ppt) from 1952 to 1972 measured in Crescent City coastal waters. These salinity values are typical for Northern California coastal waters. (Roberts et al. 2012)

The salinity data above are provided as references for the variation in salinity in the northern and southern regions of California. It is important to note that in the southern region, salinity is less variable than in the northern regions and there were only one or two instances in 20 years where salinity was 0.5 ppt above the average. In the northern region, salinity has a much larger range with seasonal wet periods driving the average salinity down. Establishing natural background salinity that considers seasonal variation is necessary in order to implement salinity objectives. Establishing natural background salinity based on the mean monthly average would capture seasonal variability. Natural background salinity should be measured at the proposed discharge location and depth of the discharge if feasible prior to commencing brine discharge. Organizations such as CalCOFI and NOAA often have historical salinity data available going back for decades and often the data are free. In the event historical data are not available for a site, three years of weekly salinity samples will capture the seasonal and inter-annual variations. Furthermore, since the receiving water limitation for salinity will be based on the mean monthly average, it is important to have a strong data set. The historical average would only be based on three data points if sampling frequency was monthly over three years. If samples are collected at a weekly frequency, the monthly average would be based on at least 12 data points.

Each facility should establish the baseline or natural background salinity of the receiving water prior to discharging brine. Natural background salinity is the salinity that results from naturally occurring processes and is without apparent human influence. Brine discharges have the potential to alter natural background salinity and elevate salinity to levels beyond the tolerance levels for local species. In some cases, establishing a reference location with similar natural salinity can be helpful in drawing comparisons between pre- and post-discharge conditions.

As required by Water Code section 13142.5(d), “Independent baseline studies of the existing marine system should be conducted in the area that could be affected by a new or expanded industrial facility using seawater in advance of the carrying out of the development.” The marine system includes water quality parameters like salinity, dissolved oxygen, and other constituents. Natural background salinity should be evaluated for each facility by determining the mean monthly average salinity in proximity of the proposed discharge location, preferably at the depth of the proposed discharge using data from at least 20 years prior to commencing the brine discharge. When historical data are not available, natural background salinity should be determined by measuring salinity at the depth of the proposed discharge for several years at relatively high frequency, and then determining the mean monthly average for establishing compliance with the receiving water limitation for salinity. Background salinity should be determined prior to discharging brine in order to best establish natural conditions. Reference locations are also useful in long-term monitoring of the effects of the brine discharge on the local biota.

Salinity of seawater can be measured by using a refractometer, electrical conductivity, total dissolved solids (TDS), the Practical Salinity Scale 1978 (PSS-78), the Thermodynamic Equation of Seawater-2010 (TEOS-10), or the sum of the major cations and anions (sodium, chloride, sulfate, bicarbonate, bromide, magnesium, calcium, and potassium). Each of these methods has advantages and disadvantages. The inorganic anions and cations listed above are typically measured by an ion chromatograph or an inductively coupled plasma mass spectrometer (ICP-MS). These instruments are designed to detect concentrations in the part per million range (mg/L), and can be sensitive into the part per trillion range (ng/L). Measuring undiluted seawater is not possible using these methods because the high concentration of salts can damage the detectors in the instruments. Some conductivity meters are capable of measuring salinity in undiluted seawater. But typically, all of the methods listed above, with the exception of total dissolved solids, will require sample dilution with freshwater prior to analysis.

A recent study on the accuracy of electrical conductivity measurements of seawater at high temperatures and salinities reported that, "precise in situ estimates of mass fraction salinities, derived from measurements of electrical conductivity in TEOS-10 using a modification of the Practical Salinity Scale 1978 (PSS-78), have been validated only when temperatures are less than 35 °C and salinities are less than 42 g/kg. The algorithm has not been validated at higher temperatures and salinities." Pawlowicz 2012) PSS-78 requires that any samples over 42 PSU are diluted with distilled water to the proper salinity range and then the water mass added must be accounted for in the calculation. (Pawlowicz 2012) There are established analytical methods for salinity that include dilution with freshwater. However, caution is warranted when a methods calls for dilution because it introduces a potential source of variability or error.

This raises concerns for salinity measurements at seawater desalination facilities because discharges of brine are likely to exceed 42 PSU, creating an analytical challenge using many of the methods listed above. Facilities have the option to measure salinity in the receiving water body. But many will opt for an effluent limitation with a dilution factor so that salinity can be monitored at the end of pipe. This is an area where methods for measuring salinity and other constituents in Table 1 of the Ocean Plan in brine may need to be develop, improved, or modified to be able to acquire accurate data that meet the method detection limits in the Ocean Plan. Until that time, salinity in brine should be measured using a standard method or EPA approved protocol (e.g. EPA 160.1, Standard Method 2520 B, EPA Method 120.1) and reported in parts per thousand (ppt; g/L)

8.7.3 Background: Receiving Water Limit Point of Compliance and Mixing Zones

Inherent to any discussion on receiving water limits is a discussion of the compliance point where that receiving water limit is enforced. The Ocean Plan (2012) allows for a zone of initial dilution (mixing zone) where receiving water is allowed to exceed a water quality objective or receiving water limit. The size of the zone of initial dilution is defined in the Ocean Plan (2012) as the point where initial dilution is achieved:

> *"Initial dilution is the process which results in the rapid and irreversible turbulent mixing of wastewater with ocean water around the point of discharge.*
>
> *"For a submerged buoyant discharge, characteristic of most municipal and industrial wastes that are released from the submarine outfalls, the momentum of the discharge and its initial buoyancy act together to produce turbulent mixing. Initial dilution in this case is completed when the diluting wastewater ceases to rise in the water column and first begins to spread horizontally.*

> *“For shallow water submerged discharges, surface discharges, and nonbuoyant discharges, characteristic of cooling water wastes and some individual discharges, turbulent mixing results primarily from the momentum of the discharge. Initial dilution, in these cases, is considered to be completed when the momentum induced velocity of the discharge ceases to produce significant mixing of the waste, or the diluting plume reaches a fixed distance from the discharge to be specified by the Regional Board, whichever results in the lower estimate for initial dilution.* (Ocean Plan Appendix I, Definition of Terms)”

In general, the zone of initial dilution is defined by the physical characteristics of a discharge, and is limited to the area where the waste undergoes turbulent mixing. For certain types of discharges, the regional water board can specify a fixed radius zone of initial dilution if that zone provides a smaller area required to achieve initial dilution. The Ocean Plan further defines the size of an acute mixing zone as ten percent of the distance from the edge of the outfall structure to the edge of the chronic mixing zone (zone of initial dilution).

The Federal definition of a zone of initial dilution (referred to as a mixing zone in Federal statutes) differs slightly from the Ocean Plan. 40 CFR 125.121(c), Ocean Discharge Criteria, states:

> *“Mixing zone means the zone extending from the sea’s surface to seabed and extending laterally to a distance of 100 meters in all directions from the discharge point(s) or to the boundary of the zone of initial dilution as calculated by a plume model approved by the director, whichever is greater, unless the director determines that the more restrictive mixing zone or another definition of the mixing zone is more appropriate for a specific discharge.”*

The Science Advisory Panel reports (Roberts et al. 2012, Foster et al. 2013) further address compliance points and mixing zones associated with desalination brine discharges. Roberts et al. (2012) recommend that the regulatory mixing zone extend 100 meters in all directions and over the whole water column. Data within the Roberts et al. (2012) report show that most discharges that undergo rapid initial dilution can easily meet a mixing zone of 100 meters; however, the report bases the size of the mixing zone on rapid initial dilution, which is typically achieved through the use of multiport diffusers. The report does not specifically examine the size of mixing zones associated with other types of brine disposal methods (e.g., flow augmentation), yet still extends the 100 meter regulatory mixing zone recommendation to all types of brine discharges.

Roberts et al. (2010) has summarized salinity concentrations at or near desalination brine discharges. The work of Roberts et al. (2010) is reproduced in a modified format in Table 8-5 below, showing that in many instances, the salinity of the brine discharge is diluted to less than 2 ppt above ambient background within only a few tens of meters of an outlet. Some of the facilities with larger discharges had plumes of elevated salinity that could be detected at a distance of hundreds of meters from an outfall. (Roberts et al. 2012) The information in

Roberts et al. did not distinguish between multiport diffusers and other types of brine disposal methods such as commingling with WWTP effluent or flow augmentation.

Commingling brine with an adequate volume of WWTP effluent will result in a discharge that is either at or near ambient salinity concentrations and should easily be able meet 2 ppt above ambient within 100 m. Facilities using flow augmentation should also have a discharge that is either at or near ambient salinity concentrations and should also easily be able meet 2 ppt above ambient within 100 m. Based on the information in Table 8-5 below and the Roberts et al. (2012) conclusions, facilities discharging raw brine through multiport diffusers should also be able to dilute their brine to 2 ppt above natural background salinity within 100 m of the discharge.

Table 8-5 Compilation of mixing zones and salinity effects related to desalination facilities (Modified from Roberts et al. 2010).

Location	Intake (MGD)	Discharge (MGD)	Salinity of Brine (ppt)	Notes	Reference
Muscat, Oman	24.41	NR	37.3	Returned to background levels within approximately 100 m of outlet.	Abdul-Wahab, 2007
Muscat, Oman	50.46	NR	40.11	Appeared to return to background levels 980 m from outlet.	Abdul-Wahab, 2007
Sitra Island, Bahrain	28	76.08	51	Salinity of receiving water reached 51 ppt, relative to reference areas of 45 ppt, plume extended at least 160 m from discharge.	Altayaran and Madany, 1992
Florida, USA	2.4	5.81	40-55	0.5 ppt above background levels within 10-20 m of outlet. Nevertheless, slight elevation was maintained for 600 m within harbor basin.	Chesher, 1971
Canary Islands, Spain	6.6	4.49	75.2	2 ppt above background on the seabed and 1 ppt on the surface within 20 m of the outlet; similar to the background levels at 100 m.	Talavera and Ruiz, 2001
Dhkelia, Cyprus	NR	NR	NR	Above background 100-200 m from outlet, occasionally as high as 60 ppt.	Einav *et al*. 2002
Alicante, Spain	13.21	19.81	68	0.5 ppt above ambient for up to 4 km from outlet along the seafloor.	Fernández-Torquemeda *et al*. 2005

Javea, Spain	7.4	NR	44	Slightly above background up to 300 m from the outlet	Malfeito *et al*. 2006
Blanes, Spain	15.85	8.72	60	At background levels within 10 m of the outlet. No apparent measurement or analysis of salinity.	Raventos *et al.* 2006
Alicante, Spain	13.21	17.17	68	2.6 ppt above ambient within 300 m of outlet; 1ppt within 600 m similar to background at 1300 m.	Ruso *et al.* 2007
Ashkelon, Israel	72.38	158.5	42	Approximately 2 ppt above ambient within 400 m of outlet, <1 ppt above ambient within 4000 m of the outlet	Safrai and Zask, 2008
Canary Islands, Spain	6.6	NR	75	75 ppt effluent diluted to 38 ppt within 20 m of outlet, no details given as to background salinity.	Sadhwani *et al*. 2005
Formentera, Balearic Islands, Spain	NR	0.53	60	5.5 ppt above background 10 m from outlet; 2.5 ppt at 20 m; 1ppt at 30 m; not measured any further than this.	Gacia *et al*. 2007

8.7.4 Regulatory Considerations

All Basin Plans include language that limits degradation of receiving water by discharges. The San Francisco Regional Water Quality Control Board's Basin Plan specifically addresses the issue of salinity in surface water by stating that:

> *"Controllable water quality factors shall not increase the total dissolved solids or salinity of waters of the state so as to adversely affect beneficial uses, particularly fish migration and estuarine habitat."*

However, the San Francisco Regional Water Quality Control Board's Basin Plan specifically exempts waters of the Pacific Ocean from that salinity control (page 3-3 of the San Francisco Regional Water Quality Control Board Basin Plan). The North Coast, San Francisco, Central Coast, Los Angeles, Santa Ana, and San Diego Regional Water Quality Control Boards do not have water quality objectives, effluent limitations, or receiving water limits that address salinity for ocean waters.

The Basin Plans from the North Coast, San Francisco, Central Coast, Los Angeles, Santa Ana, and San Diego Regional Water Quality Control Boards all incorporate the State Water Board's Ocean Plan (2012) by reference. Ocean Plan chapter II.E.1 (Water Quality Objectives, Biological Characteristics) states, "Marine communities, including vertebrate, invertebrate, and plant species, shall not be degraded." The Ocean Plan (2012) further prohibits exceedances of water quality objectives due to waste discharges, and allows new or modified receiving water limits if sound scientific information becomes available demonstrating that discharges are causing or contributing to the degradation of marine communities, or causing or contributing to the exceedance of narrative or numeric water quality objectives.

While there are no specific water quality objectives or receiving water limits for salinity, the salinity of an effluent can be regulated through the Table 1 toxicity requirements found in chapter II of the Ocean Plan. Chapter II.D.7.a of the Ocean Plan states that Table 1 water quality objectives apply to all discharges within the jurisdiction of the Ocean Plan, which would include discharges from desalination facilities into ocean waters. In the event that an effluent is determined to be toxic, excess salinity may be identified as the causative agent. Specifically, Table 1 includes a daily maximum numeric water quality objective for chronic toxicity of 1 TUc. A TUc is defined as 100/NOEL (no observable effect level), where the NOEL is expressed as the maximum percent effluent or receiving water that causes no observable effect on a test organism, as determined by the result of a critical life stage toxicity test. The chronic toxicity requirement described above must be met at the edge of the zone of initial dilution. Table 1 also includes acute toxicity requirements and measures acute toxicity in terms of TUa (acute toxicity units) defined as 100/96-hr lethal concentration 50 percent (the percent waste giving 50 percent survival of test organisms over 96 hours). So, salinity of desalination facility discharges could be regulated under existing requirements in the Ocean Plan although, the methods may not be the most direct or cost effective means of regulating salinity.

Toxicity testing requirements are based on the minimum initial dilution factor of a discharge, and are measured at the edge of the zone of initial dilution. Acute toxicity testing is required where the minimal initial dilution is greater than 1,000:1 at the edge of the zone of initial dilution. Acute and/or chronic toxicity may be required if the dilution ranges between 100 and 1,000:1. Chronic toxicity testing is required if the initial dilution falls below 100:1 at the edge of the zone of initial dilution.

8.7.5 Options

- <u>Option 1:</u> **No Action. The regional water boards will continue to regulate brine discharges on a site-specific basis, without direction from the State Water Board.** Under Option 1, the regional water boards would rely on existing Ocean Plan language to develop NPDES permits for desalination facilities. The existing Basin Plans do not expressly address salinity; therefore, the Regions would instead rely on the provisions of the Ocean Plan, including chapter II. Water Quality Objectives and Table 1 requirements that include chronic and acute toxicity. The water quality objectives would be met at the edge of the zone of initial dilution, and the size of the zone of initial dilution would be determined through modeling and empirical data as the point where turbulent mixing of the waste plume ceased.

  At present, none of the Basin Plans have standards for elevated salinity in ocean waters. As desalination facilities develop along the California coast, there will be a greater number of permits that are required to implement standards that protect ocean waters from degradation caused by high salinity. Ocean Plan chapter II.E.1 prohibits the degradation of marine communities, including vertebrates, invertebrates, and plant species. But, without consistent standards, each regional water board will permit brine discharges in a different manner, leading to inconsistencies among regions and how standards are applied throughout the state. Consequently, Option 1 is not adequate for the long-term protection of marine life and the State’s ocean waters and would not result in statewide regulatory consistency.

- <u>Option 2:</u> **Amend the Ocean Plan to establish a water quality objective for salinity.** Option 2 would create a new statewide water quality objective that would apply broadly to all brine discharges into ocean waters. The March 30, 2012 Scoping Document (found here: http://www.waterboards.ca.gov/water_issues/programs/ocean/desalination/docs/ScopingDesalMarch2012.pdf) mentions that the Desalination Amendment may address disposal of brine from sources other than desalination facilities. Brine discharges into ocean waters from non-desalination facilities (e.g., breweries, cheese factories, and bottled water and soft drink manufacturers) are currently regulated by the regional water boards on a case-by-case basis. The types of non-desalination facilities that discharge brine are diverse. As discussed in section 8.1, there is a lack of adequate information available at this time to regulate brine discharges from non-desalination facilities on a statewide basis. However, there is adequate information to address brine discharges from desalination facilities in the Desalination Amendment. The Expert Review Panel studies commissioned by the water boards primarily investigated the impacts of desalination facility brine discharges on marine life, but did not look at other types of brine discharges. There may be similarities between desalination facility discharges and other non-desalination brine discharges; however, there may be other constituents in the non-desalination brine discharges that could alter the toxicity of the brine effluent. Applying a water quality objective that restricted the salinity to no more than 2 ppt above natural background salinity to all facilities discharging brine may not be protective of water quality and aquatic beneficial uses. For these reasons, Option 2 is not recommended.

- **Option 3: Amend the Ocean Plan to establish a narrative salinity receiving water limit applicable to desalination facility brine discharges, enforced at the edge of the zone of initial dilution.** Option 3 would create a new statewide receiving water limit, specific to discharges of desalination waste brine, to protect marine communities from degradation. Option 3 would, in essence, provide a narrative interpretation of the biological characteristics objective found in chapter II.E.1 of the Ocean Plan. This option would meet the goal of providing statewide consistency. The narrative limit would be accompanied by implementation measures.

  Option 3 would require the establishment of natural background salinity, and would subsequently prohibit brine discharges from causing salinity to be greater than 2 ppt above that natural background outside the zone of initial dilution. The narrative increase of 2 ppt above background would be protective of sensitive species, while allowing flexibility for fluctuating ocean conditions. Although 2 ppt may allow salinities greater than the LOEC of 35.6 ppt observed for red abalone (Phillips et al. 2012), other studies began to observe ecological impacts when salinity increases were approximately 2 to 3 ppt above background (Roberts et al. 2012). Consequently, a narrative objective of 2 ppt is considered protective while not overly restrictive. The proposed narrative limit for elevated salinity is as follows:

  - Discharges shall not exceed a daily maximum of 2.0 ppt above natural background salinity to be measured at the edge of the zone of initial dilution. There is no vertical limit to this zone.

  The Desalination Amendment would also include language to clarify how effluent limits for this narrative limit would be calculated. The zone of initial dilution would be calculated as the point where (assuming the discharge is non-buoyant) turbulent mixing of the effluent ceases, which could result in inconsistencies among projects and regions.

- **Option 4: Amend the Ocean Plan to establish a narrative receiving water limit for salinity, to be measured no further than 100 meters horizontally from the discharge.** Under Option 4, the State Water Board would include a narrative receiving water limit similar to that as described in Option 3. However, in Option 4 the Desalination Amendment would specify that the receiving water limit must be met at a specific distance from the point of discharge.

  The current language in the Ocean Plan allows the regional water boards to set a maximum zone of initial dilution for non-buoyant discharges. All desalination brine discharges are expected to be non-buoyant at the point of discharge. The Science Advisory Panel (Roberts et al. 2012) has recommended a maximum zone of initial dilution of 100 meters from the point of discharge, based on a review of discharge technologies and existing desalination discharges.

The proposed narrative limit under Option 4 would be similar to that described in Option 3, but with the following modifications:

- Discharges shall not exceed a daily maximum of 2.0 ppt above natural background salinity to be measured no further than 100 meters (328 feet) horizontally from the discharge. There is no vertical limit to this zone
- The fixed distance referenced in the initial dilution definition shall be no more than 100 meters (328 feet).
- In addition, the owner or operator shall develop a dilution factor (Dm) based on the distance of 100 meters (328 feet) or initial dilution, whichever is smaller.

The application of a fixed distance receiving water limit in Option 4 sets a consistent statewide standard that will protect water quality and related beneficial uses of ocean waters, which meets the first project goal. For facilities that will commingle brine with wastewater and discharge positively buoyant plumes, the existing process for establishing receiving water limits is sufficient. However, the Science Advisory Panel (Roberts et al. 2012) suggested that a revised regulatory framework is needed for non-buoyant discharges such as those from desalination facilities.

Option 4 would allow, under certain circumstances like discharging a non-buoyant plume, the development of up to three separate and differently-defined mixing zones for a desalination brine discharge: a chronic toxicity mixing zone associated with Ocean Plan Table 1 pollutants; an acute toxicity mixing zone defined as 10 percent of the chronic toxicity mixing zone; and a brine toxicity mixing zone defined as the area extending 100 meters from the point of discharge. Option 4 would set a clear point of compliance for salinity limits and would ensure that there are not large areas where salinity is elevated to toxic levels. Additionally, Roberts et al. determined that a discharger should be able to dilute brine to 2 ppt above natural background within 100 meters of the discharge using any method of brine discharge.

- **Option 5: Amend the Ocean Plan to establish a numeric receiving water limit.** Adopting a numeric objective would create a new statewide water quality limitation for elevated salinity levels in the State's ocean waters through establishment of a quantitative objective as a statewide numeric standard. Adopting a numeric limit is an efficient regulatory tool because the measurement of compliance is clearly defined. The numeric limit would be met at the edge of the zone of initial dilution.

  Option 5 would prohibit brine discharges from causing ocean water to exceed a numeric limit of 37 ppt. The value of 37 ppt was chosen from literature showing that salinity increases of less than 3 ppt can be protective of biologic communities and assuming an average background salinity of 34 ppt along California's coast.

However, natural background salinity in California varies regionally and temporally based on the environmental conditions. For this reason, a numeric objective may not be a suitable limit for areas where salinity is naturally higher and the organisms living in that environment are more tolerant of higher salinities. Additionally, a 37 ppt numeric limit might allow salinities that degrade marine communities in some circumstances, particularly when there are highly sensitive species in that community.

Under this option, the numeric limit would be as follows:

- For ocean waters, salinity shall not exceed 37 ppt, at the edge of the zone of initial dilution and throughout the water column.

Option 5 would meet part of the first goal by providing a consistent statewide regulatory approach for salinity; however, the numeric limit may be overly restrictive in some areas and under-protective in others. Additionally, some areas may be challenged to meet the numeric receiving water limit for salinity because of their naturally high salinity. In cases such as these, desalination may be limited, which would not meet the second project goal of supporting the use of ocean water as a reliable supplement to traditional water supplies.

- **Option 6: Amend the Ocean Plan to require an owner or operator to establish a facility-specific salinity receiving water limit to be measured no further than 100 meters horizontally from the discharge.** Under Option 6, the regional water boards would require that each discharger of desalination brine waste examine the effects of that waste on select marine species in Table III-1 of the Ocean Plan and develop a facility-specific receiving water limit for salinity.

  An owner or operator of a facility discharging brine is prohibited from degrading receiving waters, following mixing and dilution. The composition, concentration, and volume of brine discharges will vary depending on facility-specific conditions. Currently, the regional water boards examine the facility specific conditions and issue an NPDES permit for the brine discharges based on those conditions. For Option 6, the State Water Board would amend the Ocean Plan to require that all desalination waste discharges to the ocean develop facility-specific receiving water salinity limits using specific criteria. Option 6 would provide the regional water boards with specific direction for approving a facility-specific receiving water limit for salinity.

  Receiving water limits and the water quality objective proposed in Options 2 through 5 are based upon a review of how salinity affects ecologic communities across the globe. (Roberts et al. 2012a), together with a single set of toxicity tests. (Phillips et al. 2012) The data strongly suggest that a receiving water limit of 1.7 to 3 ppt above natural background salinity should be protective of most marine life. However, if the same organisms tested in Philips et al. (2012) are exposed to a specific facility's brine discharge, the whole effluent toxicity results may be different. Option 6 recognizes there may be a need for facility-specific flexibility that would still be protective of marine life and beneficial uses.

Under Option 6, a facility would be required to undergo the following if they would like the regional water boards to consider approving a facility specific receiving water limit:

- An owner or operator would submit a proposal to the regional water board for approval of a facility-specific receiving water limit for salinity.
- To determine whether a facility-specific receiving water limit is adequately protective of beneficial uses, an owner or operator would:
  - Establish baseline biological conditions at the discharge location and at reference locations over a 12-month period prior to commencing brine discharge. The biologic surveys should characterize the ecologic composition of habitat and marine life using measures established by the regional water board. The regional water board may accept existing data at their discretion.
  - Conduct WET tests for at least the following:
    - germination and growth for giant kelp (*Macrocystis pyrifera*)
    - development for red abalone (*Haliotis refescens*)
    - development and fertilization for purple urchin (*Strongleocentrotus purpuratus*)
    - development and fertilization for sand dollar (*Dendraster excentricus*), and
    - larval growth rate for topsmelt (*Atherniops affinis*).

In essence, on owner or operator would be given the opportunity to repeat the Granite Canyon studies (Philips et al. 2012) with their effluent and develop a facility-specific receiving water limit for salinity based on the results. State Water Board staff have reduced the list of species studied in Philips et al. 2012 to reduce costs of the studies and to focus on the species that were most affected by salinity changes in the study, while still representing a variety of taxa. The species listed above are themselves representatives of other similar species. For example, abalone are in the Phylum Mollusca, an extremely diverse taxa which includes snails, shellfish, squid, octopus, nautilus, and nudibranchs. One of the reasons these seemingly diverse animals are grouped together is because they have similar developmental stages. Consequently, results from studies done on red abalone development should apply to any mollusk that undergoes a similar developmental process.

Some have suggested establishing the facility-specific receiving water limit by running toxicity studies on the species that are present in the discharge environment. However, the salinity toxicity studies should be done on laboratory raised species or species collected from a reputable vendor that have established U.S. EPA approved test protocols. Laboratory or farm raised species are acclimated to confinement and have been raised in similar conditions. Using laboratory or farm raised animals increases the accuracy and reproducibility of the studies. Wild-caught species will have different levels of physical fitness, which can result in inconsistencies in the toxicity test results. If toxicity tests are run on wild species that do not have established U.S. EPA test protocols, any differences detected may be a result of environmental variability and not actual differences. There is a high probability toxicity studies on wild caught species will result in inconclusive results. If wild-caught species are used they should be acquired from a reputable vendor.

The Desalination Amendment does not allow the use of the most sensitive species that are found in the impacted habitat to establish an alternative receiving water limitation for a number of reasons. The five species selected for WET testing in the Desalination Amendment were selected from Table III-1 of the Ocean Plan, which was developed and implemented in accordance with California Water Code sections 13170.2(c) and (d). The species in the Ocean Plan were developed and approved by the State Water Board for toxicity testing of *all* discharges into ocean waters of the state. Other waste dischargers must use the species in Table III-1 for toxicity testing, so there is no justification to allow dischargers of brine to use other species. Furthermore, as described in Section 8.7.5 of the Staff Report with SED, the species in Table III-1 and Chapter III.M.3.f.(1)(b) serve as representatives of related species. For example, larval development is the same for bivalves (e.g. clams, mussels, cockels, and oysters) from fertilization to the point just before undergoing metamorphosis to the juvenile stage. Regardless of whether a larva differentiates during metamorphosis into a California mussel living on a pier piling or into a bean clam buried in soft-bottom habitat, the larval phase will respond similarly to elevated salinity. An explanation of how and why the chronic toxicity testing protocols were developed and how using endemic species for WET testing can result in a receiving water limitation for salinity that is not adequately protective is described below.

First, California Water Code section 13170.2(c) requires that, “the state board shall develop bioassay protocols to evaluate the effect of municipal and industrial waste discharges on the marine environment” and section 13170.2(d) adds that, “the state board shall adopt the bioassay protocols and complementary chemical testing methods and shall require their use in the monitoring of complex effluent ocean discharges.” In 1990, the State Water Board adopted a list of seven critical life stage toxicity testing protocols to be used for determining compliance with the chronic toxicity objective. The protocols were developed to meet the requirement in California Water Code section 13170.2(c). In order to be included in Table III-1 of the Ocean Plan (approved tests for chronic toxicity), each test protocol had to meet all seven of the following criteria:

1. the existence of a detailed written description of the test method;
2. a history of testing with a reference toxicant;
3. interlaboratory comparisons of the method;
4. adequate testing with wastewater;
5. measurement of an effect that is clearly adverse;
6. measurement of at least one nonlethal effect; and
7. use of marine organisms native to or established in California.

The 1990 list of critical life stage toxicity testing protocols was reviewed by a 10 member external advisory panel known as the Protocol Review Committee (PRC) that included aquatic toxicology experts representing industry, academia, and government. In 1994, the PRC suggested a revised list of critical life stage protocols acceptable for use in measuring compliance and added two additional criteria (Bay et al., October 1994):

8. the protocol must have information that documents relative sensitivity to toxic/reference materials and compares it to current Ocean Plan-listed tests; and
9. the organism(s) specified in the protocol must be readily available either by field collection or by laboratory culture.

The State Water Board developed and adopted the standard critical life stage protocols in Table III-1 based on the PRC's recommendations in order to ensure toxicity data collected by dischargers were accurate, consistent, reproducible, reliable, and comparable among projects. The five species listed in the Desalination Amendment were selected from Table III-1 of the Ocean Plan, which were selected based on their longstanding history of use in toxicity test method research, development, and implementation. For additional information regarding the development of Table III-1 of the Ocean Plan and the PRC's recommendations, please see State Water Board 1995 and State Water Board 1996.

In order for an owner or operator to conduct toxicity tests on the most sensitive species with a "developed test protocols," the most sensitive species must first be identified through studies. Then the toxicity test for the species must meet all nine of the requirements above. At the time the 1995 PRC Report was released, there was only one critical life stage that was close to meeting the nine criteria. The protocol developed by Reish et al. (1994) for the polychaete *Neanthes spp.* met six of the nine criteria, but did not meet the following:

1. a written protocol is available,
2. there has been adequate testing with wastewater, and
3. there is sufficient intra- and interlaboratory testing.

Since there is only one other species (*Neanthes spp.*) that is close to meeting the standards required for adoption into Table III-1, we did not think an owner or operator would elect to perform studies to identify the most sensitive species at their site, and then develop test protocols for each of the most sensitive species that meet all nine of the above mentioned criteria. We determined the option would be cost and time prohibitive and that ultimately, no one would pursue that pathway.

In the past 20 years, the remaining three criteria for the *Neanthes spp.* may have been met; however, the Water Boards have not yet made that determination. If a regional water board determines the *Neanthes spp.* test has met the remaining three criteria and still meets the other six criteria, the regional water board can add the Neanthes spp. test to the required list of toxicity tests per Chapter III.M.3.f.(1)(c) of the Desalination Amendment. The addition of polychaetes to the toxicity testing requirements may be beneficial since polychaetes are ubiquitous in marine habitats. Some polychaete species are common in soft-bottom habitats and would serve as a good representative of a benthic soft-bottom species with low mobility. This could help to address concerns that the species in Chapter III.M.3.f.(1)(c) are not representative of the species at “my discharge” by providing an additional representative of a broader taxa.

However, the concern that the species in Chapter III.M.3.f.(1)(c) are not representative of the species at “my discharge” is unfounded. The Ocean Plan list (Table III-1) covers a broad taxonomic range as well as different physiological endpoints and meets the goal of protecting indigenous species as required in section 13170.2(b). (State Water Board 1995) The species in Table III-1 are representatives of their broader taxa (e.g. the mussel and bean clam example), which means the toxicity data from these species can be used to make general assumptions of how a brine discharge will impact a group of similar species without having to perform tests on each individual species present at a discharge.

There are a number of other issues that can occur if an owner or operator deviated from the standard Ocean Plan list (Table III-1). Allowing an owner or operator to select species for toxicity testing may also result in an inadequately protective receiving water limitation for salinity because species that are known to be more tolerant of salinity changes may be selected. Deviating from the standard Ocean Plan list by using wild-caught animals for laboratory toxicity testing can also be problematic. Wild-caught animals have varying states of fitness and variable exposure to environmental contaminants, and there are a number of other confounding environmental factors that have the potential to influence toxicity test results. Often laboratory raised animals are used in in toxicity studies order to control variables that can influence the test results. Some of the Table III-1species are collected from the field, but are consistently collected and handled by a reputable dealer. Using non-standardized methods for the collection of species and the toxicity tests themselves creates a significant risk that the toxicity tests will not be accurate. This can result in establishing an alternative receiving water limitation that is not adequately protective because it was based on inaccurate data.

In conclusion, it is important that there are standard test protocols developed for the animals that meet the abovementioned nine criteria, and the only species/test that meet all nine are in Table III-1 of the Ocean Plan. These species represent a broad taxonomic range and are representatives for other related species in California. Deviating from this list will result in regulatory inconsistencies and may result in alternative receiving water limitation that is not adequately protective of beneficial uses.

In addition to the specifications above, under Option 6, the facility-specific alternative receiving water limit would be based on the lowest observed effect concentration (LOEC) of non-lethal endpoints like development, reproduction, behavior, and growth for the most sensitive species in WET test studies as determined in the chronic toxicity studies. Note that determination of a facility-specific receiving water limit could, in some cases, result in a narrative receiving water limit that is lower than that described in the options above. In such a scenario, the discharger would be held to the lower narrative limit, since that limit would have been shown to be most protective of marine life and necessary to prevent degradation of the marine community.

After completing the studies, the regional water board would set a daily maximum above natural background salinity to be measured no further than 100 meters (328 ft) horizontally from the discharge. There would be no vertical limit to this zone. Option 6 would also allow the regional water boards to require additional information, additional toxicity studies, or to revise a receiving water limit for salinity upon the availability of new data. The language would also include implementation requirements for existing facilities that do not meet a receiving water limit at the edge of the zone of initial dilution. The regional water board in consultation with State Water Board staff would have the discretion to approve or revise the proposed facility-specific alternative receiving water limit for salinity.

8.7.6 Staff Recommendation

Staff recommends a combination of Option 4 and Option 6. The Ocean Plan should establish a narrative receiving water limit for salinity of 2 ppt above natural background, applied at a distance no greater than 100 meters from the point of discharge. The Ocean Plan should also allow facility-specific receiving water limits for salinity applied at a distance no greater than 100 meters from the point of discharge on a case-by-case basis. The brine mixing zone will be defined as the area where the salinity exceeds 2.0 parts per thousand above natural background salinity, or the concentration of salinity approved as part of an alternative receiving water limitation. The brine mixing zone should not exceed 100 meters (328 feet) laterally from the points of discharge and throughout the water column. The brine mixing zone is an allocated impact zone where there may be toxic effects on marine life due to elevated salinity.

Option 4 would establish a baseline standard to protect water quality and beneficial uses of ocean waters in a consistent manner. Options 4 also allows an owner or operator that does not want to complete additional studies to determine a facility-specific receiving water limit to use 2 ppt above natural background as their standard. If an owner or operator feels the 2 ppt above natural background is too restrictive for their specific discharge, Option 6 would provide them with an opportunity to demonstrate an alternative receiving water limit for salinity is still protective of marine life at their discharge. Using a combination of Options 4 and 6 provides an owner or operator greater flexibility for their brine discharge while protecting water quality, and related beneficial uses of ocean waters. In this instance the preferred options may not result in a statewide standard for salinity, but all facilities will be given the same opportunity to establish a facility specific receiving water limit applied at a distance no greater than 100 meters from the point of discharge that is still protective of water quality and related beneficial uses of ocean waters. Using a combination of Options 4 and 6 also supports the use of ocean water to supplement traditional water supplies. An owner or operator of a desalination facility will demonstrate compliance with the receiving water limitation through monitor salinity in the receiving water body no further than 100 m in all directions from the outfall and throughout the water column (i.e. from the benthic environment to the sea surface). Alternatively, the receiving water limitation for salinity could be converted to an effluent limitation. In this case, an owner or operator would use applicable water quality models to develop a dilution factor based on the distance of 100 meters or initial dilution, whichever is smaller. The fixed distance referenced in the Ocean Plan definition of initial dilution shall be no larger than 100 meters from the outfall.

8.7.7 Proposed Amendment Language

Please see chapter III.M.3 in Appendix A.

8.8 Should the State Water Board Develop Statewide regulations for antiscalants, biocides, and cleaning in place (CIP) liquids?

8.8.1 Antiscalants, Biocides, and CIP Liquids

Many desalination facilities, particularly those with surface water intakes, pre-treat their water prior to desalinating it to remove suspended particles that can foul the reverse osmosis (RO) membranes. Coagulants such as ferric chloride and polyaluminum sulfate are used in the pre-treatment process to aid in the settling of solids. The ultrafiltration membranes used in the pre-treatment process require periodic backwashing to dislodge particles and discharge them into a waste stream.

As seawater passes through RO membranes, the membranes can foul or scale, reducing the efficiency of the desalination process and the longevity of the membranes. Scaling occurs when salts and silicates build up on the RO membranes. Common scaling salts include; calcium carbonate, calcium sulfate, barium sulfate, strontium sulfate, silicates, calcium phosphate, and alumino-silicates. (Luo and Wang 2001) These salts can be chemically removed using antiscalants to increase the efficiency and longevity of RO membranes. Polyphosphonate, polyacrylate, and sodium hexametaphosphate are commonly used antiscalants and there are a number of other antiscalants that have proprietary formulas (e.g. General Electric's Hypersperse). (Luo and Wang 2001; NFESC NPDES No. CA0064564)

Membrane fouling is similar to scaling in that it involves build-up on the RO membranes that must be treated and removed to ensure efficiency and longevity of membranes. The four most common types of membrane fouling are adsorbed organic compounds, biological growth, metallic (hydr) oxides, and particulate matter. Removal of each of the fouling agents may require a different cleaning solution or biocide. For example, acidic solutions like 2% citric acid remove silt deposits and biofilms from membranes, whereas alkaline solutions like sodium hydroxide dissolves metal oxides or membrane scaling.

Each of these pre-treatment steps and CIP processes are an integral part of the desalination process. However, the spent cleaning solutions pose a potential threat to water quality and marine organisms if discharged directly into the ocean. The use of pre-treatment chemicals will vary depending on the pre-treatment needs of a facility. For example, many facilities using subsurface intakes will not require pre-treatment. Other facilities with subsurface intakes sited near freshwater sources may have high iron and manganese concentrations in the intake water that will require the addition of pre-treatment chemicals. The volume and frequency of use of antiscalants, biocides, and other CIP liquids among facilities will also depend on factors such as the amount of water processed at a facility and the salinity of the intake water.

8.8.2 Regulatory Considerations

The Ocean Plan does not directly address antiscalants, coagulants, biocides, and other CIP liquids. However, existing provisions in the Ocean Plan for acute and chronic toxicity will apply to desalination facilities and are likely to address toxicity of these chemicals. Regional water boards have addressed these chemicals in NPDES permits for existing desalination facilities. The NPDES permits varied among the dischargers, but in general, the permits required that the chemicals used during the desalination and filtration process be used in concentrations approved for drinking water treatment applications by National Sanitation Foundation, International (NFESC NPDES No. CA0064564) or that the waste streams from the pretreatment process and the membrane cleaning solutions are discharged into the sanitary sewer system rather than discharged offshore. The exception was West Basin Municipal Water District's pilot facility, where antiscalants and coagulants were allowed to be discharged with the effluent because the regional water board found that the impacts of these chemicals on the discharge effluent would be minimal. This is likely because the WBMWD test facility is small and the chemicals are significantly diluted prior to entering the receiving water environment, and because the facility must still comply with the toxicity requirements in the Ocean Plan. (WBMWD NPDES NO. CA0064581)

8.8.3 Options

Option 1: No Action. The regional water boards will continue to regulate antiscalants, biocides, and CIP liquids on a site-specific basis, without direction from the State Water Board. Under Option 1, the regional water boards would continue to evaluate the type of antiscalants, biocides, and CIP liquids used at a facility, as well as how much is used, and how often they are used and then include provisions to address the specific discharges in the individual NPDES permits. While this option may not result in statewide consistency, the type, volume, and frequency of use of antiscalants, biocides, and other CIP liquids will significantly vary among facilities and will also depend on factors such as the amount of water processed at a facility and the salinity of the intake water. The regional water boards have the expertise to evaluate to determine where and how the antiscalants, biocides, and other CIP liquids should be discharged (e.g. adjust pH prior to discharge or discharge to the sanitary sewer). Furthermore, the existing toxicity requirements in the Ocean Plan will ensure the protection of beneficial uses even if antiscalants, biocides, and other CIP liquids are discharged from a desalination facility.

Option 2: Amend the Ocean Plan to address the disposal of antiscalants, biocides, and CIP liquids. Under Option 2, the State Water Board would amend the Ocean Plan to require that all desalination facilities generating discharges containing antiscalants, biocides, and CIP liquids must adjust the pH of the discharges to neutral and then discharge the solutions into the sanitary sewer. Regional water boards would implement the provisions in the Ocean Plan in a facility's NPDES permit. While Option 2 would prevent any of these chemicals from entering the marine environment, this requirement may be overly restrictive and unnecessary for some of the spent cleaning solutions. For example, some of the discharges will contain only organic matter that has been back-flushed off the filter and Table 2 of the Ocean Plan already addresses suspended solids and turbidity. Discharging filter backwash containing only organic matter to the sanitary sewer would place an unnecessary burden on the wastewater treatment plant. Some discharges of spent cleaning solutions may only need to have the pH adjusted before they can be discharged into the ocean. Other spent cleaning solutions should be discharged into the sanitary sewer rather than being discharges into the ocean untreated. Since the type, volume, and frequency of use of antiscalants, biocides, and other CIP liquids will significantly vary among facilities and will also depend on factors such as the amount of water processed at a facility and the salinity of the intake water, it may not be appropriate at this time for the State Water Board to develop statewide standards.

8.8.4 Staff Recommendation

Staff recommends Option 1. The regional water boards have done an exemplary job of identifying the risks associated with the various pre-treatment and spent membrane solutions and disposal of these discharges. In general, any discharges associated with pre-treatment or CIP liquids that pose a threat to water quality and the associated beneficial uses of ocean waters should be discharged to a sanitary sewer system. Since the use of antiscalants, coagulants, biocides, and other CIP liquids varies among facilities, and that the Ocean Plan's existing toxicity requirements adequately address toxicity associated with the discharge of the chemicals, staff recommends that the regional water boards continue to address these discharges in individual NPDES permits.

8.8.5 Amendment Language

There is no section to refer to in the Desalination Amendment since antiscalants, biocides, and cleaning in place liquids will be regulated by the regional water boards through individual NPDES permits.

9 ECONOMIC ANALYSIS

The State Water Board is required to identify facilities that will be affected by the Desalination Amendment and provide an economic evaluation. The economic analysis reviews the likely compliance actions, costs, mitigation, and other economic factors required for the Desalination Amendment.

The Desalination Amendment addresses seawater intake and brine disposal for desalination facilities. A narrative receiving water limit requires an owner or operator of a desalination facility to evaluate their brine discharge to conclude whether the limitation will be met. If facilities do not meet the brine discharge receiving water limit, alternative modes of discharge include discharge through multiport diffusers, commingling with a waste water treatment plant discharge, or augmentation of intake flows to dilute the brine within the plant. In addition, the Desalination Amendment will require intake measures that apply only to new and expanded facilities. These facilities will be required to evaluate the feasibility of a subsurface intake. If infeasible, a facility will instead comply with surface water intake requirements by installing screens and reducing or eliminating impingement and entrainment. All facilities will be required to fully mitigate residual entrainment.

Appendix G reviews the economic analysis of the Desalination Amendment. The analysis includes the costs for the installation of multiport diffusers, the construction and design of a subsurface intake, screen installation for a surface intake, mitigation, operation and maintenance, and the overall desalination facility project cost under the Desalination Amendment.

10 IMPACTS ON HOUSING AND DEVELOPMENT IN CALIFORNIA

California's growing population will demand an increasing supply of water based on a variety of possible future growth scenarios. CEQA Guidelines (Cal. Code of Reg., tit. 14, ch., 3) require a discussion of growth-inducing impacts for proposed projects. Desalination may be a tool to help meet future water demands in California and consequently may have an impact on growth and housing.

10.1 Housing and Development

In the coming years, California will need a substantial amount of new housing construction (more than 200,000 units per year through 2020) if it is to accommodate projected population and household growth and remain reasonably affordable. (Landis et al. 2000) California's housing density is currently 35 percent above the national average and rising. Census data show that the Los Angeles and San Francisco metropolitan areas respectively have the second and third highest residential density in the U.S. Projections indicate that the Inland Empire, Sacramento region, and San Joaquin Valley will grow faster than other areas of the state. One of the project goals in section 4.3 is to "support the use of ocean water as a reliable supplement to traditional water supplies while protecting beneficial uses." However, the Desalination Amendment to the Ocean Plan neither prohibit nor specifically encourage desalination. Instead, the Desalination Amendment provides regulatory requirements for desalination facilities that will protect biological resources and beneficial uses of the State's water.

The Desalination Amendment will not have a direct impact on housing and development. Indirectly, the availability of new or alternative water supplies may result in additional housing and development, particularly in regions where water availability is a limited resource as described in section 12.3.13. An increased supply of drinking water supports California's growing population and housing capacity. Therefore, implementation of the Desalination Amendment could result in environmentally sustainable sources of drinking water and help meet California's growing water demands.

11 The Need to Develop and Use Recycled Water

11.1 Recycled Water in California

The State Water Board established a Recycled Water Policy in 2009, stating:

> "California is facing an unprecedented water crisis. The collapse of the Bay-Delta ecosystem, climate change and continuing population growth have combined with a severe drought on the Colorado River and failing levees in the Delta to create a new reality that challenges California's ability to provide the clean water needed for a healthy environment, a healthy population and a healthy economy, both now and in the future." (SWRCB 2009a)

With increased water demand brought on by continued drought and an increasing population, recycled wastewater is now considered an important water resource. California presently recycles approximately 650,000 acre-feet (212,000 MG) of water per year, an amount that has doubled in the last twenty years. Non-potable and potable use of recycled water can enable communities to maximize and extend the use of limited water resources. Future reuse potential in the state is estimated to be an additional 1.4 to 1.6 million acre-feet (456,000 - 521,000 MG) per year by 2030, a 109 to 139 percent increase. (SWRCB 2009a)

Appropriately treated wastewater can be used as an alternative and/or supplemental water source to increase the supply of high-quality water for potable uses. Recycled water can be used for applications such as:

1. Landscape irrigation (e.g., parks, golf courses, residential),
2. Agricultural irrigation (e.g., crops, commercial),
3. Industrial uses (e.g., cooling towers, construction),
4. Urban non-potable (e.g., toilet flushing, firefighting),
5. Potable water uses (e.g., blending in reservoirs, blending in groundwater, direct use), and
6. Recreational/ environmental uses (e.g., lakes, marshes, stream flow augmentation).

11.2 Benefits of Recycled Water

Water recycling can provide a comparatively low energy source of local water because delivery of recycled water may use less energy than either desalination or importation of water from other regions. Water recycling has the potential to provide a variety of benefits including: reduced costs, increased reliability of supply, and increased availability of potable water. The benefits of recycled water are greatest for applications that do not demand advanced levels of treatment, such as landscape irrigation.

Currently, recycled water cannot be directly used for potable applications. However, recycled water can indirectly increase the availability of local potable water. Using recycled water for non-potable applications can increase the availability of drinking-quality water for public consumption.

11.3 Future Trends in the Use of Recycled Water

In 2009, the State Water Board and Department of Water Resources collaborated on a survey to determine how much wastewater was being recycled in California. The survey indicated that eight to ten percent of municipal wastewater is recycled in reuse projects and that recycled municipal wastewater increased by approximately 144,000 acre-feet between 2001, to over 669,000 acre-feet in 2009. (SWRCB 2009b) Figure 11-1 shows long-term regional trends in recycled water use from 1970 to 2009. The amount of recycled water in the state is expected to increase by an additional 1.4 to 1.6 million acre-feet per year by the year 2030. (SWRCB 2009b)

The 2009 Municipal Wastewater Recycling Survey also quantified how the recycled wastewater was being used. As of 2009, the top three uses of recycled water in California are 1) agricultural irrigation (37 percent), 2) landscape irrigation (18 percent), and 3) seawater intrusion barriers (12 percent). Since 1970, the overall amount of recycled water used for agricultural irrigation has doubled; however, the distribution of how recycled water is being used has shifted. In 2001, 60 percent of recycled water was used for agricultural irrigation, whereas the 2009 survey showed only 37 percent was used for agricultural irrigation. This is indicative of an expansion and diversification of beneficial uses of recycled water over time.

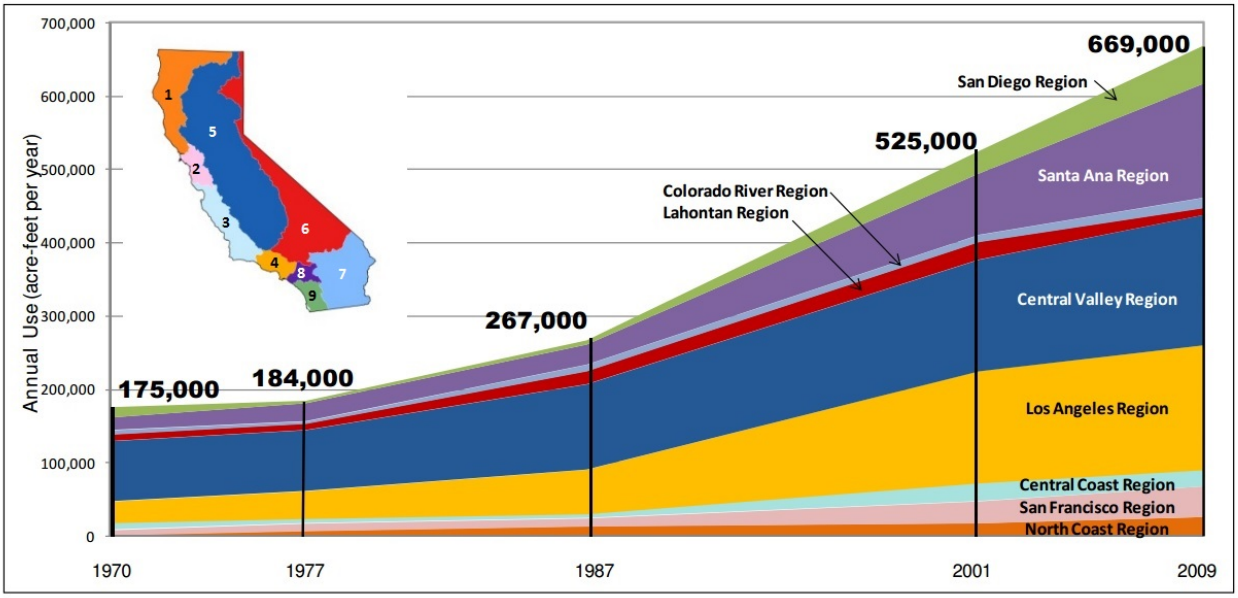

Figure 11-1 Historic trends of total recycled water use in California, by regional water boards. (SWRCB 2009b)

11.4 Impact of the Desalination Amendment on Recycled Water Use

The Desalination Amendment is not expected to impact or increase the need for water cycling. Water recycling and desalination are alternative water supply sources. Where water supplies are severely limited, recycled water, desalinated water, and other water supply alternatives could become part of the water management portfolio. In some cases both alternatives will be developed to ensure adequate supply. Where desalination is selected, the product water could present a new source for water cycling. However, the availability of this wastewater for recycling does not require that it be recycled. Additionally, commingling brine with treated wastewater is an option for brine disposal in the Desalination Amendment. It is the preferred alternative because in the context of minimizing intake and mortality of marine life, commingling brine with treated wastewater has the lowest impacts on marine life relative to other brine discharge methods. The proposed language emphasizes that the wastewater for brine dilution is water that would otherwise be discharged into the ocean. WWTPs, water recycling facilities, and desalination facilities will work together to identify the best use of the treated wastewater. Consequently, the use of treated wastewater for brine dilution would neither promote nor inhibit water recycling efforts.

12 ANALYSIS OF POTENTIAL ADVERSE ENVIRONMENTAL EFFECTS

The Secretary for Natural Resources has certified the State Water Boards' regulatory program for adoption or approval of standards, rules, regulations, or plans to be used in the Basin/208 Planning program for the protection, maintenance, and enhancement of water quality in California as an exempt regulatory program for the purpose of complying with the California Environmental Quality Act (CEQA) (Pub. Res. Code § 21080.5; Cal. Code Regs., tit. 14, §§ 15250-15252; Cal. Code Regs., tit. 23, § 3775.) Therefore, this Staff Report, including the SED, follows the requirements of the State Water Board's certified regulatory program in lieu of a separate CEQA document (Cal. Code Regs., tit. 23, § 3777.) However, this documentation adheres to the substantive directives of CEQA, including the directive to assess the significant impacts of the proposed action and determine if feasible mitigation is available to avoid or minimize the potential to cause significant impacts (Cal. Code Regs., tit. 14, §§ 15250, 15252(a).)

This section contains the principal environmental analysis of the Desalination Amendment as required by the State Water Board's Regulations for Implementation of the California Environmental Quality Act (CEQA regulations; California Code of Regulations, title 23, sections 3720-3782). Specifically, the State Water Board's CEQA regulations (Cal. Code Regs., Tit. 23, §3777) require that any water quality control plan must include or be accompanied by substitute environmental documentation that shall include, at a minimum, the following information:

(1) A brief description of the Desalination Amendment;
(2) An identification of any significant or potentially significant adverse environmental impacts of the Desalination Amendment;
(3) An analysis of reasonable alternatives to the Desalination Amendment and mitigation measures to avoid or reduce any significant or potentially significant adverse environmental impacts; and
(4) An environmental analysis of the reasonably foreseeable methods of compliance.

The project description is briefly summarized in Section 4.2 and is included in its entirety in Appendix A. The remaining analysis is organized in two parts. The first part (section 12.1) identifies the potential impacts that might generally occur from construction and operation of a coastal desalination facility, without regard to the requirements set forth in the State Water Board's Desalination Amendment. This part of the analysis was performed principally from reviewing and summarizing the environmental documentation prepared for other planned desalination facilities. The State Water Board Desalination Amendment does not approve, authorize, or otherwise support through public agency contracts, grants, subsidies, loans, or other forms of assistance any specific desalination project and the impacts described in section 12.1 are not directly or indirectly created by the State Water Board's action. In addition, it would be speculative to develop a detailed evaluation of the desalination facilities that could be proposed in the future in reaction to the State Water Board's Desalination Amendment. However, much like how the CEQA Guidelines direct a lead agency to discuss growth inducing impacts (see 14 CCR 15126.2(d)), the State Water Board Desalination Amendment could "remove an obstacle" in the proposal of a desalination facility and as such, the discussion in section 12.1 presents a generalized analysis of the possible impacts that could occur from a desalination facility but does not present a detailed analysis of the resulting impacts of, and makes no conclusions in terms of these specific impacts for approval of a particular desalination facility. The resource impact analyses are presented for purposes of full disclosure in order to fully inform the State Water Board and future lead agencies for particular desalination facilities of the potential impacts of desalination projects in general.

The review of prior environmental documentation for individual facilities also informed the Board's analysis of the actual potential impacts of the Desalination Amendment, which is presented in the second part of the analysis (sections 12.2-12.4). Specifically, section 12.2 identifies and describes reasonable alternatives associated with the project followed by section 12.3 describing alternatives identified but not analyzed in detail within the reasonable range of alternatives either because they do not achieve the underlying project objectives or are not potentially feasible, reasonable, or within the authority of this proposed rule-making action. Finally, section 12.4 analyzes the reasonably foreseeable environmental impacts associated with the State Water Board's Desalination Amendment and project alternatives, including reasonably foreseeable methods of compliance. While the analyses in section 12.1 are quantitative and detailed, the analyses in Section 12.4 are necessarily less detailed and more qualitative. This is appropriate for a programmatic level CEQA analysis where site, design, technology, and mitigation are not known.

In conducting the environmental analysis, the State Water Board is not required to engage in speculation or conjecture. Actual environmental impacts will depend upon the specific details of the location and design of the proposed desalination facility and the compliance strategies selected by each individual desalination project permittee. As all desalination facilities proposed in California will require discretionary authorizations from public agencies, detailed environmental analysis associated with individual projects will be described in project-specific CEQA documents. Although this Desalination Amendment does not authorize or approve any particular desalination project, the State Water Board's CEQA Regulations require the State Water Board to evaluate potential environmental impacts associated with the adoption of this amendment to its water quality control plan. This evaluation in section 12.4 and Appendix B describes the potential impacts to the physical environment with regard to the following resource areas:

Aesthetics
Agriculture and forest Resources
Air Quality
Biological Resources
Cultural Resources
Geology and Soils
Greenhouse Gas Emissions
Hazards and Hazardous Materials
Hydrology and Water Quality
Land Use Planning
Mineral Resources
Noise
Population and Housing
Public Services
Recreation
Transportation and Traffic
Utilities and Service Systems
Mandatory Findings of Significance

12.1 Presentation of the Impacts from Coastal Desalination Facilities

This section describes impacts that could result from construction and operation of desalination facilities in coastal areas of California, without regard to the State Water Board's Desalination Amendment. For this analysis, and the analysis in section 12.4, thresholds of significance are generally based on the checklist questions (Appendix B) and the CEQA's mandatory findings of significance (see Appendix B section XVIII). This presentation of the impacts for coastal desalination facilities is for disclosure purposes, to provide information about potential impacts of desalination facilities in general. Where relevant, this information also serves to inform the analysis of the Desalination Amendment, in section 12.4. This presentation of the impacts for coastal desalination facilities is based upon the environmental analysis of existing proposals for desalination facilities included in the following documents:

- Monterey Peninsula Regional Water Authority "Evaluation of Seawater Desalination Projects Final Report" prepared by Separation Processes, Inc. and Kris Helm Consulting. January 2013
- California American Water Company, "Coastal Water Project Final Environmental Impact Report" prepared for California Public Utilities Commission, October 30, 2009
- City of Carlsbad Precise Development Plan and Desalination Project Environmental Impact Report SCH No. 2004041081, June 13, 2006
- Deep Water Desal LLC "Project Description - Central Coast Regional Water Project," Prepared for California Public Utilities Commission, May 1, 2013
- City of Huntington Beach Draft Subsequent Environmental Impact Report – Seawater Desalination Project at Huntington Beach SCH 2001051092, December 2009
- Marin Municipal Water District "Environmental Impact Report – Marin Municipal Water District Desalination Project" SCH No. 2003082037, December 2008
- City of Santa Cruz and Soquel Creek Water District "Regional Seawater Desalination Project draft Environmental Impact Report" SCH No. 2010112038, May, 2013
- San Diego Water Authority Camp Pendleton Seawater Desalination Project Feasibility Study Report Executive Summary prepared by RBF Consulting , December 2009

As described in section 2, there are many elements to coastal desalination facilities that will not change with the State Water Board Desalination Amendment. These elements of the coastal desalination facilities typically consist of a seawater intake, an intake pipeline, a pump station to convey source water to the desalination facility, a pretreatment system for surface water intakes to remove solids and other membrane fouling constituents, a RO unit, post treatment to restore ionic balance and prevent corrosion, disinfection, a product water conveyance pipeline to storage tanks or potable water supply, and a brine pipeline installed to flow directly to the ocean or other outfall. In addition, desalination facilities require an electrical power substation, chemical storage facilities, handling facilities, buildings for a control room, a laboratory, administration facilities, a parking area, security gates, and fencing to prevent unauthorized access. Source and produce water tanks, chemical storage tanks, equalization basins and other infrastructure may also be necessary onsite depending on design. A description of onsite and offsite improvements for a sample of currently proposed facilities is included in Table 12-1. Potential environmental impacts associated with these facilities are presented for disclosure purposes below. In order to complete this presentation, the State Water Board relied upon the existing EIRs and other planning documented identified above. Although there are many facilities at various stages of planning, only EIRs from the City of Huntington Beach, City of Carlsbad, Marin Municipal Water District, and City of Santa Cruz/ Soquel Creek Water District were available at the time of this writing and reviewed for this analysis.

Table 12-1 Description of coastal desalination facilities planned or under construction in California

Production	Location Proponent and Description	Site Area	Major On-Site Features	Offsite Features
50 MGD	Carlsbad – Poseidon Main facility co-located with existing power plant less than 500 ft. from shoreline and sharing surface water intake from estuary and discharge channel across shoreline to ocean.	174,240 ft^2	44,552 ft^2 RO and post treatment control, administration building, 42,632 ft^2 pretreatment area, pump station, 48-inch pipeline to the offsite water distribution system, and 2,500 ft^2 solids processing facility and settling tanks.	Open surface intake from estuary, potable water pipeline to municipal water distribution system, and brine discharge to existing power plant cooling water return channel consisting of two rock jetties extending approximately 400 feet from Pacific Coast Highway into the water.
50 MGD	Huntington Beach – Poseidon Main facility is co-located at the existing power plant. Relies on existing power plant surface water intake and outfall structure.	479,160 ft^2	10,000 ft^2 administrative building, 38,090 ft^2 RO building, 38,220 ft^2 pretreatment filtration structure, 8,500 ft^2 solids handing structure, 4,370 ft^2 chemical storage structure, 1,800 ft^2 electrical substation building, 4,560 ft^2 lime tank farms (6), 200,000-gallon wash water and 100,000-gallon rinse water tanks, one 10,000,000-gallon produce water storage tank, connecting pipeline from power plant cooling water conveyance, and effluent pipeline to existing power plant discharge.	Install 52,800 ft. of 48-inch diameter water distribution pipeline, and two underground booster pump stations.
5 MGD	Marin/San Rafael Main facility located approximately 2,000 ft. from shoreline. Source water from offshore surface water intake. Brine discharge commingled with municipal wastewater and discharged into existing offshore diffuser into San Rafael Bay	430,000 ft^2	20,000 ft^2 RO building and workspace building, a 3,000 ft^2 laboratory and 3,000 ft^2 warehouse, other structures include pretreatment and post treatment facilities solids handling and thickening basins, power transmission and pump stations, chemical feed, and storage facilities.	10 MGD screened low velocity intake connected to a 36-inch diameter intake pipeline to shore and extending 2,000 feet to facility, effluent pumped to 2,000-foot-long 24-inch-diameter pipe, outfall pipeline is constructed of 84-inch diameter pipe to diffuser, two new pump stations to pump potable water into water distribution system, and two to three 2 million gallon potable water storage tanks.
9 MGD	Marina – Monterey Peninsula Water Supply Project (California American Water Company) Main facility located near Regional Water Treatment Plant. Source water from subsurface intake (beach wells). Brine would be pumped to treatment plant commingled and discharged through existing submerged ocean outfall diffuser	304,920 ft^2	Main structures RO building, control room/administration building, media filtration pretreatment area, post treatment and disinfection area, chemical storage and handling facility, two 300,000 gallon filtered seawater storage tanks, two 750,000 gallon finished water storage tanks, pump stations, power sub-station, brine storage basin, solids handling basins, product water pipeline(s), brine conveyance pipeline, and a raw water pipeline.	Drill and install up to 10 (8 active, 2 standby) subsurface slant wells on a 376 acre parcel which is currently used for sand mining and contains approximately 7,000 feet of shoreline. A 42- inch diameter, 14,300 foot long source water main. A 24-inch diameter, 6,300 foot long pipeline to convey RO brine to an existing wastewater treatment plant and outfall. Over 20 miles of up to 36-inch diameter, pipeline(s) to convey potable water to California American Water's existing system and as necessary to accommodate basin return flow obligation, if any, and related appurtenances. Two 3 million gallon ground storage tanks, three booster pump stations and two aquifer storage and recovery wells.
10 MGD	Moss Landing – Central Coast Regional Water Project (Deep Water LLC) Main facility located approximately 8,200 ft. southeast of shoreline and 3,000 ft. southeast of power plant. Source water from offshore surface	304,920 ft^2	Main structures include combined RO, control room/administration building, dual media, granular media and polymer pretreatment area, filter backwash area, post treatment and disinfection area, backwash rinse equalization and solids handling facilities, chemical storage and handling facility, and 5,500,000 gallon produce water storage tank,	19.8 MGD 2-mm wedge-wire screened low velocity surface water intake 70 feet below ocean surface connected to 6,000 foot 54-in. diameter pipeline to existing onshore wet well and pump station at power plant connected to 48-inch diameter

Production	Location Proponent and Description	Site Area	Major On-Site Features	Offsite Features
	water intake. Brine will be discharged through new offshore diffuser.			pipeline to convey source water to site. Brine discharged through 36-inch diameter pipeline to offshore diffuser.
2.5 MGD	Santa Cruz Main facility located approximately 2,500 ft. from shoreline. Source water from offshore surface water intake. Brine discharge commingled with municipal wastewater and discharged into existing diffuser through diffuser offshore	191,300-290,611 ft^2	39,000 ft^2 RO and pretreatment building, 5,400 ft^2 control room and laboratory and administration building, 3,000 ft^2 clarifiers/solids thickeners, 2,500 ft^2 post treatment complex. 600,000 gallon equalization basin, 600 ft^2 pump house, 25,000 ft^{2}roof mounted solar panels	7 MGD surface water intake and 36-inch diameter pipeline, 2,500 ft^2 pump station onshore, 24-inch diameter pipeline from pump station to facility, 30-inch diameter brine pipeline to municipal wastewater discharge pipeline brine commingled prior to discharge. 24-inch diameter pipeline would convey potable water to distribution system

Project design, features, and production may change as various alternatives are considered. As a result, the facility constructed may differ significantly from how it is described above.

The Carlsbad, Huntington Beach, Marin/San Rafael, and Santa Cruz facilities were included in the assessment of desalination facility impacts.

12.1.1 Aesthetics

Desalination projects in general can significantly impact aesthetics if a project creates or causes the following:

- A substantial adverse effect on a scenic vista
- Substantial damage to scenic resources, including but not limited to trees, rock outcroppings, and historic buildings within a state scenic highway
- Substantial degradation of the existing visual character or quality of the site and its surroundings
- A new source of substantial light or glare which would adversely affect day or nighttime views in the area

Aesthetic impacts comprise the adverse effects a project might have on the scenic quality and visual characteristics of public recreation areas, historically significant sites, or scenic highways. This may also include a significant degradation of the existing visual attributes that are closely linked to a facility's surroundings and topography by introducing prominent structures or features. The potential impact that a project might have on overall visual quality is evaluated against a particular setting's attractiveness, coherence and the presence of unique and popular vistas of geological, topographical or biological resources. Consideration is also given to the designated uses of the immediate vicinity and local zoning laws, ordinances, regulations, and standards.

Results of Previous Environmental Impact Analyses

Aesthetic impacts of any particular desalination facility vary depending upon existing site conditions and surrounding land use. Currently proposed facilities such as those in Carlsbad, Huntington Beach located on or adjacent to existing power plants may be less visually obtrusive than existing on-site features and require less offsite infrastructure (See table 12-1 for comparison). Accordingly the City of Carlsbad (2006) and Huntington Beach (2010), EIRs concluded that aesthetic impacts related to construction and operation was not considered significant. However, exposure of mechanical equipment including pumps, piping, and tanks or lighting could potentially result in degradation of the visual character or quality of the site and require mitigation measures. Potential mitigation measures for this impact may include:

- Screening tanks and exterior mechanical equipment from public viewpoints and highways
- Landscaping improvements to present more appealing site view for residents and visitors
- Lighting plan to minimize lighting needs for security and safety to reduce light pollution and glare.

Facilities planned in areas of mixed land use that require on-site and offsite infrastructure, such as the Marin/ San Rafael facility, could result in more significant impacts. The site is fenced and used by the project proponent for materials handling and storage in a mixed use commercial industrial area. However, several offsite features, such as water storage tanks on ridges visible from homes and highways may be significant and unavoidable because the features would degrade the existing visual character or quality of the site and its surroundings and no mitigation is available to reduce it to a less-than-significant level. (Marin Municipal Water District 2008) Architecture, landscape improvements and lighting plans to reduce glare would mitigate any other impacts to less than significant.

Santa Cruz is another facility planned within a mixed land use area where onsite and offsite facilities and infrastructure are necessary components of the proposed design. Some structures such as pump stations associated with the Santa Cruz proposal are situated near scenic views of the ocean view near Cliff Drive and the wharf. However, these features will be integrated into the existing architecture of the existing developments or located in areas shielded from public views. (City of Santa Cruz and Soquel Creek Water District 2013) The project could create a new source of substantial light that could adversely affect nighttime views in the area if the project is not properly designed. The desalination plant and pump stations would require nighttime security lighting. However, security lighting is not likely to be highly visible at night from outside the facility property.

To ensure that nighttime illumination levels are not increased beyond the property line and do not pose a nuisance, lighting will be consistent with Leadership in Environmental and Energy Design - New Construction (LEED) guidelines for light pollution reduction. (City of Santa Cruz and Soquel Creek Water District 2013) These guidelines are intended to improve energy efficiency by minimizing the use of artificial light, through the use of natural light and at night, ensuring that illumination only occurs where it is needed and does not impinge or illuminate other areas, thereby reducing light pollution. LEED provides guidelines and certifications to ensure that LEED certified buildings minimize light pollution and glare from all sources and conserve energy. This mitigation measure will reduce the impact related to new sources of light to less than significant. Solar panels planned for the facility rooftop may act as a source of glare. However, flat-plate solar PV panels are engineered to absorb rather than reflect sunlight, in order to maximize electricity production; and are designed with at least one anti-reflective layer that reduces glare. Solar panels would be oriented to the south to face the sun and would not be visible with this orientation from ridgeline homes or from traffic on major roadways. Therefore, the impact related to new sources of glare associated with the Desalination Amendment would be less than significant. (City of Santa Cruz and Soquel Creek Water District 2013)

Impact Analysis
The location and design of future desalination and associated aesthetics impacts are unknown and cannot be extrapolated from these existing studies or other reports. Siting and design depend on many project specific factors including volume or product water flow rate needed to meet the project goals, existing infrastructure, availability of land, and energy supply needs, local land use and plans in addition to water quality and related beneficial uses. The State Water Board evaluated EIRs for planned desalination facilities and those facilities under construction. These projects evaluated do not represent the universe of all potential facilities that could be constructed; rather these projects represent a small sample of potentially viable projects that could be constructed in the foreseeable future. It is foreseeable that new

desalination facilities may become necessary in many areas of the state because California's water supply problems are unlikely to improve without development of new and alternatives sources of water supply. As all desalination facilities proposed in California will require discretionary authorizations from public agencies, detailed environmental analysis associated with individual projects will be described in project-specific CEQA documents. It is likely that some facilities could cause significant impacts to scenic vistas, harm scenic resources, degrade visual character or result in increased glare requiring the need to impose mitigation measures. It is possible that some of these visual resource impacts could be significant and unavoidable.

12.1.2 Agriculture and Forest Resources

Desalination projects in general can have significant impacts on agriculture and forest resources, if a project causes or results in the following;

- Convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Farmland), as shown on the maps prepared pursuant to the Farmland Mapping and Monitoring Program of the California Resources Agency, to non-agricultural use;
- Conflict with existing zoning for agricultural use, or a Williamson Act contract
- Conflict with existing zoning for, or cause rezoning of, forest land (as defined in Public Resources Code section 12220(g)), timberland (as defined by Public Resources Code section 4526), or timberland zoned Timberland Production (as defined by Government Code section 51104(g))
- Result in the loss of forest land or conversion of forest land to non-forest use
- Involve other changes in the existing environment which, due to their location or nature, could result in conversion of Farmland, to non-agricultural use or conversion of forest land to non-forest use

In determining whether impacts to agricultural resources are significant environmental effects, lead agencies may refer to the California Agricultural Land Evaluation and Site Assessment Model (1997) prepared by the California Department of Conservation as an optional model to use in assessing impacts on agriculture and farmland. In determining whether impacts to forest resources, including timberland, are significant environmental effects, lead agencies may refer to information compiled by the California Department of Forestry and Fire Protection regarding the state's inventory of forest land, including the Forest and Range Assessment Project and the Forest Legacy Assessment Project; and forest carbon measurement methodology provided in Forest Protocols adopted by the California Air Resources Board (CARB).

The California Department of Conservation maintains online mapping tools to identify areas of prime or unique farmlands and farmland of statewide importance (http://maps.conservation.ca.gov/ciff/ciff.html). According to the Department of Conservation, prime unique farmland is present in several coastal regions. Coastal land designated as prime or unique farmland located within two miles of the shoreline is present in the following areas identified by the nearest community or geographic feature; Point Arena, Moss Beach, Half Moon Bay to Santa Cruz, Oceano, El Capitan State Park to Santa Barbara, portions of Ventura and Oxnard, San Clemente, Oceanside, Carlsbad and portions of Tijuana Slough.

Results of Previous Environmental Impact Analyses
Impacts to agriculture and forest resources are limited to those areas where these land uses occur. As none of the four facilities reviewed would be located on or adjacent to lands zone or designated for agriculture or forestry, these types of impacts were not evaluated.

Impact Analysis
The location and design of future desalination and associated impacts to agriculture and forestry are unknown. The State Water Board evaluated EIRs for four planned or under construction desalination facilities situated on or near the coast. Although these projects were determined by the lead agency to have no potential impact on agriculture or forestry resources, these projects may not be representative of all projects that could be constructed in the foreseeable future. Because California's water supply needs are unlikely to decrease, new sources of water supply may become necessary in many areas of the state.

Desalination facilities represent an alternative source of water for coastal areas, many of which suffer from limited groundwater supplies and dwindling surface water availability. As all desalination facilities proposed in California will require discretionary authorizations from public agencies, detailed environmental analysis associated with individual projects will be described in project-specific CEQA documents. It is likely that some desalination facilities will be constructed within areas that could result in conversion of Prime Farmland, Unique Farmland, or Farmland of Statewide Importance to non-agriculture use or result in loss of forest land or cause other changes that could cause significant impacts to existing agriculture and forest land uses, requiring the need to impose mitigation measures. It is possible that some of these impacts could be significant and unavoidable.

12.1.3 Air Quality

Desalination projects in general can have significant impacts on air quality if a project causes or results in the following:

- Conflict with or obstruct implementation of the applicable air quality plan
- Create a condition causing violation of any air quality standard or contribute substantially to an existing or projected air quality violation
- Result in a cumulatively considerable net increase of any criteria pollutant for which the project region is non-attainment under an applicable federal or state ambient air quality standard (including releasing emissions which exceed quantitative thresholds for ozone precursors)
- Expose sensitive receptors to substantial pollutant concentrations
- Result in objectionable odors affecting a substantial number of people

Due to the large number and types of source, air pollution can be a significant problem in densely populated urban areas. However, air pollution can affect less densely populated areas as well. In coastal areas, air pollution is typically transported inland by onshore winds until it reaches a barrier, such as mountains or inversion layers that in combination minimize further dispersion. Where mountains exist close to the coast, air pollution is typically localized.

However, where coastal plains extend inland, a gradual degradation of air quality occurs from the mountains coastward, creating large areas that do not meet air quality standards. Air quality impacts may cause adverse effects on the health and welfare of all people living, working or visiting the area affected by the project. Air pollution emissions and air quality standards are reported in different units depending on purpose. Daily emissions signify the quantity of pollutant released into the air and have a unit of pounds per day (lbs/day). The term “concentrations” means the amount of pollutant material per volumetric unit of air, typically reported in units of parts per million (ppm) or micrograms per cubic meter (µg/m^3). Averaging periods may range from as short as one hour to an annual arithmetic mean.

The U.S. EPA oversees state and local implementation of federal Clean Air Act requirements. The Clean Air Act requires U.S. EPA to develop national air quality standards and approve State Implementation Plans to meet and/or maintain the national ambient standards. Within the state, the CARB is the agency responsible for coordinating both State and federal air pollution control programs. In 1988, the State legislature adopted the California Clean Air Act (CCAA), which established a statewide air pollution control program. The CCAA’s requirements include annual emission reductions, increased development and use of low emission vehicles, and submittal of air quality attainment plans by air districts. The CCAA also requires CARB to establish ambient air quality standards for the state. Both Federal and State standards have been adopted for ozone, respirable particulate matter, fine particulate matter, carbon monoxide, nitrogen dioxide, sulfur dioxide, and lead. Additionally, the CARB has established State standards for pollutants that have no federal ambient air quality standard, including sulfate, visibility, hydrogen sulfide, and vinyl chloride. State and federal ambient air quality standards for both groups of pollutants called criteria pollutants are presented in Table 12-2. The California Air Quality Standards are more stringent than the national standards.

Local air districts typically establish guidelines for assessing a projects’ potential air quality impact in accordance with CEQA. Local lead agencies will typically rely on air quality standards (Table 12-2) and local air district management strategies and plans or develop thresholds of significance specific to the district for such analyses. CEQA encourages local air districts to develop thresholds of significance for planning and development, but does not require them. Coastal air districts adopted thresholds of significance or published guidance including suggested thresholds of significance presented in Tables 12-3 through 12-7. Some districts may also rely upon screening criteria to screen projects that will have no significant impact on air quality from intensive air quality studies. Screening criteria are not included.

Table 12-2 State and federal ambient air quality standards

Pollutant	Averaging Time	California	Federal Primary	Federal Secondary
Ozone (O_3)	I hr	0.09 ppm (180 µg/m^3)		Same as Federal Primary
	8 hrs	0.070 ppm (137 µg/m^3)	0.075 ppm (147 µg/m^3)	
Respirable Particulate Matter (PM_{10})	24 hrs	50 µg/m^3	150 µg/m^3	Same as Federal Primary
	Ann. Arith. Mean	20 µg/m^3		
Fine Particulate Matter ($PM_{2.5}$)	24 hrs		35 µg/m^3	Same as Federal Primary
	Ann. Arith. Mean	12 µg/m^3	15 µg/m^3	
Carbon Monoxide (CO)	I hr	20 ppm(23 µg/m^3)	35 ppm (40 µg/m^3)	
	8 hrs	9 ppm (10 µg/m^3)	9 ppm (10 µg/m^3)	
Nitrogen Dioxide (NO_2)	I hr	0.18 ppm (339 µg/m^3	100 ppb (188 µg/m^3)	
	Ann. Arith. Mean	0.030 ppm (57 µg/m^3)	0.053 ppm (100 µg/m^3)	Same as Federal Primary
Sulfur Dioxide (SO_2)	I hr	0.25 ppm (655 µg/m^3)	0.75 ppm (196 µg/m^3)	
	3 hrs			0.5 ppm (1300µg/m^3)
	24 hrs	0.04 ppm (105 µg/m^3)	0.14 ppm (for certain areas)	
	Ann. Arith. Mean		0.030 ppm (for certain areas)	
Lead (Pb)	30 day ave.	1.5 µg/m^3		
	Calendar Quarter		1.5 µg/m^3(for certain areas)	Same as Federal Primary
	Rolling 3 month ave.		0.15 µg/m^3	
VRP	8 hrs	Extinction of 0.23 per km		
Sulfates	24 hrs	25 µg/m^3		
Hydrogen Sulfide (H_2S)	1 hr	0.03 ppm (42 µg/m^3)		
Vinyl Chloride	24 hrs	0.01 ppm (26 µg/m^3)		

hr	hour	ave	Average
hrs	hours	ppm	parts per million
VRP	Visibility reducing particulates	µg/m^3	Micrograms per cubic meter
Ann	Annual		
Arith	Arithmetic		

Table 12-3 Mendocino County Air Quality Management District Thresholds of Significance

Project- Level Analysis	Construction- Related	Operational - Related	
Pollutant	**Average Daily Emissions (lbs/day)**	**Average Daily Emissions (lbs/day)**	**Maximum Annual Emissions (ton/yr)**
ROG	54	54	10
NO_X	54	54	10
PM_{10} (exhaust)	82	82	15
$PM_{2.5}$ (exhaust)	54	54	10
$PM_{10}/PM_{2.5}$ (fugitive dust)	BMPs	None	None
CO (local)	None	9.0 ppm 8-hour average, 20.0 ppm 1-hour average	
Accidental Release of Acutely Hazardous Air Pollutant	None	Storage of acutely hazardous materials locating near receptors or new receptors locating near stored or used acutely hazardous materials considered significant	
Odors	None	5 confirmed complaints per year averaged over three years	
Risk and Hazards (Individual project)	Comply with qualified community risk reduction plan or Increased cancer risk exceeding 10 in one million Increased non-cancer risk exceeding 1.0 Hazard Index (chronic or acute) Ambient $PM_{2.5}$ increase exceeding 0.3 μg/m^3 annual average Zone of influence: 1,000-foot radius from property line of source or receptor		
Risk and Hazards (Cumulative Threshold)	Comply with qualified community risk reduction plan or Increased cancer risk exceeding 100 in one million Increased non-cancer risk exceeding 10.0 Hazard Index (chronic or acute) Ambient $PM_{2.5}$ increase exceeding 0.8 μg/m^3 annual average Zone of influence: 1,000-foot radius from property line of source or receptor		

*Mendocino County Air Quality Management District adopted the Bay Area AQMD CEQA Thresholds of May 28th, 2010 to evaluate new projects. For more information go to: http://www.co.mendocino.ca.us/aqmd/CEQA2010.htm

Table 12-4 Monterey Bay Air Pollution Control District Thresholds of Significance

Construction direct emissions	
Pollutant	**Daily Emissions**
PM$_{10}$ (exhaust)	82 lbs/day or determination that project actions will not cause exceedance of ambient air quality standard
Operational Emissions	
Pollutant	**Daily Emissions lbs/day**
VOCs	137 (direct and indirect)
NO$_x$, as NO$_2$	137 (direct and indirect)
PM$_{10}$	82 (on-site)
CO	550 (direct)
SO$_x$, as SO$_2$	150 (direct)

This table presents numeric emission based thresholds however additional thresholds have been adopted based on site conditions and size of area affected that may also be applicable to individual projects. See the Monterey Bay Air Pollution Control District CEQA Significance Thresholds at: http://www.mbuapcd.org/mbuapcd/pdf/mbuapcd/pdf/CEQA_full.pdf

Table 12-5 San Luis Obispo County Air Pollution Control District Thresholds of Significance

Construction direct emissions			
Pollutant	**Daily Emissions**	**Quarterly (Tier 1)**	**Quarterly (Tier 2)**
ROG + NO$_x$ (combined)	137 lbs	2.5 tons	6.3 tons
Diesel Particulate Matter (DPM)	7 lbs	0.13 tons	0.32 tons
Operational emissions			
Pollutant	**Daily Emissions (lbs/day)**	**Annual Emissions (tons/year)**	
Ozone Precursors (ROG + NO$_x$)	25	25	
Diesel Particulate Matter (DPM)(	1.25		
Fugitive Particulate Matter (PM$_{10}$), Dust	25	25	
CO	550		

See the San Luis Obispo County Air Pollution Control District for specific guidance regarding the application of these thresholds and mitigation required. Their website is located at: http://www.slocleanair.org/images/cms/upload/files/CEQA_Handbook_2012_v1.pdf

Table 12-6 Ventura County Air Pollution Control District Thresholds of Significance

Planning Area	**Pollutant**	**Daily Emissions (lbs/day)**
Ojai Planning Area	Reactive Organic Compounds	5
	Nitrogen Oxides	5
Remainder of Ventura County	Reactive Organic Compounds	25
	Nitrogen Oxides	25

See Ventura County Air Pollution Control District planning guidelines for greater detail at: http://www.vcapcd.org/pubs/Planning/VCAQGuidelines.pdf

Table 12-7 South Coast Air Quality Management District Thresholds of Significance

Mass Daily Thresholds		
Pollutant	**Construction (lbs/day)**	**Operation (lbs/day)**
NO_X	100	55
VOC	75	55
PM_{10}	150	150
$PM_{2.5}$	55	55
SO_X	150	150
CO	550	550
Lead	3	3
Toxic Air Contaminants	Maximum Incremental Cancer risk exceeding 10 in 1 million Cancer Burden greater than 0.5 excess cancer cases in areas exceeding 1 in 1 million Increased non-cancer risk exceeding 1.0 Hazard Index (chronic or acute)	
Odor	http://www.arb.ca.gov/DRDB/SC/CURHTML/R402.HTM	

http://www.aqmd.gov/ceqa/handbook/signthres.pdf

CARB and local air districts are tasked with identifying areas that meet or do not meet ambient air quality standards. When monitored pollutant concentrations are lower than ambient air quality standards these areas are designated as “attainment areas” on a pollutant-by-pollutant basis. Areas that exceed ambient standards are designated as “nonattainment areas”. Areas that recently exceeded ambient standards, but are now in attainment, are designated as a “maintenance areas.” Classifications determine the applicability and minimum stringency of pollution control requirements. State designated attainment and nonattainment zones encompassing marine and estuarine waters of California are identified in Table 12-8. Attainment Zones and Nonattainment Zones relative to National Air Quality Standards are presented in Table 12-9. After an area is designated as a nonattainment zone, the CARB and local air districts are responsible for developing clean air plans to demonstrate how and when nonattainment zones will attain air quality standards established under both federal and CCAA.

Table 12-8 2012 Attainment and Nonattainment Zones relative to State Ambient Air Quality Standards – Zones encompassing enclosed bays and estuaries

Local Air District	O_3	PM_{10}	$PM_{2.5}$	CO	NO_2	SO_2	Pb	Sulf.	H_2S	VRP
North Coast Unified	A	N	A	A	A	A	A	A	A/U	U
Mendocino	A	N	A	A	A	A	A	A	U	U
Northern Sonoma	N	A	A	U	A	A	A	A	U	U
San Francisco Bay Area	N	N	N	A	A	A	A	A	U	U
Monterey Bay Unified	N	N	A	A	A	A	A	A	U	U
San Luis Obispo	N	N	A	A	A	A	A	A	A	U
Santa Barbara	N	N	U	A	A	A	A	A	A	U
Ventura	N	N	A	A	A	A	A	A	U	U
South Coast	N	N	N	A	N	A	N	A	U	U
San Diego	N	N	N	A	A	A	A	A	U	U

A	Attainment	CO	Carbon Monoxide
N	Nonattainment	NO_2	Nitrogen Dioxide
U	Unclassified	SO_2	Sulfur Dioxide
O_3	Ozone (I hour)	Pb	Lead
PM_{10}	Respirable Particulate Matter	Sulf	Sulfates

$PM_{2.5}$	Fine Particulate Matter	H_2S	Hydrogen Sulfide
VRP	Visibility Reducing Particulates	NT	Nonattainment – transitional

Table 12-9 2012 Attainment and Nonattainment Zones relative to National Ambient Air Quality Standards – Zones encompassing enclosed bays and estuaries

Local Air District	O_3	PM_{10}	$PM_{2.5}$	CO	NO_2	SO_2	Pb
North Coast Unified	U	U	U	U	U	U	U
Mendocino	U	U	U	U	U	U	U
Northern Sonoma	U	U	U	U	U	U	U
San Francisco Bay Area	N	U	N	U	U	A	U
Monterey Bay Unified	A	U	U	U	U	U	U
San Luis Obispo	AN	U	U	U	U	U	U
Santa Barbara	AN	U	U	U	U	U	U
Ventura	N	U	U	U	U	A	U
South Coast	N	N	N	U	U	A	N
San Diego	N	U	U	U	U	A	U

A	Attainment	CO	Carbon Monoxide
N	Nonattainment	NO_2	Nitrogen Dioxide
U	Unclassified	SO_2	Sulfur Dioxide
O_3	Ozone (I hour)	Pb	Lead
PM_{10}	Respirable Particulate Matter	Sulf	Sulfates
$PM_{2.5}$	Fine Particulate Matter	H_2S	Hydrogen Sulfide
VRP	Visibility Reducing Particulates	NT	

As presented in Table 12-8 and 12-9, ozone, respirable and fine particulate matter are the major causes of nonattainment relative to state standards in California. CARB also tracks toxic air contaminants that may cause or contribute to an increase in mortality or serious illness, or that may pose a hazard to human health. Toxic air contaminants are generally present in minute quantities in the ambient air; however, their high toxicity or health risk may pose a threat to public health even at low concentrations.

Over 200 contaminants have been designated as toxics listed by CARB in California. This diverse list of contaminants includes volatile organic compounds (VOCs) such as benzene, metals such as lead and nickel, asbestos related minerals, and particulate emissions from diesel-fueled engines, as well as tobacco smoke. CARB generates the California Toxics Inventory that provides emissions estimates by stationary (point and aggregated point), area wide, on road mobile (gasoline and diesel), off road mobile (gasoline, diesel, and other), and natural sources. These emissions inventories are used by CARB to improve air quality and reduce air pollution.

To address naturally occurring asbestos in surface soils and exposed rock, CARB revised their asbestos limits in 1998 for crushed serpentinite and ultramafic rock in surfacing applications from 5 percent to less than 0.25 percent. This amendment also included dust control measures for activities that disturb rock and soil containing naturally occurring asbestos. For construction and grading projects that will disturb one acre or less, the regulation requires several specific actions to minimize emissions of dust such as vehicle speed limitations, application of water prior to and during the ground disturbance, keeping storage piles wet or covered, and track-out prevention and removal. Construction projects that will disturb more than one acre must prepare and obtain district approval for an asbestos dust mitigation plan. The plan must specify how the operation will minimize emissions and must address specific emission sources. Regardless of the size of the disturbance, activities must not result in emissions that are visible crossing the property line. Asbestos containing ultramafic rock and serpentine are present in all coastal counties except Ventura County in Southern California, though only in a few cases to do these materials outcrop near or on the California coast.

Results of Previous Environmental Impact Analyses

Long term impacts associated with the operation of desalination facilities under construction in Carlsbad, or proposed for Huntington Beach, Marin, and Santa Cruz were analyzed and determined by the respective lead agencies to cause less than significant impacts to air quality with no mitigation necessary for any of the individual projects. Emissions analyzed for these projects varied but considered employee travel to and from plants in personal vehicles, trips for service and maintenance, and delivery trucks, stationary source emissions produced at the project site, and consumption of electricity and natural gas. In all four cases, the operational emissions predicted fell below the local or regional significance threshold. However, the Carlsbad plant was analyzed and determined to have no significant impacts; although, the proponent determined that these emissions could contribute to cumulative regional impacts from emission associated with PM_{10} and ozone. These analyses included indirect impacts associated with power generation although the actual sources of power and associated emissions are difficult to predict far into the future. (City of Carlsbad 2006)

Air quality impacts associated with construction of the Carlsbad facility could generate emissions of criteria pollutants on a short-term basis; however, the frequency durations and magnitude of these emissions would not result in violations of air quality standards and therefore were determined to be not significant. (City of Carlsbad 2006) On- and offsite construction activities associated with the proposed Huntington Beach facility were determined to cause significant and unavoidable impacts to air quality for NO_X emissions during construction over a 27-month period. According to the City of Huntington Beach (2009), despite the implementation of the recommended mitigation measures, overall aggregate emissions would exceed the SCAQMD standards for NO_X. Thus, construction related air emissions would be significant and unavoidable. The Marin facility's construction activities could include direct emissions of fugitive dust (PM_{10}) and exhaust pollutants (NOx, CO, PM_{10}, SO_2, and ROG) from diesel-fueled construction equipment and construction workforce related traffic, and indirect emissions associated with generation of electricity supplied for construction. These impacts were determined to be less than significant after mitigation. (Marin Municipal Water District 2008) Air quality impacts associated with construction of the Santa Cruz facility were determined to be less than significant and no mitigation required.

Impact Analysis

Construction impacts from any particular desalination facility predominantly result from two sources: fugitive dust from surface disturbance activities; and exhaust emissions resulting from the use of construction equipment (including, but not limited to: graders, dozers, back hoes, haul trucks, stationary electricity generators, vessels and construction worker vehicles). One of the pollutants of concern relating to construction is particulate matter, since PM_{10} is emitted as windblown (fugitive) dust during surface disturbance and as exhaust of diesel fired construction equipment (particularly as $PM_{2.5}$). Other emissions of concern include architectural coating products off - gassing (VOCs) and other sources of mobile source (on - road and off - road) combustion (NOx, SOx, CO,PM_{10}, $PM_{2.5}$, and VOCs) associated with construction equipment. In order for the lead agency for CEQA compliance on a particular desalination facility to evaluate the air quality impact of emissions associated with construction, the project proponent must identify the specific type of equipment that will be used. Emissions from the equipment must be quantified and evaluated in the context of local or regional significance thresholds established by the appropriate Air Quality Management Districts where the project is located. Construction related emissions that have the potential to exceed the thresholds must be mitigated. Mitigation for construction related activities may include:

- To minimize emissions from all internal combustion engines:
    - Where feasible, use equipment powered by sources that have the lowest emissions, or are powered by electricity
    - Utilize equipment with the smallest engine size capable of completing project goals to reduce overall emissions
    - Minimize idling time and unnecessary operation of internal combustion engine powered equipment

- For diesel powered equipment:
    - Utilize diesel powered equipment meeting Tier 2 or higher emissions standards to the maximum extent feasible.
    - Utilize portable construction equipment registered with the State’s Portable Equipment Registration Program
    - Utilize low sulfur diesel fuel and minimize idle time
    - Ensure all heavy duty diesel powered vehicles comply with state and federal standards applicable at time of purchase.
    - Utilize diesel oxidation catalyst and catalyzed diesel particulate filters or other approved emission reduction retrofit devices installed on applicable construction equipment used during individual projects.

- To control dust emissions:
    - Spray down construction sites with water or soil stabilizers
    - Cover all hauling trucks
    - Maintain adequate freeboard on haul trucks
    - Limit vehicle speed in unpaved work areas
    - Suspend work during periods of high wind or

  - Install temporary windbreaks
  - Use street sweeping to remove dust from paved roads during earth work

- Monitor on-site air quality in relation to local agency and Air District standards and mitigate impacts

- When working in areas known to contain naturally occurring asbestos:
  - Relocate earthwork to avoid geologic material containing asbestos
  - Develop asbestos dust mitigation plan in accordance with local air quality management district requirements
  - Spray down construction sites with water or soil stabilizers
  - Pre-wet the ground to the depth of anticipated cuts;
  - Suspend grading operations when wind speeds are high
  - Apply water prior to any land clearing; or
  - Shake or wash wheels of vehicles leaving sites
  - Cover all exposed piles

As all desalination facilities proposed in California will require discretionary authorizations from public agencies, detailed environmental analysis associated with individual projects will be described in project-specific CEQA documents. The operation of desalination facilities by themselves are unlikely to result in significant impacts to air quality directly. Emissions from operations are limited to electricity generation to operate the project facilities and equipment, on and offsite pump station operations and mobile source emissions from employees and delivery or service vehicles. Indirect impacts associated with power generation are unknown because the source of electricity for all future facilities is unknown. Such emissions are difficult to estimate in absence of specific design plans or data collected during operation and the CEQA analysis for a particular desalination facility could find these impacts significant, requiring the need to impose mitigation measures. It is possible that some of these impacts could be significant and unavoidable.

12.1.4 Biological Resources

Desalination projects in general can significantly impact biological resources if a project creates or causes the following:

- A substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special status species in local or regional plans, policies, or regulations by the California Department of Fish and Wildlife (CDFW) or U.S. Fish and Wildlife Service
- A substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, and regulations by the CDFW or U.S. Fish and Wildlife Service
- A substantial adverse effect on federally protected wetlands as defined by section 404 of the CWA (including but not limited to marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means

- Substantial interference with the movement of native, resident or migratory fish, or wildlife species with established native or migratory wildlife corridors, or impede the use of native wildlife nursery sites
- A conflict with any local policies or ordinances protecting biological resources, such as tree preservation policy or ordinance
- A conflict with the provisions of an adopted habitat conservation plan, natural community conservation plan, or other approved local, regional, or state habitat conservation plan

State and federally listed species inhabiting coastal habitats and waters of California are presented in Table 12-10 through 12-15.

Table 12-10 List of threatened and endangered invertebrates inhabiting coastal areas and waters of California (CDFW Biogeographic Data Branch State and Federally Listed Endangered and Threatened Animals of California January 2013)

Common Name	Scientific Name	Habitat/Range	Listing
Morro Shoulderband snail	*Helminthoglypta walkeriana*	Adjacent lands along perimeter of Morro Bay, San Luis Obispo County	Federally listed as endangered
White abalone	*Haliotis sorenseni*	Rocky substrates interspersed with sand channels. 20-40 m, Point Conception south	Federally listed as endangered
Black abalone	*Haliotis cracherodii*	intertidal and shallow subtidal rocks Point Arena south	Federally listed as endangered
Riverside fairy shrimp	*Streptocephalus woottoni*	Vernal pool habitats in Ventura Orange and San Diego Counties	Federally listed as endangered
San Diego fairy shrimp	*Branchinecta sandiegonensis*	Vernal pool habitats from Santa Barbara to San Diego Counties	Federally listed as endangered
California freshwater shrimp	*Syncaris pacifica*	Low gradient streams from Tamales Bay to San Francisco	State and Federally listed as endangered
Ohlone tiger beetle	*Cicindela ohlone*	Santa Cruz County	Federally listed as endangered
Mission blue butterfly	*Icaricia icarioides missionensis*	San Francisco area where lupine is present	Federally listed as endangered
Lotis blue butterfly	*Lycaeides argyrognomon lotis*	Coastal Mendocino County	Federally listed as endangered

Common Name	Scientific Name	Habitat/Range	Listing
Palos Verdes blue butterfly	*Glaucopsyche lygdamus palosverdesensis*	Palos Verde Peninsula	Federally listed as endangered
El Segundo blue butterfly	*Euphilotes battoides allyni*	Dunes adjacent to LAX	Federally listed as endangered
Smith's blue butterfly	*Euphilotes enoptes smithi*	Dunes and grasslands along central coast	Federally listed as endangered
San Bruno elfin butterfly	*Callophrys mossii bayensis*	Outcrops and cliffs in coastal scrub on the San Francisco peninsula	Federally listed as endangered
Behren's silverspot butterfly	*Speyeria zerene behrensii*	Coastal marine terraces of southern Mendocino and northern Sonoma Counties	Federally listed as endangered
Oregon silverspot butterfly	*Speyeria zerene hippolyta*	Coastal dunes Del Norte County	Federally listed as threatened
Myrtle's silverspot butterfly	*Speyeria zerene myrtleae*	Coastal dunes from Sonoma to San Mateo County	Federally listed as endangered

Table 12-11 List of threatened and endangered fish inhabiting coastal waters of California (CDFW Biogeographic Data Branch State and Federally Listed Endangered and Threatened Animals of California January 2013)

Common Name	Scientific Name	Primary Habitat	Listing
Green sturgeon	*Acipenser medirostris*	Ocean Waters from Oregon Border to Monterey	Federally listed as threatened
Pacific eulachon	*Thaleichthys pacificus*	Anadromous	Federally listed as threatened
Coho salmon	*Oncorhynchus kisutch*	Anadromous, Central California north	State and Federally Listed
Steelhead	*Oncorhynchus mykiss*	Anadromous,	State and Federally Listed
Chinook salmon	*Oncorhynchus tshawytscha*	Anadromous, Central California north	State and Federally Listed
Tidewater Goby	*Eucyclogobius newberryi*	Polyhaline/marine	Federally listed as endangered

Table 12-12 List of threatened and endangered amphibians inhabiting coastal areas of California (CDFW Biogeographic Data Branch State and Federally Listed Endangered and Threatened Animals of California January 2013)

Common Name	Scientific Name	Primary Habitat	Listing
California tiger salamander	*Ambystoma californiense*	Vernal pool habitats from	State Threatened, Federally listed as endangered

Common Name	Scientific Name	Primary Habitat	Listing
		Sonoma to Santa Barbara County	
Santa Cruz long-toed salamander	*Ambystoma macrodactylum croceum*	Santa Cruz County	State and Federally listed as endangered
California red-legged frog	*Rana aurora draytonii50*	Coastal drainages from Point Reyes to Santa Monica Mountains	Federally listed as threatened

Table 12-13 List of threatened and endangered reptiles inhabiting coastal areas and waters of California (CDFW Biogeographic Data Branch State and Federally Listed Endangered and Threatened Animals of California January 2013)

Common Name	Scientific Name	Primary Habitat	Listing
Green sea turtle	*Chelonia mydas*	San Diego Bay and coastal waters	Federally listed as threatened
Loggerhead sea turtle	*Caretta caretta*	Coastal waters from Point Conception, south	Federally listed as endangered
Olive ridley sea turtle	*Lepidochelys olivacea*	Coastal waters	Federally listed as threatened
Leatherback sea turtle	*Dermochelys coriacea*	Point Arena to Point Arguello	Federally listed as endangered
Island night lizard	*Xantusia riversiana*	Channel Islands	Federally listed as threatened
San Francisco garter snake	*Thamnophis sirtalis tetrataenia*	Open hillsides from San Mateo to Santa Cruz County	State and Federally listed as endangered

Table 12-14 List of threatened and endangered birds inhabiting coastal areas and waters of California (CDFW Biogeographic Data Branch State and Federally Listed Endangered and Threatened Animals of California January 2013)

Common Name	Scientific Name	Primary Habitat	Listing
Short-tailed albatross	*Phoebastria albatrus*		Federally listed as endangered
California condor	*Gymnogyps californianus*	Coastal areas from Los Angeles to Monterey including islands	State and Federally listed as endangered
Bald eagle	*Haliaeetus leucocephalus*	Coastal areas and islands	State listed as endangered
California black rail	*Laterallus jamaicensis coturniculus*	Localized populations occur from Bodega Bay to Seal Beach	State listed as threatened
California clapper rail	*Rallus longirostris obsoletus*	Bay area salt marshes	State and Federally listed as endangered
Light-footed clapper rail	*Rallus longirostris levipes*	Salt marshes from Ventura County south	State and Federally listed as endangered

Common Name	Scientific Name	Primary Habitat	Listing
Western snowy plover	*Charadrius alexandrinus nivosus*	Coastal sandy beaches and adjacent estuaries	Federally listed as threatened
California least tern	*Sterna antillarum browni*	Coastal areas from San Diego to San Francisco and islands	State and Federally listed as endangered
Marbled murrelet	*Brachyramphus marmoratus*	Coast typically from Santa Barbara north	State listed as endangered, Federally listed as threatened
Xantus's murrelet	*Synthliboramphus hypoleucus*	Southern California ocean waters and islands	State listed as threatened
Coastal California gnatcatcher	*Polioptila californica californica*	Southern California coastal scrub	Federally listed as threatened
Northern spotted owl	*Strix occidentalis caurina*	Coastal forests from Marin County to Canada	Federally listed as threatened
Willow flycatcher	*Empidonax traillii*	Localized populations in Southern California coastal riparian corridors	State listed as endangered
San Clemente loggerhead shrike	*Lanius ludovicianus mearnsi*	San Clemente Island	Federally listed as threatened
Least Bell's vireo	*Vireo bellii pusillus*	Southern California lowland riparian habitat	State and Federally listed as endangered
San Clemente sage sparrow	*Amphispiza belli clementeae*	San Clemente Island	Federally listed as threatened
Belding's savannah sparrow	*Passerculus sandwichensis beldingi*	coastal salt marshes of southern California	State listed as endangered

Table 12-15 List of threatened and endangered mammals inhabiting coastal areas and waters of California (CDFW Biogeographic Data Branch State and Federally Listed Endangered and Threatened Animals of California January 2013)

Common Name	Scientific Name	Primary Habitat	Listing
Point Arena mountain beaver	*Aplodontia rufa nigra*	Coastal riparian corridors in and adjacent to Point Arena	Federally listed as endangered
Morro Bay kangaroo rat	*Dipodomys heermanni morroensis*	Adjacent lands along perimeter of Morro Bay, San Luis Obispo County	
Pacific pocket mouse	*Perognathus longimembris pacificus*	Southern California coastal dunes and sandy habitats	Federally listed as endangered
Island fox	*Urocyon littoralis*	Offshore islands	State listed as threatened, federally listed as endangered

Common Name	Scientific Name	Primary Habitat	Listing
Guadalupe fur seal	*Arctocephalus townsendi*	Coastal waters from Sonoma County south	State and Federally listed as threatened
Southern sea otter	*Enhydra lutris nereis*	Coastal waters from San Mateo Co. to Santa Barbara Co.	
North Pacific right whale	*Eubalaena japonica*	Coastal Waters	Federally listed as endangered
Sei whale	*Balaenoptera borealis*	Coastal Waters	Federally listed as endangered
Blue whale	*Balaenoptera musculus*	Coastal Waters	Federally listed as endangered
Fin whale	*Balaenoptera physalus*	Coastal Waters	Federally listed as endangered
Humpback whale	*Megaptera novaeangliae*	Coastal Waters	Federally listed as endangered
Killer whale	*Orcinus orca*	Coastal Waters	Federally listed as endangered
Sperm whale	*Physeter macrocephalus*	Coastal Waters	Federally listed as endangered

Under the Federal Endangered Species Act, NOAA Fisheries, and the U.S. Fish and Wildlife Service may designate critical habitats essential for the recovery and survival of federally listed threatened and endangered species. Critical habitat includes areas occupied by the species; areas needed for a listed species population to grow and recover; and areas requiring special protection from development-related disturbances. Critical habitat designated by NOAA Fisheries for marine and anadromous species is available from http://www.nmfs.noaa.gov/pr/species/criticalhabitat.htm. An owner or operator of a project that requires federal permits and could harm federally listed threatened and endangered species or adversely affect critical habitats must consult with NOAA Fisheries about marine habitats and the U.S. Fish and Wildlife Services for terrestrial and freshwater listed species. Section 7.1 provides background information on marine ecosystems and sensitive habitats in California and describes the natural locations of the habitats, the type of marine life they support, the ecological functions of the habitat, how they are beneficial to the ecosystem as a whole, and the need to protect these sensitive habitats. Section 7.2 assesses the importance of marine biodiversity in California and the ecological importance of several sensitive species and why it is critical to protect and maintain marine biodiversity.

State Protected Habitats -Marine Waters

The Marine Managed Areas Improvement Act defines MPAs as a named, discrete geographic marine or estuarine area seaward of the mean high tide line or the mouth of a coastal river. This definition includes any area of intertidal or subtidal terrain, together with its overlying water and associated flora and fauna that has been designated by law or administrative action to protect or conserve marine life and habitat. The MPA designation encompasses State Marine Reserves, State Marine Parks and State Marine Conservation Areas. Section 8.4.4 provides an overview of MPAs and also provides a description of SWQPAs as another subcategory of

MMAs under the authority of the State Water Board that is also important to protect. MPAs are defined within California Public Resources Code section 36700 as:

A "State Marine Reserve" is a nonterrestrial marine or estuarine area that is designated so the managing agency may achieve one or more of the following:

1. Protect or restore rare, threatened, or endangered native plants, animals, or habitats in marine areas.
2. Protect or restore outstanding, representative, or imperiled marine species, communities, habitats, and ecosystems.
3. Protect or restore diverse marine gene pools.
4. Contribute to the understanding and management of marine resources and ecosystems by providing the opportunity for scientific research in outstanding, representative, or imperiled marine habitats or ecosystems.

A "State Marine Park" is a non-terrestrial marine or estuarine area that is designated so the managing agency may provide opportunities for spiritual, scientific, educational, and recreational opportunities, as well as one or more of the following:

1. Protect or restore outstanding, representative, or imperiled marine species, communities, habitats, and ecosystems.
2. Contribute to the understanding and management of marine resources and ecosystems by providing the opportunity for scientific research in outstanding representative or imperiled marine habitats or ecosystems.
3. Preserve cultural objects of historical, archaeological, and scientific interest in marine areas.
4. Preserve outstanding or unique geological features.

A "State Marine Conservation Area" is a nonterrestrial marine or estuarine area that is designated so the managing agency may achieve one or more of the following:

1. Protect or restore rare, threatened, or endangered native plants, animals, or habitats in marine areas.
2. Protect or restore outstanding, representative, or imperiled marine species, communities, habitats, and ecosystems.
3. Protect or restore diverse marine gene pools.
4. Contribute to the understanding and management of marine resources and ecosystems by providing the opportunity for scientific research in outstanding, representative, or imperiled marine habitats or ecosystems.
5. Preserve outstanding or unique geological features.
6. Provide for sustainable living marine resources

MPAs have been designated by the California Fish and Game Commission and California State Park and Recreation Commission. MPAs are managed by CDFW and the California Department of Parks and Recreation.

A “State Water Quality Protection Area” is a nonterrestrial marine or estuarine area designated to protect marine species or biological communities from an undesirable alteration in natural water quality, including, but not limited to, areas of special biological significance that have been designated by the State Water Board. SWQPAs are areas that require special protections and the State Water Board may adopt prohibitions of discharge per the Ocean Plan.

Federal Critical and Special Habitat – Marine Waters

Under the National Marine Sanctuaries Act, Congress tasked NOAA with the authority to designate, protect and manage National Marine Sanctuaries. The purpose of the National Marine Sanctuaries is to provide a comprehensive and coordinated approach to conserving natural marine communities and managing those activities that could potentially harm those communities. Four National Marine Sanctuaries have been designated in California: the Gulf of Farallones National Marine Sanctuary, the Monterey Bay National Marine Sanctuary, Cordell Bank and the Channel Islands National Marine Sanctuary. Within National Marine Sanctuaries it is unlawful to destroy or injure a sanctuary resource.

The Magnuson-Stevens Fishery Conservation and Management Act was reauthorized in 2006 and requires NOAA fisheries in conjunction with regional fishery management councils to develop conservation and management plans for the nation’s fishery resources through the preparation and implementation of fishery management plans. In development of the fishery management plans, NOAA fisheries must identify Essential Fish Habitat and habitat areas of particular concern. (Pacific Fishery Management Council 2011) All ocean waters of California have been designated as Essential Fish Habitat under the Pacific Coast Groundfish Management Plan. Any entity applying for a federal permit that could adversely affect areas designated as Essential Fish Habitat are required to consult with regional fishery management councils and NOAA fisheries to minimize loss of habitat. (http://www.pcouncil.org/wp-content/uploads/GF_FMP_FINAL_Dec2011.pdf). The Pacific Coast Groundfish Management Plan also identifies habitat areas of special concern, a designation used to denote habit at greater risk of destruction, a greater resource value for spawning, rearing, or recruitment that could potentially require more stringent management and protection than the general Essential Fish Habitat designation. Habitat Areas of Particular Concern are considered a subcategory of Essential Fish Habitat described in more detail in section 7.1 and include the following areas:

- Estuaries
- Canopy Kelp
- Seagrass beds
- Seamounts

Other Habitat Areas of Particular Concern are areas of interest in California. These areas include all seamounts such as, Gumdrop Seamount, Pioneer Seamount, Guide Seamount, Taney Seamount, Davidson Seamount, and San Juan Seamount. Also included in these areas are Mendocino Ridge, Cordell Bank, Monterey Canyon, and specific areas in the Federal waters of the Channel Islands National Marine Sanctuary. (Pacific Fishery Management Council 2011)

Results of Previous Environmental Impact Analyses - Construction

The city of Carlsbad (City of Carlsbad 2006) determined that construction of the Carlsbad desalination facility would result in a temporary loss of sensitive vegetation and habitat consisting of chaparral, coastal scrub, wetland and open channel. The City also found that the facility could temporarily impact existing habitat of the coastal California gnatcatcher. The city found these impacts significant but also found that they could be mitigated by monitoring, avoidance and replacement through mitigation bank credits and actual land acquisition. Mitigation of impacts to the coastal California gnatcatcher would be reduced to less than significant by avoiding construction activities during breeding season.

In reviewing construction of the Huntington Beach facility, the City of Huntington (City of Huntington Beach 2006) found that construction would cause no significant impacts to biological resources on site. However, several threatened or endangered species may nest or feed in nearby areas and as a result were found to potentially be impacted during construction related activities. These include the Western snowy plover (*Charadrius nivosus),* Belding's savannah sparrow *(Passerculus sandwichensis beldingii)* and California least tern *(Sterna antillarum brownie).* Mitigation would be accomplished by construction surveys, relocation and noise abatement, resulting in less than significant impacts. (City of Huntington Beach 2006)

Construction of the Marin facility was determined to impact biological resources as described below. It should be noted that the Marin facility would be constructed within San Francisco Bay so the aquatic impacts may not reflect potential impacts that could occur if a similarly sized and designed facility was constructed on or near the ocean. (Marin Municipal Water District 2008) Clearing and construction of the Marin facility could result in the failure of nesting efforts by protected nesting birds, including the white-tailed kite, northern harrier, and loggerhead shrike; California clapper rail that could potentially be present in local riparian habitat; and non-listed birds protected by the Migratory Bird Treaty Act. These impacts were determined to be less than significant with mitigation. Mitigation included preconstruction surveys, consultation with CDFW, exclusion buffers and postponement of activities till after nests have been vacated. (Marin Municipal Water District 2008) Clearing and construction of the Marin facility could also result in the conversion of woodland and annual grassland habitat supporting a variety of resident and migratory species, including foraging and/or nesting habitat for the pallid bat, Townsend's big-eared bat, short-eared owl, loggerhead shrike, northern harrier, white-tailed kite, peregrine falcon, and ferruginous hawk. These impacts were determined to be less than significant with mitigation. Mitigation would consist of avoidance or replacement of trees greater than six inches diameter at a ratio of 2:1 with native healthy trees and development of a management plan in coordination with the city and county. Potential impacts to fish, invertebrates, and marine mammals associated with construction could occur from underwater pile-driving noise during reconstruction of a pier extending into the bay. Mitigation measures proposed include consultation with NOAA Fisheries to identify seasonal work windows for those species at risk, utilizing bubble curtains (avoidance technology), and monitoring for dead or injured fish during these activities. With mitigation these impacts were determined to be less than significant. For marine mammals pile driving may require an incidental harassment authorization from NOAA Fisheries if noise exceeds specific standards. Underwater pile driving may also affect marine mammals, necessitating an Incidental Take Authorization from NOAA Fisheries. Similar mitigation measures would be employed to minimize the impact, such as monitoring, in order to avoid those activities when marine mammals are present. These impacts were determined to be less than significant. (Marin Municipal Water District 2008)

Construction of the Santa Cruz facility could potentially impact threatened or endangered species where the facilities encroached upon riparian habitat or where subsurface pipelines cut across stream channels. (City of Santa Cruz and Soquel Creek Water District 2013) Potentially impacted species identified include the Red-legged Frog and Steelhead. The City of Santa Cruz is proposing mitigation consisting of surveys, monitoring, avoidance, relocation of frogs, and sedimentation/siltation controls to reduce impacts to the habitats of these species to less than significant. The only unavoidable and significant impact is the loss of over-wintering habitat for the Monarch butterfly from construction related disturbance and losses. (City of Santa Cruz and Soquel Creek Water District 2013) Mitigation consisting of avoidance where feasible and replacement cannot reduce this impact to less than significant. Construction related to the intake structure and upgrades to the wastewater outfall would result in the disturbance of habitat and generation of noise and vibration. Mitigation proposed includes monitoring underwater noise, installation of bubble curtains to reduce noise below ecologically relevant thresholds and avoiding noise generating activities if marine mammals are present within an exclusion zone. (City of Santa Cruz and Soquel Creek Water District 2013) Construction of the seawater intake would occur within designated critical habitat for green sturgeon and Habitat Areas of Particular Concern associated with rocky reef and kelp canopy. However these actions are short-term disturbances and are not anticipated to impact the green sturgeon critical habitat. To mitigate impacts to kelp canopy Habitat Areas of Particular Concern to less than significant, the proponents are proposing to establish a 100 foot setback for the intake structure from any kelp canopy identified during the preconstruction survey.

Potential biological construction related impacts for subsurface intakes are described further in section 8.3.2 and 8.3.2.1. Surface and Subsurface intake construction related impacts are compared in section 8.4.2 describing that although subsurface intakes could potentially have more construction related impacts, the construction period is much shorter and much less severe to the long term operation impacts caused by surface water intakes. Section 8.5 and 8.5.1.3 goes into detail on how construction related mortality should be mitigated to offset unavoidable impacts.

Results of Previous Environmental Impact Analyses – Operation

No operational impacts related to the Carlsbad intake or outfall was identified. However, monitoring of the effects related to the discharge would be performed. (City of Carlsbad 2006) A study was done to estimate impingement and entrainment at the Huntington Beach stand-alone desalination facility using data from the Huntington Beach Generating Station. Based on these estimations, the Huntington Beach facility intake under stand-alone operation at 152 MGD (intake flow rate) would result in an estimated average impingement of 0.3 kg (0.7 lb) of fish and 0.1 kg (0.2 lb) of shellfish daily. No threatened or endangered species are expected to be impinged. This rate of impingement was considered less than significant. (City of Huntington

Beach, 2010) Larval entrainment losses due to operation of the project in the stand-alone operating condition are projected to affect only a small fraction of the larvae within the source water (0.02−0.33 percent). Impacts on marine organisms due to the potential entrainment resulting from the project are relatively small, and would not substantially reduce populations of affected species, or affect the ability of the affected species to sustain their populations. Therefore, entrainment impacts would be less than significant. (City of Huntington Beach 2010)

During operations, the intake of 30 MGD from San Francisco Bay by the Marin facility was estimated to entrain 229,061,594 Pacific herring, 1,860,969 gobies, 615,894 northern anchovies and 565,866 yellowfin gobies annually, based on pilot plant studies. However, these values would not be expected to impact the sustainability of these species. As a result, these impacts were determined to be less than significant. Impacts to biological resources associated with the discharge of brine were considered less than significant. (Marin Municipal Water District 2008) This less than significant determination is based on the following: first, the commingling of brine discharge with wastewater prior to discharge results in a 0.06 psu average increase in salinity, representing an increase of less than 0.1 part per thousand within 0.5 meters of the outfall which would rapidly be diluted even further. This increase is considered insignificant, well below the range of salinity variability observed in the receiving water. Second, the contaminants in the source water-receiving water would be more concentrated by the desalination process and in the corresponding discharge; however, the overall mass loading into the water body would not change. The potential for impingement was also determined to have a less than significant impact on biological resources following established CDFW and NOAA design criteria for the bay and estuary that include positive barrier fish screens (3/32 inches) operating at a velocity of 0.33 feet per second to minimize impingement. (Marin Municipal Water District 2008)

Operation of the Santa Cruz facility is not expected to result in significant and unavoidable impacts. (City of Santa Cruz and Soquel Creek Water District 2013) Entrainment would cause no significant impacts. The abundance of the federally listed black abalone in the site vicinity is not large enough to represent a viable or sustainable population and the intake structure itself is not located in critical habitat of the black abalone. Entrainment of other larvae is also not expected to have a significant impact on the marine ecosystem as the highest estimated entrainment represented less than 6/100ths of 1 percent of the source water populations for white croaker and gobies. Entrainment for rocky shoreline species was less, and calculated to represent less than 3/100ths of 1 percent for larval sculpins and rockfish. According to the Santa Cruz and Soquel Creek Water District, (2013) the entrainment losses calculated are comparable to the reproductive capacity of a single white croaker female fish over its lifetime and significantly less than the estimated annual catch rate.

To reduce impingement, the intake structure would be fitted with a wedge wire screen with 2.38 millimeter openings and operated at a rate not to exceed 0.33 feet per second based on the CDFW requirements. Pilot tests performed by the proponent using similar specifications resulted in no observed impingement to fish or invertebrates. Brine would be commingled with wastewater prior to discharge and, coupled with dilution, is not expected to exceed the salinity of the receiving water. (City of Santa Cruz and Soquel Creek Water District 2013) Thermal impacts are not expected since the discharge is anticipated to be the same temperature as the source water**.**

Section 8.3.1.1.2 provides additional detail on biological operational impacts from a surface water intake and compares that to the elimination of operational impacts from a subsurface intake in section 8.3.2. Section 8.5 goes into detail on how marine life mortality will be mitigated to offset unavoidable impacts. Section 8.5.1.1 discusses intake-related mortality during operation of the plant, and section 8.5.1.2 specifically addresses discharge-related mortality. Mitigation would not be required for a facility operating with a subsurface intake because this form of intake has demonstrated elimination of biological impacts.

Impact Analysis

Although the analysis for the four facilities described above results in few significant impacts, it is unlikely that all future facilities would result in similar impacts to biological resources for the following reasons. The abundance and distribution of state and federally listed marine and terrestrial threatened and endangered species vary significantly throughout the coast. Further, critical habitat designated for federally listed species and Essential Fish Habitat designated for fisheries management encompass significant portions of California’s nearshore marine waters. In addition, entrainment studies conducted for the Huntington Beach and Marin facilities indicated that fish and invertebrates are entrained by surface water intakes. While these studies concluded that the observed entrainment would have a less than significant impact, it cannot be concluded that all future facilities will also result in no impact on the sustainability of local species, or the recovery and propagation of state and federally listed species. Further, the limited research conducted by the four proponents considered in this analysis did not attempt to evaluate potential impacts to the food web.

Larval fish and eggs represent a principal component of the food web. Though entrainment-induced mortality would result in the organisms being consumed upon discharge, those organisms would consist of benthic scavengers and detrital feeders rather than water column predators. It cannot be assumed that impacts associated with impingement will be less than significant for all future facilities. Therefore, it is likely that significant impacts to biological resources may occur with implementation of a particular desalination facility, triggering the need to impose mitigation measures. It is possible that some of these impacts could be significant and unavoidable. The impacts associated with the discharge of brines in the receiving water are described in Water Quality (section 12.1.9).

12.1.5 Cultural Resources

Desalination projects in general can significantly impact cultural resources if a project cause or result in the following:

- A substantial adverse change in the significance of a historical resource as defined in title 14; chapter 3; article 5; section 15064.5
- A substantial adverse change in the significance of an archaeological resource pursuant to title 14; chapter 3; article 5; section 15064.5

- Direct or indirect destruction of a unique paleontological resource or site or unique geologic feature
- A Disturbance of any human remains, including those interred outside of formal cemeteries?

A historical resource includes a resource listed in or eligible for listing in the California Register of Historical Resources. The California Register includes resources on the National Register of Historic Places, as well as California State Landmarks and Points of Historical Interest. Properties that meet the criteria for listing also include districts which reflect California's history and culture, or properties which represent an important period or work of an individual, or yield important historical information. Properties of local significance that have been designated under a local preservation ordinance (local landmarks or landmark districts) or that have been identified as local historical resources are also included in the California Register. (California Office of Historical Preservation 2006) An archeological site may be considered an historical resource if it is significant in the architectural, engineering, scientific, economic, agricultural, educational, social, political, military or cultural annals of California. (Pub. Resources Code § 5020.1(j)) or if it meets the criteria for listing on the California Register (Cal. Code. of Regs. tit. 14, § 4850) The State of California does not maintain a database or maps identifying unique paleontological and geological resources. In lieu of these resources, agencies frequently rely on the Society of Vertebrate Paleontology document titled "*Standard Procedures for the Assessment and Mitigation of Adverse Impacts to Paleontological Resources"* (2010) or **"***Assessment and Mitigation of Adverse Impacts to Nonrenewable Paleontological Resources: Standard Guidelines" (1995)*.

Results of Previous Environmental Impact Analyses

No historic sites were identified within the footprint of the Carlsbad facility or associated infrastructure. However, cultural sites have been reported in the project area. Impacts to cultural resources are expected to be less than significant with mitigation, which includes avoidance or, if that is not feasible, data recovery and/or removal. (City of Carlsbad 2006) No cultural resources were identified on the Huntington Beach project site project and no historical or archaeological resources are known to exist within or surrounding the proposed booster pump station sites. As a result, impacts to cultural resources were determined to be less than significant though mitigation consisting of monitoring, which is required during earthwork. (City of Huntington Beach, 2010) Construction of the Marin facility would not directly or indirectly destroy a unique paleontological resource or site or unique geologic feature. (Marin Municipal Water District 2008) However, archeological resources may be present at select locations within the site and pipeline footprint. Monitoring by trained workers and experts at high risk locations is required and, if encountered, work will be stopped to assess and characterize the significance of the finding before proceeding. Impacts of the Marin facility related to these resources were determined to be less than significant with mitigation. (Marin Municipal Water District 2008)

Construction of the Santa Cruz facility would not cause a substantial adverse impact on any known historical or unique archaeological resource. However, unknown historical resources could be present that require onsite monitoring by a qualified archaeologist during earthwork activities to assess the significance of any finds. Mitigation would consist of avoidance or, if that is not feasible, data recovery and/or removal. Paleontologically rich or sensitive strata could be encountered during construction of the Santa Cruz facility. (City of Santa Cruz and Soquel Creek Water District 2013) Mitigation would be accomplished through worker training and monitoring. Construction of the Santa Cruz was not expected to have a significant impact on cultural resources after mitigation. (City of Santa Cruz and Soquel Creek Water District 2013)

Impact Analysis

Potential impacts to known identified cultural resources may be avoidable through records search, surveys, and consultation with local experts. However, impacts to unknown cultural resources are difficult to estimate. Therefore, it is possible that significant impacts to cultural resources may occur with implementation of a particular desalination facility, triggering the need to impose mitigation measures. Where unknown cultural resources are encountered, mitigation could include pre-construction surveys, monitoring during construction and avoidance or if that is not feasible, data recovery and/or removal. It is possible that some of these impacts could be significant and unavoidable.

12.1.6 Geology and Soils

Desalination projects in general can have a significant impact if a project were to cause or result in the following:

- Exposure of people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:
    - Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault
    - Strong seismic ground shaking
    - Seismic-related ground failure, including liquefaction
    - Landslides
- Substantial soil erosion or the loss of topsoil
- Project would be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse
- Project would be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property
- Project would have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of waste water

The geology of coastal California is highly variable, in part a function of the large geographic extent of the state. Coastal bedrock and surface deposits are comprised of Precambrian crystalline basement rocks, Paleozoic igneous and sedimentary formations, Tertiary accretionary prism/marine sediments, Pliocene to Quaternary marine terraces, Quaternary to Holocene coastal sediments such as dunes, beaches, and other alluvium, and heavily reworked Anthropocene deposits. The California Geological Survey has published geologic maps for the state that highlight local geologic deposits. (Gutierrez et al. 2010)

California is located along an active tectonic plate margin, where the Pacific plate interacts with the North American and Juan de Fuca plates. There are hundreds of known faults, both active and inactive, throughout the state. The San Andreas Fault is the largest in California and is one of the largest lateral transform faults in the world, running for more than 700 miles through both coastal and inland areas. As a consequence of the tectonic activity in the region, there are significant seismic hazards along the California coast. Faulting can also weaken the strength of formation along the fault zone. Depending on location, the interaction of geology and environment can result in additional hazards to humans and the environment. Weathering of loosely consolidated sediments can result in coastal hazards including ground failure, landslides, subsidence, or collapse. Soil composition can adversely affect the stability of key structures through expansion/contraction. Heavy surf and accompanying rainfall can result in significant coastal erosion in some locations causing loss of structures, scenic vistas and highways. Sea level rise can further exacerbate coastal erosion.

Seismicity in the Central and Southern California coasts is largely driven by the San Andreas Fault and related transform fault activity (although normal and reverse faults are not uncommon). The presence of a subduction zone north of Point Arena increases seismic risks along the Northern California coast. Active faults are mapped by the California Geologic Survey in response to the Alquist-Priolo Earthquake Fault Zoning Act of 1972, which required the State Geologist to establish Earthquake Fault Zones around the surface traces of active faults. (Bryant and Hart 2007) The maps identify fault zones that are subject to construction requirements in order to mitigate the effects of seismicity on certain types of structures. Specifically, the Act prohibits construction of buildings used for human occupancy over the surface trace of active faults. Before a project can be permitted, cities and counties must require a geologic investigation to demonstrate that proposed buildings will not be constructed across active faults.

Other earthquake associated hazards such as seismically induced liquefaction and landslides, not addressed in Alquist-Priolo Earthquake Fault Zoning Act were the subject of the Seismic Hazards Mapping Act of 1990, addressing non-surface fault rupture earthquake hazards. Under the Seismic Hazards Mapping Act, the California Geological Survey prepares seismic hazard zone maps to local governments that delineate hazard zones, specific areas susceptible to liquefaction, earthquake-induced landslides or other ground failures. The Seismic Hazards Mapping Act requires local governments and planning agencies to require geotechnical studies for projects proposed within seismic Hazard zones. Under the Coastal Zone Act, section 30253 requires that new development minimize risks to life and property associated with geologic hazard and neither creates nor contributes to erosion or geologic instability. Minimum building requirements to address geological hazards are also set forth in the Uniform Building Code and the California Building Code. Frequently, local agencies (Cities and Counties) adopt ordinances to mitigate hazards associated with locally known or identified geological hazards and subsurface conditions.

Results of Previous Environmental Impact Analyses

The City of Carlsbad and City of Huntington Beach identified expansive or unstable soils as the only potential issue relating to geology and soils that requires mitigation for their respective desalination facilities. (City of Carlsbad 2006; City of Huntington Beach 2010) Native soils in the footprint of foundations and along pipeline segments would need to be removed and replaced by engineered fill. The actual specifications would be determined from geotechnical studies.

Marin Municipal Water District (2008) identified only one potential impact related to geology and soils that required mitigation. Erosion of disturbed graded or exposed soils from construction activities during periods of wet weather was identified as the only significant impact associated with geology and soils. Erosion would be mitigated to less than significant by minimizing earthwork on or near stream crossings and incorporating erosion control related best management practices (BMPS) into all construction and grading plans.

The Santa Cruz Facility and related infrastructure are not sited within an Alquist-Priolo fault zone (City of Santa Cruz and Soquel Creek Water District 2013), though there is potential for significant earthquake induced ground motion. According to the City of Santa Cruz and Soquel Creek Water District, (2013), this unavoidable hazard poses significant risk to all structures including roads, bridges, buildings, water storage facilities, and buried and surface pipelines in the project area. In addition, development on or near coastal bluffs may contribute to slope failure and erosion. Though preliminary studies have been conducted, final mitigation plans will be developed based on detailed geotechnical studies. These studies will be conducted to assess the properties of landside soils and seaward sediments to determine the type of foundations and anchoring necessary. Bluff retreat or coastal erosion for shoreside pumping stations was also evaluated but considered less than significant with appropriate setbacks calculated from local studies. In summary, potential impacts associated with geological hazards were considered less than significant or less than significant with mitigation. (City of Santa Cruz and Soquel Creek Water District 2013)

Impact Analysis

Although the analysis described above results in few significant impacts for the four projects evaluated, it is unlikely that all future facilities would encounter similar geological or soil related hazards for the following reasons. Much of the coast of California is a seismically active. Potential risks include significant ground motion, liquefaction or landslides. As described in the fault zone maps prepared by the California Geological Survey, not all active faults have been identified or the fault traces accurately and hazards accurately located. (California Geological Survey 2012) In addition many coastal areas are underlain by formations of low strength where precipitation induced landslides are frequent within the coastal hills and bluffs. Therefore, it is possible that significant impacts to geologic resources and soils may occur with implementation of a particular desalination facility, triggering the need to impose mitigation measures. It is possible that some of these impacts could be significant and unavoidable.

12.1.7 Greenhouse Gases

Desalination projects in general can significantly increase greenhouse gas emissions if a project were to:

- Generate Greenhouse gas emissions, either directly or indirectly, that may have a significant impact on the environment
- Conflict with an applicable plan, policy or regulation adopted for the purpose of reducing the emissions of greenhouse gases

Greenhouse gases trap heat in the atmosphere, which in turn heats the surface of the Earth. Some greenhouse gases occur naturally and are emitted to the atmosphere through natural processes, while others are created and emitted solely through human activities. The emission of greenhouse gases through the combustion of fossil fuels (i.e., fuels containing carbon) in conjunction with other human activities, appears to be closely associated with global warming. In 2006, Assembly Bill 32 (California Global Warming Solutions Act) was approved, mandating a reduction of greenhouse gas emissions to 1990 levels by 2020. Senate Bill 97 (Chapter 185, Statutes of 2007) amends the CEQA statute to clearly establish that greenhouse gas emissions and the effects of these emissions are appropriate subjects for CEQA analysis. It directs the Office of Planning and Research to develop draft CEQA Guidelines "for the mitigation of greenhouse gas emissions or the effects of greenhouse gas emissions" by July 1, 2009 and directs the Natural Resources Agency to certify and adopt the CEQA Guidelines by January 1, 2010. The amended CEQA guidelines became effective on March 18, 2010.

Climate change refers to any significant change in measures of climate, such as average temperature, precipitation, or wind patterns over a period of time. Climate change may result from natural factors, natural processes, and human activities that change the composition of the atmosphere and alter the surface and features of the land. Significant changes in global climate patterns have recently been associated with global warming, including an average increase in the temperature of the atmosphere near the Earth's surface, attributed to accumulation of greenhouse gas emissions in the atmosphere. State law defines greenhouse gases to include the following: CO_2, methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride (Health and Safety Code, §38505(g).) The most common greenhouse gases that results from human activity is CO_2, followed by CH_4 and nitrous oxide. Few coastal air districts have adopted thresholds of significance in order to evaluate the potential for a project to contribute significant GHG emissions. Established thresholds are presented in Table 12-16.

Table 12-16 GHG Thresholds of Significance for Operational Emissions Impacts

Local Air District	Pollutant	Threshold
Mendocino	GHGs – Projects other than Stationary Sources	Compliance with Qualified GHG Reduction Strategy OR 1,100 MT of CO_2e/yr OR

Local Air District	Pollutant	Threshold
		4.6 MT CO_2e/SP/yr (residents+employees)
	GHGs – Stationary Sources	10,000 MT/yr
San Luis Obispo	Greenhouse Gases (CO2, CH4, N20, HFC, CFC, F6S)	Consistency with a Qualified GHG Reduction Plan OR 1,150 MT CO_2e/year OR 4.9 CO_2e/SP/year (residents + employees)
South Coast	**GHG**	10,000 MT/yr CO2e for industrial facilities

Carbon Dioxide Equivalent - A metric used to compare emissions of various greenhouse gases. It is the mass of CO_2 that would produce the same estimated radiative forcing as a given mass of another greenhouse gas. CO_2 equivalents are computed by multiplying the mass of the gas emitted by its global warming potential.

Greenhouse Gas - Greenhouse gases include; CO_2, CH_4, N_2O, hydrochlorofluorocarbons (HCFCs), ozone (O_3), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride.

Direct emissions of GHG from facility processes are relatively insignificant compared to potential indirect emissions associated with energy needs. Energy consumption associated with desalination ranges from 12,000-18,000 kilowatts-hours per million gallons (kWh/mgal), which makes it the most energy intensive alternative compared to other water supply options. (Pacific Institute 2013b) The RO process consumes about 67 percent of the total energy used for a desalination plant, about 13 percent is used for post treatment and pumping, another 13 percent is used for pretreatment, and about 7 percent is used for pumping seawater to the plant. This estimates that on average about 1,050 kWh/mgal is used for withdrawing seawater to a facility. (Pacific Institute 2013b)

A subsurface intake feasibility assessment was conducted for the Huntington Beach Desalination facility that calculated the increase in energy requirements for the use of an intake well compared to a surface water intake. The assessment concluded that the use of a vertical intake well system would result in about a 10 percent increase in energy consumption. If a facility opted to withdraw seawater by use of a subsurface intake, total energy costs of pumping seawater would increase compared to an open ocean intake. However, the energy requirements of pretreatment (13 percent) required for a surface water intake may not be required for a subsurface intake. (Water Globe Consulting LLC 2010) This study was performed after completion of the Huntington Beach EIR. In the case of surface water intakes with the addition of screening technologies, the increment of energy consumption will vary depending on the facility's intake capacity, the number of surface intake pipes, the surface area sizing of the screens, and the slot sizes of the screens. In comparison, the State Water Project is estimated to use 7,900-14,000 kWh/mgal to deliver water from the Central Valley to southern California (Pacific Institute 2013b), water imported via the Colorado River aqueduct consumes 6,100 kWh/mgal, and local groundwater pumping uses about 500-3,500 kWh/mgal.

While energy consumption estimates can be applied to assess potential GHG emissions for individual and currently proposed facilities, there are two additional factors to consider. The first and most important factor is the source of energy. Hydropower, solar photovoltaic, and wind energy are not associated with significant GHG emissions (NRC 2008). Other potential sources such as closed loop geothermal and energy generated from biofuels are also carbon neutral. (NRC 2008) Facilities that rely upon these sources would not increase GHG emissions. Facilities that rely primarily on fossil fuel derived energy could indirectly increase GHG emissions. For those facilities obtaining energy from a regional or state wide power supply grid, quantification of the indirect GHG emissions associated with such variable and indirect sources would be speculative. (City of Huntington Beach 2006) The second factor that must be considered is whether the water supply replaces an existing supply or represents a new source for growth. If the supply replaces and existing source, the energy required to operate the facility could in part be offset by the reduced use or reliance on existing sources of water that also consume energy (Pacific Institute 2013b). As a result, the potential GHG emissions are difficult to estimate without understanding the sources of energy and the need for the water supply.

Results of Previous Environmental Impact Analyses

Poseidon Resources Surfside LLC (Poseidon) developed estimates of the greenhouse gas emissions associated with the operation for the Carlsbad facility (Poseidon 2008) and the Huntington Beach facility (Poseidon 2010). The Carlsbad report provides a single estimate of total annual emissions while the Huntington Beach report provides estimates for four configuration options. The estimates of electrical use and gross indirect CO_2 emissions are presented in Table 12-17..

Table 12-17 Theoretical Energy Use and GHG Emissions for Carlsbad and Huntington Beach facilities (Poseidon 2008; 2010)

Facility	Operating Rate (MGD product water)	Electricity (kWh)	Total GHGs (metric tons CO_2e)
Carlsbad	50	750,000,000	90,000
Huntington Beach	50	750,000,000	80,000

These estimates exceed the South Coast Air District thresholds for industrial sources (Table 12-16). Note that these emissions cannot be attributed to a single source. Rather, these emissions represent indirect emissions from the power grid that utilizes energy from a variety of energy producers. In addition, these estimates do not reflect offsets realized through reduced reliance on sources such as the State Water Project or the Colorado River aqueduct. Proponents for both facilities have indicated that operations will be carbon neutral, an outcome that would be achieved through the purchase of offsets and reductions achieved by reduced use of other water supplies. As a result, both facilities were described as having less than significant impact on GHG emissions. According to the San Diego County Water Authority (2012), the CCC has ordered the proponents of the Carlsbad facility to perform detailed GHG emissions studies to ensure that the facility is carbon neutral. The analyses to be performed each year include:

1. Determine the energy consumed by the Project for the previous year
2. Determine San Diego Gas and Electric (SDG&E) emission factor for delivered electricity from its most recently published Annual Emissions Report
3. Calculate the Project's gross indirect GHG emissions resulting from Project operations by multiplying its electricity use by the emission factor
4. Calculate the Project's net indirect GHG emissions by subtracting emissions avoided as a result of the Project (Avoided Emissions) and any existing offset projects and/or Renewable Energy Credits (RECs)
5. If necessary, purchase carbon offsets or RECs (or pay an in-lieu fee) to zero-out the Project's net indirect GHG emissions.

The Marin project would directly generate little GHG emissions on-site, consisting of vehicle exhaust generated by the facility's small workforce. (Marin Municipal Water District 2008) Indirect emissions associated with the generation of electricity used by the plant are presented in Table 12-18. With a county population at 252,988 (2005), the GHG per capita emissions would be increased by 0.016 to 0.12 ton/year or a percent increase of 0.13 to 0.95 percent. According to the Water District, the proposed desalination facility does not represent a significant source of GHG emissions (Marin Municipal Water District 2008).

Table 12-18 Estimated Energy Use and GHG Emissions for the Marin facility (Marin Municipal Water District 2008).

Operating Rate	Electricity (kWh)	Total GHGs (metric tons CO_2e)
5 MGD average Conditions	10,037,500	4,006.6
10 MGD average Conditions	18,615,000	7,430.4
15 MGD average Conditions	28,470,000	11,364.2
15MDG drought conditions*	76,650,000	**30,595.9**

*Represents worst case scenario

Direct and indirect GHG emissions associated with the Santa Cruz facility operation were estimated to be 207.98 and 3,326.11 metric tons per year of CO_2e, respectively. The total amount is 3,501.36 metric tons per year (CO_2e). The City Council and the District Board of Directors have agreed via resolution that the Desalination Amendment would be net carbon neutral. (City of Santa Cruz and Soquel Creek Water District 2013) Given that GHG emissions will be fully offset through the purchase of GHG offset projects, GHG emissions of the Desalination Amendment would be less than significant. (City of Santa Cruz and Soquel Creek Water District 2013)

Impact Analysis

Although GHG emissions would occur from construction of a particular desalination facility, energy use is the primary source of GHG emissions associated with desalination facilities. Facilities that rely on hydropower, solar photovoltaic, wind, closed loop geothermal or biofuels could be operated on a carbon neutral basis. However, it is unlikely that these sources can meet the demand for continuous around the clock operation throughout the state. Therefore, it is likely that significant impacts through GHG emissions may occur with implementation of a particular desalination facility, triggering the need to impose mitigation measures. Desalination facility proponents could also develop renewable energy plants to supplement the electrical grid for the power used by the desalination facility (Pacific Institute 2013b) or alternatively purchase carbon offsets as proposed by City of Santa Cruz and Soquel Creek Water District. While the quality or reliability of carbon offsets have been questioned (Pacific Institute 2013b), the ARB has prepared and adopted verification standards to ensure that any offsets purchased in California will be reliable and effective. (CARB 2013) It is possible that some of these impacts could be significant and unavoidable.

12.1.8 Hazards and Hazardous Materials

Desalination projects in general can significantly increase the risks associated with hazards or hazardous materials if a project were to:

- Create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials
- Create a significant hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment
- Emit hazardous emissions or handle hazardous or acutely hazardous materials, substances, or waste within one-quarter mile of an existing or proposed school
- Be located on a site which is included on a list of hazardous materials sites compiled pursuant to Government Code section 65962.5 and, as a result, would create a significant hazard to the public or the environment
- Result in safety hazard for people residing or working
  - Within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport,
  - Within the vicinity of a private airstrip
- Impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan
- Expose people or structures to a significant risk of loss, injury or death involving wildland fires, including where wildlands are adjacent to urbanized areas or where residences are intermixed with wildlands

Hazardous materials can be transported by rail, tractor-trailer or light truck from bulk storage and distribution centers to retailers or directly to customers. Hazardous materials may be stored in large quantities in above ground and underground storage tanks. Where spills or releases occur, these materials can potentially ignite creating an immediate and acutely hazardous condition involving loss of life and property or create long term environmental problems. Contaminated soil, groundwater and surface waters can result in long term exposure and human health and ecological risks associated with inhalation of contaminant vapors, through contaminated drinking water or, if released or spilled, contaminants enter the food chain, resulting in dietary exposure. Airports also present a unique hazard associated with low flying aircraft. Wildlands and undeveloped areas are susceptible to forest and grass fires. Where urban development encroaches on these areas, forest and grass fires can cause significant loss of life and property. There is also the potential for human health hazards associated with the construction. Use of heavy equipment during construction can increase the risk of accidents to workers or others present on or near the work area.

As discussed in sections 2.1 and 8.3, seawater desalination facilities that rely on RO require chemical additions for pre and post treatment and membrane maintenance. All chemicals must be transported and stored on site in bulk. Pretreatment may include the addition of acids, coagulants and flocculants. Post treatment requires disinfection by chlorination or less reactive sodium hypochlorite, pH control through addition of CO_2 and conditioning using sodium or calcium hydroxide to protect the water distribution system. (NRC 2007; WHO 2006) Dechlorination is accomplished through addition of sodium bisulfite. Membranes are typically taken off line periodically and cleaned using dilute hydrochloric or critic acid. In addition, biocides such as chlorine may be used to clean intake and discharge pipes.

The transport, storage and use of hazardous materials is strictly regulated by multiple state and federal agencies The Resource Conservation and Recovery Act provides the authority for EPA to regulate hazardous materials from “cradle to grave,” (or from point of generation to disposal). Under California Code of Regulation Title 22, the Department of Toxic Substances Control (DTSC) is responsible for permitting facilities that generate, transport, treat, store and dispose of hazardous waste, and the local agencies may be delegated primary enforcement authority by DTSC. The California Health and Safety Code requires facilities that use or store hazardous materials to prepare and maintain an inventory of hazardous materials that includes the type, quantity, and storage location of materials, prepare an emergency response plan, and train employees to safely and appropriately inspect and handle hazardous materials and appropriately respond in emergency situations. The California Health and Safety Code also contains specific requirements on leak prevention detection and monitoring and reporting requirements.

The intent of the California Occupational Safety and Health Act (OSHA) is to maintain a safe workplace for all employees including safety training, safety equipment and communication including labels and signs on all hazardous materials. Cleanup of hazardous waste sites is addressed in Resource Conservation and Recovery Act and in the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, and 1988 Superfund Amendment and Reauthorization Act Amendment. Through he Comprehensive Environmental Response, Compensation, and Liability Act, also known as Superfund, EPA created a national policy and procedures to identify and cleanup sites contaminated by releases of hazardous substances. EPA manages the restoration and cleanup of Superfund sites. Other sites where releases of hazardous materials have occurred may fall under the jurisdiction of DTSC, the Regional Water Quality Control Board or local environmental health officials or Fire Departments. EPA and state agencies, including DTSC and the Water Boards, maintain searchable databases that can be used to locate known sites were contaminants have been released into the soil, groundwater and surface waters.

Results of Previous Environmental Impact Analyses

The City of Carlsbad identified two potential issues that could cause or result in a hazard or release of hazardous materials that required mitigation. (City of Carlsbad 2006) These were the transport, storage and disposal of hazardous materials, and the potential to expose hazardous waste during excavation and earthwork related construction activities. According to the City of Carlsbad pre and post treatment will require the following products (City of Carlsbad 2006):

- Citric Acid (2% solution)
- Sodium Hydroxide (0.1% solution)
- Sodium Tripolyphosphate (2 % solution)
- Sodium Dodecylbenzene (0.25% solution)
- Sulfuric Acid (0.1% solution).
- Sodium Hypochlorite (12%)
- Ferric Sulfate (70%)
- Polymer (0.5%)
- Sulfuric Acid (20%)
- Sodium Bisulfate (20%)
- CO_2 (100%)
- Lime (15%)
- Sodium Hypochlorite (12%)
- Ammonia (10%) Disinfection

In order to mitigate potential impacts associated with the spill, leak or accidental discharge, the City is proposing mitigation through the following. (City of Carlsbad 2006)

- Exhaust system for indoor hazardous material storage areas;
- Automatic sprinkler system for indoor hazardous material storage areas;
- Separation of incompatible materials by isolating them from each other with noncombustible partition.
- Use of chlorine in liquid form (sodium hypochlorite) to mitigate concerns associated with accidental toxic gas plume releases and potential odor emissions from the chlorine storage facility
- Use of aqua ammonia of concentration below the regulatory threshold limit of 20 percent and amount below the regulatory threshold of 20,000 gallons to mitigate concerns associated with accidental release of significant toxic ammonia gas plume releases
- Liquid chemical storage tanks equipped with a pressure relief valve, vapor equalization, a carbon filter vent, and vacuum breaker
- Secondary containment and capture systems for bulk storage systems
- Leak containment and capture systems for piping and conveyance systems
- Safety programs and plans including worker education and training
- Regular inspection of storage and process systems
- 24-hour site security and limited access points

Exposure to potential environmental contamination could occur during trenching and excavation associated with construction activities. These impacts into the environment may be significant and require mitigation. The City of Carlsbad has proposed to mitigate the potential for exposure, by monitoring areas of existing contamination during trenching of pipelines. When contaminated soil or groundwater are encountered appropriate action including avoidance or removal and special handling measures will instituted, as determined by the City of Carlsbad Construction Inspector. Impacts associated with the exposure and release of hazardous materials would be mitigated to less than significant through incorporation of these measures. (City of Carlsbad 2006)

No impacts associated with hazardous conditions or releases associated with hazardous materials or waste were identified by the City of Huntington Beach. (City of Huntington Beach 2010) The Marin Municipal Water District evaluated the Marin project in relation to potential hazards, hazardous conditions and hazardous materials and waste and determined that any impacts would be less than significant, and as a result, no mitigation would be necessary. (Marin Municipal Water District 2008) The City of Santa Cruz and Soquel Creek Water District (2013) identified exposure to hazardous waste during construction as a potential significant impact. A preliminary review revealed several sites with known or documented soil or groundwater contamination on or near the foot print of proposed pipelines. Work on the pipeline could potentially result in the excavation of contaminated soil containing petroleum fuels and additives, metals and creosote coated railroad ties. Some of the contamination may be encountered within one quarter mile of a school. In order to mitigate impacts associated with subsurface contamination, soil and groundwater investigations are proposed in areas of greatest risk. The data and information from these studies will be used to develop management plans to reduce potential exposure to workers, residents and schools and to ensure the waste materials generated are handled and disposed of in accordance with local state and federal laws. These impacts are characterized as less than significant with mitigation.

Impact Analysis

Although the analysis described above results in few significant impacts for the four projects evaluated, it is unlikely that workers and residents near all future facilities would encounter the same hazards, or potentially be exposed to similar hazardous materials that can be mitigated. In the planning of future facilities, potential hazards may not be immediately recognizable or identified. Storage and use of large quantities of hazardous materials always presents some risk. Contaminated soil and groundwater may be uncommon in rural or undeveloped areas. However, in metropolitan areas where desalination facilities are more likely to be constructed, subsurface contamination may be encountered frequently. Therefore, it is possible that significant impacts from hazards and hazardous materials may occur with implementation of a particular desalination facility, triggering the need to impose mitigation measures. If unknown contaminants are encountered, the potential exposure to workers and residents may be difficult to mitigate. It is possible that some of these impacts could be significant and unavoidable.

12.1.9 Hydrology and Water Quality

Desalination projects in general can have significant impacts to hydrology and water quality if a project were to cause or result in:

- Violation of any water quality standards or WDRs
- Substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level (e.g., the production rate of pre-existing nearby wells would drop to a level which would not support existing land uses or planned uses for which permits have been granted)
- Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner which would result in substantial erosion or siltation on- or off-site
- Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner which would result in flooding on- or off-site
- Create or contribute runoff water which would exceed the capacity of existing or planned storm water drainage systems or provide substantial additional sources of polluted runoff
- Otherwise substantially degrade water quality
- Place housing within a 100-year flood hazard area as mapped on a federal Flood Hazard Boundary or Flood Insurance Rate Map or other flood hazard delineation map
- Place within a 100-year flood hazard area structures which would impede or redirect flood flows
- Expose people or structures to a significant risk of loss, injury or death involving flooding, including flooding as a result of the failure of a levee or dam
- Inundation by seiche, tsunami, or mudflow

Along the coast, most rainfall occurs from October through April, though monsoonal flows may provide significant precipitation in late summer and early fall especially in southern California. Average rainfall in watersheds draining the coastal region can vary from over 100 hundred inches per year along the Redwood Coast to 14 inches or less in southern California.

Landside construction activities that disturb one or more acres of soil or part of a larger common plan of development are required to obtain coverage under the General Permit for Discharges of Storm Water Associated with Construction Activity, requiring the development and implementation of a Storm Water Pollution Prevention Plan (SWPPP). The SWPPP must list BMPs the discharger will use to protect storm water runoff and the placement of those BMPs. Additionally, the SWPPP must contain a visual monitoring program; a chemical monitoring program for "non-visible" pollutants, to be implemented if there is a failure of BMPs; and a sediment monitoring plan if the site discharges directly to a water body listed on the CWA 303(d) list for sediment. Municipal storm water permits (which may be referred to as MS4 permits) are implemented by local government entities. These storm water permits may require erosion control and grading ordinances, to protect water quality. Municipal permits also include provisions that support low impact development and requirements that are intended to minimize impacts associated with hydromodification within the affected watersheds. Hydromodification provisions require new development to be designed so that the wet weather runoff does not significantly alter the flow frequency and duration in the affected watershed from pre-development conditions. In addition, Coastal Development permits issued by the California Coastal Commission or Local Coastal Program as authorized under the California Coastal Act may also include requirements to protect water quality.

Under Porter-Cologne, the Water Boards regulate waste discharges that could affect water quality through WDRs. In 1972, the California Legislature amended Porter-Cologne to provide the State with the necessary authority to implement an NPDES permit program in lieu of a U.S. EPA-administered program under the CWA. To ensure consistency with CWA requirements, Porter-Cologne requires that the Water Boards issue and administer NPDES permits such that all applicable CWA requirements are met. In ocean waters of California, all point source discharges including waste and storm water discharges must comply with the California Ocean Plan. Discharge requirements contained in the Ocean Plan can be found at: http://www.swrcb.ca.gov/water_issues/programs/ocean/docs/cop2012.pdf

In addition, Porter-Cologne contains a provision addressing coastal facilities that withdraw water for industrial purposes, although the provision only applies to “new or expanded facilities.” Section 13142.5(b) requires each new or expanded coastal power plant or other industrial installation using seawater for cooling, heating or industrial processing to use “the best available site, design, technology, and mitigation measures feasible to minimize the intake and mortality of all forms of marine life.” Although the Ocean Plan provides the regional water boards with all necessary provisions to protect water quality from impacts associated with the discharge of waste and storm water, currently, the regional water boards must enforce these provisions on a case by case basis.

The discharge of dredge and fill material into waters of the U.S would require the project proponent to obtain a permit from the Corps under CWA section 404 and Water Quality Certification from the regional water board under CWA section 401. CWA section 401 allows the State to grant or deny water quality certification for any activity which may result in a discharge to navigable waters of the US and which requires a federal permit. Title 23, California Code of Regulations, section 3830 et seq. provides the regulatory framework under which Water Boards issue Water Quality Certifications under CWA section 401. The Corps may not issue a section 404 permit if the State denies water quality certification. In waters of the State that are not waters of the US, instead of a certification of a federal permit, these actions would require WDRs issued by the Water Boards. For either a Water Quality Certification or WDRs, the regional water board would require all actions to comply with State Water Quality Control Plans and Policies and the applicable regional water board Basin Plan.

In order to certify a project, the Water Board must certify that the proposed discharge will comply with all of the applicable requirements of CWA sections 301, 302, 303, 306, and 307 (42 U.S.C. §§ 1311, 1312, 1313, 1316, and 1317). Essentially, the Water Boards must find that there is reasonable assurance the certified activity will not violate water quality standards.

Water quality standards include water quality objectives and the designated beneficial uses of the receiving water. CEQA compliance is required under the section 401 water quality certification process. In order to meet water quality objectives, effluent limits, receiving water limits and/or BMPs are employed to ensure compliance. BMPs can consist of drilling equipment that minimizes re-suspension of fine grain materials, use of settling tanks to reduce excessive turbidity in discharge, use of silt curtains to reduce dispersal of turbidity plume beyond the dredge site, coffer dams in small channels, and accurate positioning of disposal equipment during excavation and dredging.

Results of Previous Environmental Impact Analyses

The City of Carlsbad identified construction related impacts to water quality as the only significant impacts requiring mitigation. (City of Carlsbad 2006) All other impacts were considered less than significant. Salinities associated with the discharge of brine were projected to be 1.9 to 3.8 ppt above the natural range of ocean salinity 95 percent of the time, and the maximum salinity at the edge of the zone of initial dilution would be less than 36.2 ppt. (City of Carlsbad 2006) Extended exposure to salinity levels above 40 ppt would be avoided under all proposed operating conditions. For pH, when the brine concentrate is mixed with the power plant discharge, the pH of the combined discharge is increased to 7.8, and is considered well within the range of ambient conditions and within the Ocean Plan pH limit of 0.2 pH unit deviation from the ambient ocean water. (City of Carlsbad 2006) Storm water quality impacts associated with construction were considered significant but avoidable with mitigation. Wet weather induced erosion sedimentation and siltation could potentially be increased during or after earthwork activities or associated with materials handling. To mitigate these impacts, the City of Carlsbad is requiring the project applicant to comply with all applicable regulations set forth in the MS4 permit requirements for urban runoff and storm water discharge and any construction related regulations adopted by the city in accordance with the MS4 permit. (City of Carlsbad 2006) According to the City of Carlsbad, the applicant must file a Notice of Intent with the State Water Board to obtain coverage under the NPDES General Permit for Storm Water Discharges Associated with Construction Activity and implement a SWPPP. The SWPPP shall include both construction and post-construction pollution prevention and pollution control measures. (City of Carlsbad 2006)

Impacts associated with the discharge from the Huntington Beach facility were considered less than significant. However, construction and operation could impact storm water quality. (City of Huntington Beach 2010) Construction impacts would be mitigated through the application for coverage and compliance with the provisions of the NPDES General Permit for Storm Water Discharges Associated with Construction Activities, and development and implementation of an Erosion Control Plan. (City of Huntington Beach 2010)

The only impact associated with water quality and hydrology identified by the City of Marin was the potential risk associated with tsunamis. (Marin Municipal Water District 2008) According to the City of Marin, these risks can be lessened or mitigated completely by the application of appropriate engineering design.

The City of Santa Cruz and Soquel Creek Water District are proposing to commingle the brine waste with wastewater from the regional WWTP prior to discharge. (City of Santa Cruz and Soquel Creek Water District 2013) As discussed previously in section 8.6.2.1 and 8.6.2.2, the dilution with wastewater in the discharge stream coupled with discharge through a diffuser that is designed to provide rapid and turbulent mixing and hence more dilution reduces the impacts associated with brine waste upon discharge to less than significant. Potential construction-phase water quality impacts would also be controlled through compliance with the NPDES General Permit for Storm Water Discharges Associated with Construction Activities, local municipal permits and the preparation and implementation of a SWPPP in accordance with NPDES permitting requirements for the City of Santa Cruz and Soquel Creek Water District (2013). According to the City of Santa Cruz and Soquel Creek Water District (2013), the SWPPP describes the construction-phase erosion and sediment control and other pollutant control BMPs that would need to be implemented. The SWPPP would set forth a BMP monitoring and maintenance schedule, and would identify the responsible entities during the construction and post-construction phases. (City of Santa Cruz and Soquel Creek Water District 2013) Implementation of these measures would reduce impacts to storm water quality to less than significant.

Construction of the Santa Cruz intake pipeline in the ocean would include tunneling and use of drilling muds. (City of Santa Cruz and Soquel Creek Water District 2013) Release of the muds in the marine environment could cause significant impacts. Mitigation would include a pre-construction geologic study to identify geologic materials and potential for release of drilling muds during tunneling; maintaining a barge on station equipped with personnel and materials to cleanup releases, continuous monitoring to detect releases and plans and procedures to follow if a leak occurs. The implementation of these measures would mitigate the potential impact to less than significant. To mitigate water quality impacts associated with dredging activities, closed-bucket dredging systems will be used in conjunction with a turbidity curtain and scheduling to avoid high surf to minimize construction related turbidity. (City of Santa Cruz and Soquel Creek Water District, 2013) These activities will require a CWA section 401 Water Quality Certification from the regional water board. The Water Quality Certification requires the permittee to comply with all applicable plans and policies and meet all water quality criteria. According to the City of Santa Cruz and Soquel Water District, in the event that increased turbidity is detected, the certification may require a specific time of attenuation, or further isolation of the work area with additional turbidity screens. (City of Santa Cruz and Soquel Creek Water District 2013)

Impact Analysis

Although the analysis described above results in few significant impacts to hydrology and water quality, it is unlikely that all future facilities would result in similar impacts for the following reasons. It is unlikely that construction and operation of a coastal desalination facility would alter the drainage of streams or rivers, place housing or structures within a flood plain, redirect or impede flood waters or expose people or structures to significant risk or loss due to flooding. However, projects that disturb large areas have the potential to cause increased erosion and discharge of sediment and other pollutants into local watershed and water bodies. The addition of new impervious surfaces can increase runoff rates and quantity which can further impact water quality during wet weather. Potential water quality impacts during construction of a subsurface intake are described further in section 8.3.2 and 8.3.2.1. Surface and Subsurface intake construction related impacts are compared in section 8.4.2 noting that although subsurface intakes could potentially have more construction related impacts, the construction period is much shorter and much less severe than the long term operation impacts caused by surface water intakes. Therefore, it is possible that significant impacts to hydrology and water quality may occur with implementation of a particular desalination facility, triggering the need to impose mitigation measures. It is possible that some of these impacts could be significant and unavoidable.

The discharge of brine waste generated through desalination can also affect water quality and impact marine life if not adequately diluted or if discharged in an area where aquatic communities are sensitive to small changes in salinity. These potential impacts are assessed in much greater detail in section 8.6. Impacts associated with entrainment and impingement also represent a potential threat to the beneficial uses established for the protection of California ocean waters. The potential impacts are also assessed in greater detail in section 8.3. Section 8.5 goes into detail on how marine life mortality will be mitigated to offset unavoidable impacts from construction and operation of a plant. Section 8.5.1.1 discusses intake-related mortality during operation of the plant, and section 8.5.1.2 specifically addresses discharge-related mortality. Mitigation would not be required for a facility operating with a subsurface intake because this form of intake has demonstrated elimination of marine life mortality.

12.1.10 Land Use and Planning

Desalination projects in general can have significant impacts to land use and planning if a project were to:

- Physically divide an established community
- Conflict with any applicable land use plan, policy, or regulation of an agency with jurisdiction over the project (including, but not limited to the general plan, specific plan, local coastal program, or zoning ordinance) adopted for the purpose of avoiding or mitigating an environmental effect
- Conflict with any applicable habitat conservation plan or natural community conservation plan

The California Coastal Act of 1976 provides broad authority to the CCC to protect terrestrial and marine habitat and regulate development within the Coastal Zone. Land use planning functions are also carried out by local jurisdictions in accordance with general plans (Gov. Code § 65300 et seq.) and state zoning law (Gov. Code § 65800 et seq.).

Results of Previous Environmental Impact Analyses

Construction of the Carlsbad facility could temporarily impact land use associated with airport operations. (City of Carlsbad 2006) Impacts to this land use activity would be mitigated to less than significant by coordination and approval by the Airport Operations Manager prior to construction within Flight Activity Zones and Runway Protection Zone. Construction and operation of the Huntington Beach facility was determined to have no significant impacts to land use and planning because the facility would be located in an area already zoned as industrial and currently occupied by a power plant. (City of Huntington Beach 2010) The Marin Municipal Water District proposed a tank site within a land use designation of Open Space. (Marin Municipal Water District 2008) As mitigation, the City proposed to trade at a minimum mitigation ratio of 1:1 land to offset the loss with a preference for land contiguous to other existing open space. This impact was identified as less than significant with mitigation. (Marin Municipal Water District 2008)

The Santa Cruz facility was determined to conflict with local agency plans. (City of Santa Cruz and Soquel Creek Water District 2013) This determination is based on the partial conflict with City policies related to protection of sensitive habitat for the monarch butterfly as discussed in section 12.1.4. Approval of a Coastal Development Permit is dependent upon the Coastal Commission’s evaluation of the project’s consistency with these provisions of the Coastal Act. The Coastal Act require that marine resources be maintained, enhanced and, where feasible, restored, and that uses of the marine environment shall be carried out in a manner that will sustain the biological productivity of coastal waters and maintain healthy populations of all species of marine organisms. These impacts to land use and planning may be significant and unavoidable. (City of Santa Cruz and Soquel Creek Water District 2013)

Impact Analysis

Impacts to land use and planning are more likely to occur where the facility intake outfall and associated pipelines are not confined to a single site, are constructed within sensitive habitats or conflict with the requirements of the Coastal Act. Although the analysis described above results in few significant and unavoidable impacts, it is unlikely that all future facilities would not conflict with land use plans or policies or conflict with the Coastal Zone Act. Therefore, it is possible that significant impacts to land uses may occur with implementation of a particular desalination facility, triggering the need to impose mitigation measures. It is possible that some of these impacts could be significant and unavoidable.

12.1.11 Mineral Resources

Desalination projects in general can cause significant impacts to mineral resources if a project were to result in the loss of availability of:

- a known mineral resource that would be of value to the region and the residents of the state, or
- a locally-important mineral resource recovery site delineated on a local general plan, specific plan or other land use plan

The California coastal environment is rich in mineral resources, including sand and gravel mining for construction materials, mining for industrial materials (diatomite, clay, quartz, and dimension stone) and metallic minerals (chromite, placer gold, manganese, mercury, platinum, and silver) in addition to fossil fuel deposits(oil and natural gas). The Surface Mining and Reclamation Act of 1975 establishes policies for conservation and development of mineral lands, The Act contains specific provisions for the classification of mineral lands by the State Mining and Geology Board and requires local planning agencies to incorporate the designated mineral resource zones into their general plans to ensure adequate protection for future needs. The designated mineral resource zones (MRZ) are defined below.

- MRZ1 : areas where adequate information indicates that no significant mineral deposits are present or where it is judged that little likelihood exists for their presence;
- MRZ 2: areas where adequate information indicates that significant mineral deposits are present or where it is judged that a high likelihood for their presence exists;
- MRZ 3: areas containing mineral deposits, the significance of which cannot be evaluated from available data;
- MRZ 4: areas where available information is inadequate for assignment to any other MRZ.

Though thresholds of significance vary among local planning agencies, development occurring with an area designated MRZ2 is frequently considered a significant impact. County resources consulted include the following:

- San Diego County General Plan, August 3, 2011 - http://www.sdcounty.ca.gov/pds/generalplan.html
- County of Orange General Plan updated March 22, 2011 http://ocplanning.net/planning/generalplan2005
- Revised Draft October 2013 Los Angeles County Draft General Plan 2035 – http://planning.lacounty.gov/generalplan/draft2013
- Ventura County General Plan RESOURCES APPENDIX – 06-28-11 Edition - http://www.ventura.org/rma/planning/pdf/plans/General-Plan-Resources-Appendix-6-28-11.pdf
- Santa Barbara Comprehensive Plan Environmental Resource Management Element Adopted 1980, republished May 2009 – http://sbcountyplanning.org/PDF/maps/COMP%20Plan%20Maps/Environmental%20Resource%20Management%20Element%20(ERME)/ERME2_Southcoast.pdf
- California Department of Conservation Division of Mines and Geology 1989. Mineral Land Classification Portland Cement Concrete Aggregate and Active Mines of all other Mineral Commodities in the San Luis Obispo- Santa Barbara Production Consumption Region, Special Report 162. https://archive.org/stream/minerallandclass162dupr#page/n54/mode/1up
- Sonoma County Permit and Resource Management Department - http://www.sonoma-county.org/prmd/activemap/index.htm.

Land designated as MRZ2 by the California Geological Survey or land actively mined represented a very small fraction of undeveloped coastal land from the Oregon border to the international border at San Ysidro. Only within select areas of San Diego and San Luis Obispo counties is mining actively occurring. Mining aggregate from river beds and channels is the main resource extracted.

Results of Previous Environmental Impact Analyses
No impacts to mineral resources were identified by the City of Carlsbad (2006), the City of Huntington Beach (2010), Marin Municipal Water District (2008) or the City of Santa Cruz and Soquel Creek Water District (2013).

Impact Analysis
Desalination facilities are typically proposed to provide an alternative source of water for existing communities where mining of mineral resources is not a predominant or economically important land use. Further, few areas exist where mineral resources could be lost by construction of such a facility on land mapped as MRZ2. Therefore, it is unlikely that significant impacts to mineral resources would occur with implementation of a particular desalination facility.

12.1.12 Noise

Desalination projects in general can cause significant noise impacts if a project were to result in:

- Exposure of persons to or generation of noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies
- Exposure of persons to or generation of excessive groundborne vibration or groundborne noise levels
- A substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project
- A substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project
- For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, the project would expose people residing or working in the project area to excessive noise levels
- For a project within the vicinity of a private airstrip, the project would expose people residing or working in the project area to excessive noise levels

The California Health and Safety Code section 46022 defines noise as “excessive undesirable sound, including that produced by persons, pets and livestock, industrial equipment, construction, motor vehicles, boats, aircraft, home appliances, electric motors, combustion engines, and any other noise producing objects.” Significant impacts would occur if exposure to noise levels exceeded local standards, result in the generation of excessive groundborne vibration or groundborne noise levels or significantly increase ambient noise levels in the project vicinity above existing levels. Though guidelines and thresholds have been developed by EPA and California Department of Health Services (CDHS), noise levels with few exceptions are regulated at the local level (counties, cities) through ordinances and land use planning and zoning laws.

Table 12-19 Levels of environmental noise requisite to protect public health (U.S. EPA, 1974)

Effect	Level	Area
Hearing Loss	$L_{eq(24)} \leq 70$dB	All areas
Outdoor activity interference and annoyance	$L_{dn} \leq 55$ *dB*	Outdoors in residential areas and farms and other outdoor areas where people spend widely varying amounts of time and other places in which quiet is a basis for use
Outdoor activity interference and annoyance	$L_{eq(24)} \leq 55$ dB	*Outdoor areas where people spend limited amounts of time, such as school yards, playgrounds, etc.*
Indoor activity interference and annoyance	$L_{dn} \leq 45$ *dB*	Indoor residential areas
Indoor activity interference and annoyance	$L_{eq(24)} \leq 45$ *dB*	Other indoor areas with human activities such as schools, etc.

$L_{eq(24)}$ *represents the sound energy averaged over a 24-hour period while*
L_{dn} *represents the* L_{eq} *with a 10 dB nighttime weighting.*
The hearing loss level identified here represents annual averages of the daily level over a period of forty years.

Table 12-20 California Department of Health Services Office of Noise Control Guidelines

Land Use	Normally Acceptable	Conditionally Acceptable	Normally Unacceptable	Clearly Unacceptable
Single Family, Duplex, Mobile Homes	50 - 60	55 - 70	70 - 75	> 70
Multi-Family Homes	50 - 65	60 - 70	70 - 75	> 70
Schools, Libraries, Churches, Hospitals, Nursing Homes	50 - 70	60 - 70	70 - 80	>80
Transient Lodging - Motels, Hotels	50 - 65	60 - 70	70 - 80	>80
Auditoriums, Concert Halls, Amphitheaters		50-70		>65
Sports Arena, Outdoor Spectator Sports		50-75		>70
Playgrounds, Neighborhood Parks	50-70		67-75	>72
Golf Courses, Riding Stables, Water Recreation, Cemeteries	50-75		70-80	>80

Land Use	Normally Acceptable	Conditionally Acceptable	Normally Unacceptable	Clearly Unacceptable
Office Buildings, Business and Professional Commercial	50-70	67-77	>75	
Industrial, Manufacturing, Utilities, Agriculture	50-75	70-80	>75	

Category Definitions

Normally Acceptable: Specified land use is satisfactory, based upon the assumption that any buildings involved are of normal conventional construction without any special noise insulation requirements.

Conditionally Acceptable: New construction or development should be undertaken only after a detailed analysis of the noise reduction requirements is made and needed noise insulation features included in the design. Conventional construction, but with closed windows and fresh air supply systems or air conditioning will normally suffice.

Normally Unacceptable: New construction or development should generally be discouraged. If new construction or development does proceed, a detailed analysis of the noise reduction requirements must be made and needed noise insulation features included in the design.

Clearly Unacceptable: New construction or development should generally not be undertaken

Guidelines such as these are used by local agencies for land use planning and provide the basis for local noise thresholds. Frequently, local agencies include additional criteria to address specific activities, duration, and specific periods and days of the week when certain noise generating activities are permitted.

Results of Previous Environmental Impact Analyses

Construction and operation of the Carlsbad desalination facility was determined by the City of Carlsbad to have no potential impact on noise levels or vibration. (City of Carlsbad 2006) Construction of the three remaining facilities was determined to have a less than significant impact on noise and vibration with mitigation. The Marin facility would temporarily increase ambient noise levels during the construction period. This impact is considered significant and unavoidable. (Marin Municipal Water District 2008) Mitigation used to reduce these impacts includes limiting construction work to week day hours from 8:00 a.m. to 5:00 p.m. except in those areas were nighttime construction is necessary to minimize congestion. Other mitigation measures include equipping all internal combustion engines with intake and exhaust mufflers recommended by manufacturers, locating stationary noise-generating construction equipment far from noise-sensitive receptors, pre-drill foundation to reduce pile driving impacts, notify residents and workers within 500 feet of pile driving activities of construction schedule, and designating a noise disturbance coordinator responsible for responding to complaints about construction noise, with authority to implement additional noise reduction practices in response to complaints. (Marin Municipal Water District 2008) Both the Huntington Beach and Santa Cruz facility require similar mitigation measures to reduce construction related noise and vibration impacts to less than significant.

Operation of the Huntington Beach facility could cause impacts related to noise that could be potentially significant. (City of Huntington Beach 2010) To mitigate these potential impacts to less than significant, the applicant will be required to perform an acoustical analysis of the facility that identifies the sources of noise and associated magnitude and mitigation measures including double walls, acoustic barriers, and baffles for inclusion in the final design. Stationary sources must meet the City of Huntington Beach industrial noise standard at the property line. Operation of the Santa Cruz facility was also determined to have significant noise related impacts that could be mitigated to less than significant using an approach similar to that incorporated in the Huntington Beach facility. (City of Santa Cruz and Soquel Creek Water District 2013) Mitigation measures include sound-insulating building structures, noise control enclosures, and acoustical barriers such as solid equipment screen walls. An acoustical analysis is required to ensure all operations will meet maximum sound levels of 6 dBA above local ambient for noise at the plant site; and 5 dBA above the local ambient for noise sources at the pumping station, if in a residential area. (City of Santa Cruz and Soquel Creek Water District 2013)

Impact Analysis

Construction of desalination facilities will require heavy construction equipment and other activities that can generate noise levels exceeding local noise thresholds. Such impacts would be of temporary duration. Impacts from noise and vibration associated with the construction and operation of desalination facilities were similar between facilities and could be mitigated with appropriate design features such as proper scheduling proper notification and sound attenuating facility design. It is likely that other desalination facilities would have similar noise impacts and required mitigation would also be similar.

12.1.13 Population and Housing

Desalination projects in general can cause significant impacts to population, growth, and need for more housing if a project were to result in:

- Induce substantial population growth in an area, either directly (for example, by proposing new homes and businesses) or indirectly (for example, through extension of roads or other infrastructure)
- Displace substantial numbers of existing housing, necessitating the construction of replacement housing elsewhere
- Displace substantial numbers of people, necessitating the construction of replacement housing elsewhere

Results of Previous Environmental Impact Analyses

Construction and operation of the Carlsbad desalination facility, Huntington Beach facility and the Santa Cruz facility were all determined to have no potential impact on population and housing. (City of Carlsbad 2006; City of Huntington Beach 2010; City of Santa Cruz and Soquel Creek Water District 2013) Construction and operation of the Marin desalination facility would not directly induce substantial population growth in the area. However, the Desalination Amendment would remove an obstacle to growth. Therefore the Desalination Amendment would indirectly contribute to growth in the service area. (Marin Municipal Water District 2008)

Impact Analysis

The construction and operation of desalination facilities are unlikely to result in the displacement of housing or people. Desalination facilities are typically constructed to provide an alternative source of water for existing communities as replacement for existing but dwindling sources such as local surface and groundwater sources. Thus location of these facilities is unlikely to directly result in substantial population growth however; the existence of a reliable water supply could induce more people to reside in the area where a reliable water supply is available. In addition future desalination facilities may be constructed for the sole benefit of new development. As a result, the construction and operation of desalination facilities may induce growth and housing either directly or indirectly.

12.1.14 Public Services

Desalination projects in general can cause significant impacts to public services if a project were to cause or result in: substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities, need for new or physically altered governmental facilities, the construction of which could cause significant environmental impacts, in order to maintain acceptable service ratios, response times or other performance objectives for any of the public services:

- Fire protection
- Police protection
- Schools
- Parks
- Other public facilities

Results of Previous Environmental Impact Analyses

The City of Carlsbad did not identify any potentially significant impacts associated with Public Services. (City of Carlsbad 2006) No significant impacts to services were identified for the Huntington Beach facility. However the City of Huntington Beach identified service fees that must be paid, including (City of Huntington Beach 2010):

- Applicable School Mitigation fees
- Traffic Impact fees
- Wastewater Connection fee
- Encroachment permit fees
- Water Service Connection fees

In addition the applicant must comply with the City's waste reduction and recycling program and prepare a waste reduction plan for construction and operation as a condition of the grading permit. (City of Huntington Beach 2010) The Marin Municipal Water District did not identify any significant impacts to Public Services associated with the construction or the operation of the Marin Desalination facility. However, impacts were identified associated with traffic and transportation (See section12.1.16) and Utilities and Service Systems described in section 12.1.17. (Marin Municipal Water District 2008)

Impact Analysis
The impact on communities affected by the construction and operation of future desalination facilities is unknown. Although previous environmental analysis of potential impacts did not identify significant impacts, the potential to induce growth as described in section 12.1.13 (above) in the affected water supply service area could potentially result in the need for additional public services. Therefore, it is possible that significant impacts from the need for public services may occur with implementation of a particular desalination facility, triggering the need to impose mitigation measures. It is possible that some of these impacts could be significant and unavoidable.

12.1.15 Recreation

Desalination projects in general can cause significant impacts to recreation if a project were to result in:

- Increase the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facility would occur or be accelerated?
- Include recreational facilities or require the construction or expansion of recreational facilities which might have an adverse physical effect on the environment?

Results of Previous Environmental Impact Analyses
Construction and operation of the Carlsbad, Huntington Beach and Santa Cruz desalination facilities were not expected to result in potential impacts to recreation. (City of Carlsbad 2006; City of Huntington Beach, 2010; City of Santa Cruz and Soquel Creek Water District 2013)

As described in section 12.1.10, construction of the Marin facility would result in the loss of approximately 2 acres of open space land due to construction of a water storage tank (Marin Municipal Water District 2008). As mitigation the City proposed to trade at a minimum mitigation ratio of 1:1 land to offset the loss with a preference for land contiguous to other existing open space. This impact was identified as less than significant with mitigation.

Impact Analysis
As discussed in sections 12.1.13 and 12.1.14, the potential increase in growth could result in the use of and need for parks and recreational facilities. Therefore, it is possible that significant impacts from the need for recreation facilities may occur with implementation of a particular desalination facility, triggering the need to impose mitigation measures. It is possible that some of these impacts could be significant and unavoidable.

12.1.16 Transportation and Traffic

Desalination projects in general can have a significant impact on transportation and traffic if a project were to:

- Conflict with an applicable plan, ordinance or policy establishing measures of effectiveness for the performance of the circulation system, taking into account all modes of transportation including mass transit and non-motorized travel and relevant components of the circulation system, including, but not limited to intersections, streets, highways and freeways, pedestrian and bicycle paths, and mass transit
- Conflict with an applicable congestion management program, including, but not limited to level of service standards and travel demand measures, or other standards established by the county congestion management agency for designated roads or highways
- Result in a change in air traffic patterns, including either an increase in traffic levels or a change in location that results in substantial safety risks
- Substantially increase hazards due to a design feature (e.g., sharp curves or dangerous intersections) or incompatible uses (e.g., farm equipment)
- Result in inadequate emergency access
- Conflict with adopted policies, plans, or programs regarding public transit, bicycle, or pedestrian facilities, or otherwise decrease the performance or safety of such facilities

Results of Previous Environmental Impact Analyses

The Carlsbad facility was found to impact traffic during construction. (City of Carlsbad 2006) These impacts would be mitigated through preparation and implementation of a detailed traffic plan that includes:

- Signage, striping, flagging operations to ensure safe passage of motorists and pedestrians through construction zones,
- Process to regularly coordinate construction schedules and locations with local emergency service providers
- Alternate traffic routes published in a local newspaper

The City of Huntington Beach also identified impacts to traffic associated with construction on or within roadways as a potential impact (City of Huntington Beach 2010) and required mitigation similar to Carlsbad by requiring the development and implementation of an approved Traffic Management Plan. During construction of the Marin facilities, work in road ways would conflict with applicable adopted policies, plans, or programs supporting alternative transportation. (Marin Municipal Water District 2008) Mitigation would consist of communication and coordination with public transit agencies to avoid disruption of operations and identification of alternative stops that would not be affected by pipeline work in roadways. These impacts were determined to be less than significant with mitigation. (Marin Municipal Water District 2008) The Santa Cruz facility would not have significant impacts on transportation or traffic. (City of Santa Cruz and Soquel Creek Water District 2013)

Impact Analysis

Transportation and traffic may be impacted during construction of desalination facilities. Movement and transport of equipment onto the site and work on pipeline alignments in roadways or right-of-ways may create significant delays that may not be avoidable. Many coastal communities are densely populated and rely on a few highways such as Pacific Coast Highway to connect coastal towns and cities. As these roads are already highly affected by traffic during much of the year any disruption even short term can cause significant disruption and delays. Therefore, it is possible that significant transportation and traffic impacts may occur with implementation of a particular desalination facility, triggering the need to impose mitigation measures. It is possible that some of these impacts could be significant and unavoidable.

12.1.17 Utilities and Service Systems

Desalination projects in general can cause significant impacts to utilities and service systems if a project were to:

- Exceed wastewater treatment requirements of the applicable Regional Water Quality Control Board
- Require or result in the construction of new water or wastewater treatment facilities or expansion of existing facilities, the construction of which could cause significant environmental effects
- Require or result in the construction of new storm water drainage facilities or expansion of existing facilities, the construction of which could cause significant environmental effects
- Have sufficient water supplies available to serve the project from existing entitlements and resources, or are new or expanded entitlements needed
- Result in a determination by the wastewater treatment provider which serves or may serve the project that it has adequate capacity to serve the project’s projected demand in addition to the provider’s existing commitments
- Be served by a landfill with sufficient permitted capacity to accommodate the project’s solid waste disposal needs
- Comply with federal, state, and local statutes and regulations related to solid waste

Results of Previous Environmental Impact Analyses

During construction of the Huntington Beach facility, excavation and installation of pipelines in roadways may encounter underground utilities and service systems. (Huntington Beach 2010) Prior to excavation and trenching geophysical surveys will be performed to delineate the trace of buried utilities. This information will be incorporated into final plans. Where necessary, buried utilities would be moved, capped and or removed as necessary for installation of the pipeline under the direction of the City of Huntington Beach Department of Public Works. This impact was determined to be less than significant after mitigation. (Huntington Beach 2010) The Marin Municipal Water district did not identify any impacts associated with utilities or service systems. An option considered for the Santa Cruz facility is the discharge of solids to the WWTP. To ensure that the wastewater treatment system is not disrupted, the City and wastewater district will establish design criteria for percent solids to control solids deposition in the wastewater collection system and establish monitoring program to ensure that solids do not collect in the system or create an upset within the WWTP. The design criteria and monitoring and maintenance procedures will be developed in conjunction with City Public Works Department. This potential impact is considered less than significant with mitigation.

Impact Analysis
Although the analysis described above results in few significant impacts to utilities and service systems, it is unlikely that all future facilities would result in similar impacts for the following reasons. Design of the treatment systems' components may place additional loads on wastewater treatments systems for residual solids and membrane cleaning chemicals that could exceed the capacity of the plant or cause a disruption of the treatment effectiveness. In addition, the new source of water could result in an increase in usage that could result in an increase in wastewater. Added hardscape and impermeable pavement can cause additional burden on storm water treatment systems and conveyance systems. Solids generated from desalination facilities require that landfills have available space to accommodate waste. Therefore, it is possible that significant impacts to utilities and public service systems may occur with implementation of a particular desalination facility, triggering the need to impose mitigation measures. It is possible that some of these impacts could be significant and unavoidable.

12.1.18 Cumulative Impacts

Although the possibility of significant and unavoidable impacts may occur to several resource topic areas, cumulative impacts at a regional scale are most likely to be significant for biological resources, water quality, air quality, greenhouse gas emissions, population and housing and transportation. As described in 12.1.4 and 12.1.9 it is likely that significant impacts to biological resources and water quality may occur with implementation of a particular desalination facility, therefore it triggers the need to impose mitigation measures. As described in section 12.1.7, individual facilities can mitigate impacts associated with greenhouse gas emissions through the purchase of carbon offsets to achieve carbon neutral operations. As described in section 12.1.13, the increased availability of water could result in increased growth within the facility service area This increased availability of water would have a cumulative impact on population, housing, traffic, transportation and services. Therefore, it is possible that significant cumulative impacts may occur with implementation of a particular desalination facility, triggering the need to impose mitigation measures. It is possible that some of these impacts could be significant and unavoidable.

12.2 Projects Alternatives Considered

The preceding section provided an analysis of the types of impacts that might result from the construction and operation of a particular desalination facility. That information was presented for purposes of full disclosure in order to fully inform the decision-maker of the potential impacts of desalination projects in general. However, as noted at the beginning of section 12, the State Water Board's Desalination Amendment does not approve, authorize, or otherwise support through public agency contracts, grants, subsidies, loans, or other forms of assistance any specific desalination project and the impacts described in section 12.1 are not directly or indirectly created by the State Water Board's action but serve as the environmental baseline for the impact analysis of the proposed amendment. Potential impacts that could be caused by the Desalination Amendment are discussed in section 12.4.

This section describes project alternatives considered in the analysis and the reasonably foreseeable methods of compliance associated with each alternative, as required under the State Water Board's CEQA Regulations (California Code of Regulations, tit. 23, section 3777, subdivision (b)(3)). The Desalination Amendment includes several options for seawater intake and brine discharge. Which option a desalination facility may choose to comply with will depend on a number of site specific factors that cannot be divined by the State Water Board at this step in the environmental review process. For this analysis, the Desalination Amendment as presented in Appendix A, represents Alternative 2 discussed below. The exact extent and nature of these impacts will depend on the actual mix of compliance options chosen by the particular desalination facility. As a result, the analysis in Section 12 is necessarily less detailed and more qualitative. This is appropriate for a programmatic level CEQA analysis where site, design, technology, and mitigation are not known..

Alternative 1 would consist of an amendment to the Ocean Plan that includes the same four basic project elements as the Desalination Amendment (see section 4.2), but would more explicitly direct the regional water boards in how to interpret the requirements of Porter Cologne section 13142.5(b). Specifically, this alternative would require that new and expanded desalination facilities draw seawater through subsurface intakes and discharge brine through either commingling effluent, or through multiport diffusers capable of achieving a receiving water limit of no more than 2 ppt above background salinity following completion of initial dilution. Expanded facilities would be required to upgrade to subsurface intakes upon renewal of the facility's NPDES permit or as conditioned under their current permit. Existing desalination facilities would not be required to upgrade to subsurface intakes until such time as they expanded operations, though they would be required upon renewal of the facilities NPDES permit to upgrade discharge technology as necessary to meet receiving water limits.

Other elements of Alternative 1 would be equivalent to the Desalination Amendment. Specifically, Alternative 1 would direct the Regional boards to require an analysis of subsurface conditions, marine aquatic resources, and receiving water quality to ensure the use of the best available site, design, technology, and mitigation measures. The specific studies required by Alternative 1 would be somewhat different from the Desalination Amendment, as very few to none analyses would be required to evaluate intake related mortality. However, dischargers would still need to evaluate the geology and hydrogeology for the purpose of providing a reliable and consistent water supply for the desalination facility and to design an intake system that would be most effective (e.g. vertical well, slant well, or infiltration gallery).

Alternative 1 would prohibit the discharge of brine through a diffuser in MPAs, SWQPAs, areas of high biological productivity, or in areas where there are sensitive habitats and organisms, including threatened and endangered species. Alternative 1 would also require studies to establish a biological baseline for comparison with conditions after operation commences. Finally, Alternative 1 would require desalination facilities to fully mitigate for all marine life mortality associated with construction and operational activities. The mitigation requirements would be the same as the Desalination Amendment and are discussed in detail in Section 8.5.

Alternative 1 would result in construction of facilities that are similar to, but potentially of greater complexity than would occur in absence of the amendment. Construction activities would include drilling, excavating, installing subsurface intakes, tunneling or trenching a pipeline, and constructing a diffuser at the point of discharge. These activities would require land and sea-based heavy equipment in order to complete construction. During facility operation, monitoring would be required of the effluent and receiving water to ensure the receiving water limit is met and that marine aquatic resources are not affected. Periodic maintenance of the subsurface intake and diffuser outfall would be necessary to ensure optimal performance and efficiency. Maintenance could consist of surging or jetting with compressed air or water to remove fines from well screens and chemical treatment to remove scale buildup.

This alternative is considered feasible and would result in the least intake and discharge related aquatic life mortality. However, this alternative would not meet all project goals described in section 4.3. Specifically, as noted in section 8.4, restricting desalination facilities to locations where subsurface intakes are feasible would restrict available site alternatives, which could lead to a facility that is overall less protective of marine life because it could preclude a project proponent from considering the totality of site, design, technology or mitigation alternatives. As a result, Alternative 1 would not meet the project goals of protecting water quality and related beneficial uses of ocean waters, and providing desalination as an alternative to traditional water supplies.

Alternative 2 (Proposed Project) would consist of an amendment to the Ocean Plan that would allow greater flexibility in intake and discharge methods than identified in Alternative 1. Facilities could use subsurface intakes, surface intakes screened and operated at low intake velocities, or intakes using an alternative method to prevent entrainment so long as the alternative method provides equivalent protection as provided by a screened, low flow intake. With regards to brine discharge, this alternative would allow dilution through co-mingling with another waste stream, discharge through a diffuser capable of achieving a receiving water limit of no more than 2 ppt above background salinity following completion of initial dilution, or an alternative disposal technology where it can be demonstrated that the technology provides a comparable level of protection.

Under this alternative, a project proponent could choose to construct and operate a facility equivalent to Alternative 1, in which case the project would also have equivalent impacts as Alternative 1. It is possible that the project proponent could also choose new intake methods and discharge technologies that have yet to be identified or developed and are therefore not reasonably foreseeable. Any attempt to evaluate the impacts of these alternatives and technologies would be speculative. However, once identified, these alternative methods and technologies will be reviewed as part of the project specific CEQA efforts, and, in the case of intakes, as part of the regional water boards' 13142.5(b) determination. As a result, evaluation of impacts associated with Alternative 2 will focus on facilities using surface intakes screened and operated at low intake velocities, and waste discharge using either commingled effluent, or through a diffuser capable of achieving a receiving water limit of no more than 2 ppt above background salinity following completion of initial dilution. Under Alternative 2, screens intakes would require a slot opening sizes that could be as small as 0.5 or as large as 1 millimeter depending on the final State Water Board decision.

Alternative 2 would prohibit the discharge of brine through a diffuser in MPAs, SWQPAs, areas of high biological productivity, or in areas where there are sensitive habitats and organisms, including threatened and endangered species. Alternative 2 would also require studies to establish a biological baseline for comparison with conditions after operation commences. Finally, Alternative 2 would require desalination facilities to fully mitigate for all marine life mortality associated with construction and operational activities. The mitigation requirements would be the same as the Desalination Amendment and are discussed in detail in Section 8.5.

As with Alternative 1, Alternative 2 would result in construction of facilities that are similar to, but potentially of greater complexity than would occur in absence of the alternative. Onshore and offshore construction would be necessary to install the surface water intake and outfall diffuser or other intake method or discharge technology chosen. During facility operation, monitoring would be required of the effluent and receiving water to ensure the receiving water limit is met and that marine aquatic resources are not adversely affected. Periodic inspections and maintenance of the surface intake screens, pipelines, and diffuser outfall would be necessary to prevent fouling and ensure optimal performance and efficiency. These activities would necessitate the need for support vessels and divers to survey and maintain both the intake screens and the outfall diffuser. This alternative is considered feasible and meets all project goals described in section 4.3.

Alternative 3 would consist of an amendment to the Ocean Plan that would provide sufficient flexibility in how regional water boards could interpret Porter Cologne section 13142.5(b) to allow for an open, uncontrolled intake and a simple large diameter outfall or channel. Regional water boards would still be required to consider the best use of site, design, technology and mitigation, and this alternative would require the same types of studies to determine most suitable site location, define baseline biological conditions, and identify mitigation requirements.

Construction activities would take place for both intake and discharge, although the extent and duration of construction would be limited in comparison to other alternatives as the intake and outfall would be significantly less structurally complex. During facility operation, monitoring would be required of the effluent and receiving water to ensure the receiving water limit is met and that marine aquatic resources are not adversely affected. Under this alternative, periodic maintenance of the surface intake, pipelines, and diffuser outfall would be necessary to prevent fouling and ensure optimal performance and efficiency. Offshore maintenance would necessitate the need for support vessels and divers to survey and maintain the intake and outfall. This alternative is feasible and could result in fewer construction related impacts (see 12.4 below), but due to operational impacts (see 8.3 and 12.4), this alternative does not meet the project goals of minimizing intake and mortality of all forms of marine life, and protecting water quality and related beneficial uses of ocean waters.

Alternative 4 would consist of an amendment to the Ocean Plan that would be identical to Alternative 2 except in regards to the formation of the receiving water limit. It would require the same type of intake and discharge controls as Alternative 2 (Desalination Amendment) except that at discharge, the diffuser would need to be capable of achieving a receiving water limit of no greater than 5 percent above natural background salinity upon completion of initial dilution. Other project elements, such as the siting studies and mitigation requirements (e.g. fully mitigate for all marine life mortality associated with the desalination facility) would be equivalent to Alternative 2.

While this alternative is considered feasible, it does not meet the first project goal because it would not provide a consistent statewide approach to protecting water quality. In most locations, a 5 percent salinity range is roughly equivalent to 2 ppt. However, under Alternative 4, the actual receiving water limit would vary among facilities based on a facility's natural background salinity. When natural background salinity is higher, the receiving water limit for salinity would allow a greater salinity range than when natural background salinity is lower. For example if natural background salinity is 36 ppt a 5 percent receiving water limit would limit salinity to 1.8 ppt above natural background salinity, whereas if natural background salinity is 32 ppt a facility would be held to a limit 1.6 ppt above natural background salinity. In areas where natural background salinity exceeds 40 ppt, a 5 percent receiving water limit may not be adequately protective of marine life and the regional water board would need to identify a site specific receiving water limit of something less than 5%. In addition, it would not meet the goal to support desalination as it could result in an overly restrictive receiving water limit in areas with naturally low salinity.

Alternative 5 represents the "no project alternative." Under this alternative there would be no Desalination Amendment of the Ocean Plan to specifically address intakes and outfalls associated with desalination facilities. This alternative would require the regional water boards to continue preparing permits and certifications on a case by case basis for desalination facilities that withdraw from and discharge into ocean waters without the benefit of a uniform statewide approach for controlling potentially adverse impacts of seawater intakes and brine discharges. Under this alternative the regional water boards could, based on the data and information presented, adopt appropriate findings and require a permittee to take an action consistent with either of the alternatives described above, some variation of each or combination of alternatives. Although feasible, this alternative does not meet project goal No. 1 described in section 4.3.

12.3 Alternatives Considered But Not Analyzed

Several other alternatives were identified during the environmental review process but not considered reasonably foreseeable or within the authority of this proposed rule-making action, or do not meet the goals of the project as described in section 4.3. The alternatives considered but not analyzed in detail in this document are described below.

Prohibition of discharge of desalination brine into ocean waters. Porter Cologne section 13243 provides that a "regional board, in a water quality control plan or in waste discharge requirements, may specify certain conditions or areas where the discharge of waste, or certain types of waste, will not be permitted." As such, the State Water Board could choose to prohibit discharges of desalination brine to the ocean. However, desalination represents a potentially reliable alternative for many coastal communities faced with dwindling surface and groundwater supplies. The State Water Board is attempting in the Desalination Amendment to support desalination as an available alternative while ensuring water quality and marine life are not sacrificed as a result. Activities that could affect California's waters "shall be regulated to attain the highest water quality which is reasonable, considering all demands being made and to be made on those waters and the total values involved, beneficial and detrimental, economic and social, tangible and intangible" (§13000). Therefore, because this alternative does not meet any of the goals presented in section 4.3, it was eliminated from detailed analysis.

Allow for desalination of ocean waters only after all water conservation strategies have been implemented. This concept would authorize surface water intakes only after strict water conservation efforts have been fully implemented and realized. Full implementation would require maximum re-use and recycling of all wastewater, and implementing strict conservation practices for all municipal domestic, agricultural and industrial users of fresh or potable water supplies. This alternative was not considered for further analysis because this alternative would require regulatory actions that are beyond the State Water Board authority and jurisdiction.

12.4 Analysis of Project Alternatives

As discussed at the beginning of section 12, section 12.4 analyzes the reasonably foreseeable environmental impacts associated with the State Water Board's Desalination Amendment and project alternatives including reasonably foreseeable methods of compliance. The Desalination Amendment only addresses specific aspects of the design, construction and operation of desalination facilities, and does not approve, authorize, or otherwise support through public agency contracts, grants, subsidies, loans, or other forms of assistance any specific desalination project as a whole. As a result, the scope of the environmental analysis and types of potential impacts are limited to only those directly or indirectly created by the State Water Board's action, as compared to a particular desalination facility and many of the impacts described in section 12.1 will not be directly or indirectly created by the State Water Board's action. In addition, while the analyses in section 12.1 are quantitative and detailed, the analyses in Section 12.4 are necessarily less detailed and more qualitative. This is appropriate for a programmatic level CEQA analysis where site, design, technology, and mitigation are not known. Since the project alternatives only describe activities related to the coastal and nearshore intakes and outfalls, only those issues potentially affected are included in this analysis of project alternatives. The State Water Board used the Environmental Checklist required by its CEQA Regulations (Cal. Code Regs., Tit. 23, §3777; Appendix A) to identify which impacts required specific evaluation (see Appendix B of this document). The issues evaluated consist of the following:

- Aesthetics
- Air Quality
- Biological Resources
- Greenhouse Gas Emissions
- Hydrology and Water Quality

12.4.1 Aesthetics

Alternative 1 would not in itself directly cause or result in aesthetic impacts. Indirectly, however, implementation of the alternative would require a permittee of a new or expanded desalination facility to construct and operate subsurface intake structures and outfalls capable of achieving the necessary dilution to meet the receiving water limit. Permanent infrastructure would consist of pumps, power supply and piping necessary to move water from source to plant and move waste (brines) from plant to outfall. The number, size and location of structures could differ from facility to facility based on the amount of seawater intake and the design of the subsurface intakes. However, it is reasonable to assume that power supply and piping would be located below ground where any impact to aesthetics would be limited to temporary construction impacts. Pumping stations could be either above ground, or below ground in vaults. Any remaining infrastructure would likely be located within the footprint of the desalination facility and have no aesthetic impact apart from that already discussed in section 12.1.1.

The impact of pump stations on aesthetics would depend on the type and size of the subsurface intake structure. Pumping stations could be located in a central structure (as with a Ranney Collector) or be distributed along the coastline. Likewise, the number of pump stations required would depend on the type of intake structure and the limitation of the surrounding geology. As noted in Section 8.3.2, vertical well intake structures would likely require approximately one well head per one million gallon of production capacity. While the pump station required for a vertical well could be relatively compact, it is reasonably foreseeable that numerous, distributed pump stations would be required for larger facilities. A distributed system of vertical wells may also require construction of access roads to maintain the pumps.

Installation of subsurface intakes would require onshore and offshore construction, excavation and emplacement activities requiring heavy equipment working onshore and or offshore. The State Water Board anticipates the duration of these aesthetic impacts would be short-term (e.g. one to four months) during construction, as the infrastructure would typically be constructed underground, onshore and near shore, and on the ocean floor offshore. Construction equipment including excavators, backhoes, loaders, haul trucks, drill rigs and support vehicles would be necessary for onshore activities. Barge or other vessel mounted dredging and pipe laying equipment would be necessary for seaward activities. In public areas, construction equipment would be secured within fenced secured staging areas when not in use or transported offsite or secured at an appropriate anchorage.

Although it would be speculative to assess site specific aesthetic impacts associated with this alternative, because of the possibility of substantial adverse effects on the scenic vistas within the coast and the possibility of substantially degrading the existing visual character or quality of a desalination project site and its surroundings, the impacts to aesthetic resources is considered potentially significant.

Mitigation for aesthetic impacts from construction activities includes limiting construction to spring, fall, and winter week-days to avoid disrupting recreational, pleasure boating or site-seeing activities associated with the summer tourist season. Permanent aesthetic impacts could be mitigated by requiring when feasible intake structures that allow for centralized pumping stations. Alternatively, local permitting agencies could require pumping station be installed in utility vaults or be sited outside of where public or recreational uses are anticipated or in other in less sensitive areas. Residual impacts from these facilities are not expected to change the visual character of the surrounding area and would be likely mitigated to less than significance through compliance with Coastal Development permit issued by the California Coastal Commission or Local Coastal Program. These permits have mitigation and monitoring requirements as part of their own agency's jurisdiction. While these requirements would likely reduce the impacts to aesthetics to less than significant, these actions are outside of the jurisdiction of the water boards to implement and enforce. Therefore, these impacts may be significant and unavoidable.

Alternative 2 (Proposed Project) would consist of an amendment to the Ocean Plan that allows a greater range of intake methods and discharge technologies than Alternative 1. As with Alternative 1, Alternative 2 would not in itself directly cause or result in aesthetic impacts. Indirectly, implementation of the alternative by a regional water board could require a permittee to construct or modify a subsurface intake or a surface water intake near or offshore, and construct outfalls capable of achieving the necessary dilution. In this case, impacts would be similar to those described under Alternative 1 with minor differences. Under Alternative 2, a project proponent could choose to construct and operate a facility equivalent to Alternative 1, such as a subsurface intake, in which case the project would have equivalent impacts as Alternative 1. However, if the facility operates with a screened surface water intake the required pump stations would be more feasible to co-locate within the footprint of the desalination facility where impacts would be the same as a general desalination facility (see section 12.1.1). As a result, Alternative 2 would be less likely to have a substantial adverse effect on scenic vistas or substantially degrade the character of quality of the site and its surroundings. Nevertheless, Alternative 2 would not require colocation and it is it is reasonably forseeable that some facilities may require separate pumping stations that could have an adverse impact to scenic vistas. In addition, construction impacts also have a significant potential to cause temporary adverse impacts to aesthetic resources. Available Mitigation would be the same as identified in Alternative 1. While this mitigation would likely reduce the impacts to aesthetics to less than significant, these required actions are outside of the jurisdiction of the water boards to implement and enforce. Therefore, these impacts may be significant and unavoidable. However, these impacts are outweighed by the overriding need to minimize intake and mortality of aquatic life, minimize water quality impacts, and ensure that discharges do not impair beneficial uses of waters of the state

Alternative 3 would consist of an amendment to the Ocean Plan that allows for an open uncontrolled intake and a simple large diameter outfall or channel. This alternative relies on the proposed receiving water limit to protect water quality from the effects of salinity on aquatic life in the receiving water. This alternative would create short term impacts associated with construction in the nearshore environment. However, similar to Alternative 1 and 2, much of the infrastructure would be buried underground or laid on the ocean bottom. Exposed infrastructure would also be similar to alternative 1 and 2. Available Mitigation would be the same as identified in Alternative 1. While mitigation would likely reduce the impacts to aesthetics to less than significant, the required actions are outside of the jurisdiction of the water boards to implement and enforce. Therefore, these impacts may be significant and unavoidable

Alternative 4 would consist of an amendment to the Ocean Plan that differs from Alternative 2 only in regards to the receiving water limit of no greater than 5 percent above background salinity upon completion of initial dilution. While this alternative might require increased intake of seawater or reduced production of freshwater in order to meet more restrictive discharge limits, this would not significantly change the type or size of facilities required. As a result, Aesthetic impacts, and potential mitigation would be equivalent to those described under Alternative 2. While mitigation would likely reduce the impacts to aesthetics to less than significant, the required actions are outside of the jurisdiction of the water boards to implement and enforce. Therefore, these impacts may be significant and unavoidable

Alternative 5 represents the "no project alternative." Under this alternative there would be no amendment of the Ocean Plan to specifically address intakes and outfalls associated with desalination facilities. Under this alternative, the regional water boards would take any necessary action to comply with Porter Cologne sections 13142.5(b) and 13260 et seq. For new discharges, a regional water board could require an open surface water intake, a screened surface water intake or a subsurface intake. Similarly, a regional water board could require a single large diameter outfall or a diffuser to rapidly mix the effluent through turbulent mixing. Aesthetic impacts, and potential mitigation would be equivalent to those described under Alternative 1 and 2. While mitigation would likely reduce the impacts to aesthetics to less than significant, the required actions are outside of the jurisdiction of the water boards to implement and enforce. Therefore, these impacts may be significant and unavoidable

12.4.2 Air Quality

Alternative 1 would consist of an amendment to the Ocean Plan that would require a desalination facility to withdraw seawater through a subsurface intake, and discharge waste brine through either a commingled effluent outfall, or through a diffuser capable of achieving a receiving water limit of 2 ppt above background salinity following completion of initial dilution. Under this alternative, adoption of the project alternative as an amendment to the Ocean Plan would not in itself directly cause or result in air quality impacts. Indirectly, implementation of the alternative, by a regional water board through the permitting process would require a permittee to construct subsurface intake structures on shore and construct outfalls capable of achieving the necessary dilution to meet the receiving water limit. Other aspects of the desalination facility, and air emissions associated with the construction and operation of these facilities would be unaffected by Alternative 1. As a result, the reasonably foreseeable air quality impacts are limited to construction and operation of the intake and discharge structures.

Specific activities undertaken by a permittee will depend upon many site and situation-specific factors that cannot be determined at this time but the impacts of Alternative 1 are expected to be similar to those identified in section 12.1.3. Site-specific local weather conditions and topography will also influence the dispersion of pollutants emitted during implementation of Alternative 1. As a result, this discussion provides a qualitative analysis of potential impacts, as a quantitative analysis such as modeling of emissions and associated results would be speculative.

Onshore and offshore construction related to the subsurface intake and either an outfall, or diffuser could include excavation and emplacement activities requiring heavy equipment working onshore and/or offshore. The State Water Board anticipates that the duration of these activities would be short term (e.g one to four months). When building a subsurface intake more landside construction along beaches could occur; however, those emissions could be offset by the eliminating of the offshore component of construction related to the intake. Construction at the facility may require less time and correspondingly result in lower emissions if the subsurface intakes lower the need for multistage pretreatment systems. Construction equipment including excavators, backhoes, loaders, haul trucks, rotary drill rigs and support vehicles may be necessary for Alternative 1 land based construction activities. Barge or other vessel mounted dredging and pipe laying equipment, tug boats and support vessels would be necessary for seaward activities. Once construction of the project has been completed, the on-site activities would be limited to periodic monitoring and inspection. Some maintenance requiring construction or reconditioning would be necessary over the lifetime of an individual project, though the duration and level of effort would be considerably less than the original construction.

Construction related air impacts for Alternative 1 predominantly result from two sources: fugitive dust from surface disturbance activities; and exhaust emissions resulting from the use of construction equipment (including, but not limited to: graders, dozers, back hoes, haul trucks, stationary electricity generators, vessels and construction worker vehicles). One of the pollutants of concern during construction is particulate matter, since PM_{10} is emitted as windblown (fugitive) dust during surface disturbance and as exhaust of diesel fired construction equipment (particularly as $PM_{2.5}$). Other emissions of concern include architectural coating products off - gassing (VOCs) and other sources of mobile source (on - road and off - road) combustion (NO_x, SO_x, CO,PM_{10}, $PM_{2.5}$, and VOCs) associated with construction equipment. In order to evaluate the specific air quality impact of emissions due to dredging, disposal, and capping equipment, or other actions, the project proponent must identify the specific type of equipment that will be used. Emissions from the equipment must be quantified and evaluated in the context of local or regional significance thresholds established by the appropriate Air Quality Management Districts where the project is located. Emissions have the potential to conflict with or obstruct implementation of applicable air quality plans, as well as result in the cumulatively considerable net increase of any criteria pollutant for which the project region is non-attainment under an applicable federal or state ambient air quality standard. Therefore these exceedances of air quality thresholds may be potentially significant.

Alternative 1 should not create significant impacts to air quality associated with the operation of the facility. Any air quality impacts would be largely a function of power generation as described in section 12.1.3. Additional electricity may be required for pumping the intake water and/or pumping effluent through a diffuser at a rate that maximizes turbulent mixing. On average, energy consumption associated with desalination ranges from 12,000-18,000 kWh/mgal for withdrawing seawater into a facility. (Pacific Institute 2013b) Electricity required to pump subsurface water from an estimated depth of 50 meters could require a 5 to 10 percent increase in electricity over open surface intakes. However, unlike a surface water intake, a subsurface intake does not require a pretreatment process. Therefore, 13 percent of the energy requirement for pretreatment is no longer needed, thus offsetting the 5-10 percent increase. (Pacific Institute 2013b) As a result use of subsurface intakes would not substantially change the power generation related to intake of seawater.

All air quality impacts anticipated from the construction of facilities compliant with the requirements of Alternative 1 could be mitigated to less than significant by incorporating the following practices into individual projects.

- To minimize emissions from all internal combustion engines
    - Where feasible, use equipment powered by sources that have lowest emissions, or powered by electricity
    - Utilize equipment with smallest engine size capable of completing project goals to reduce overall emissions
    - Minimize idling time and unnecessary operation of internal combustion engine powered equipment
- For diesel powered equipment
    - Utilize diesel powered equipment meeting Tier 2 or higher emissions standards to the maximum extent feasible.
    - Utilize portable construction equipment registered with the States portable equipment registration program
    - Utilize low sulfur diesel fuel and minimize idle time
    - Ensure all heavy duty diesel powered vehicles comply with state and federal standards applicable at time of purchase.
    - Utilize diesel oxidation catalyst and catalyzed diesel particulate filters or other approved emission reduction retrofit devices installed on applicable construction equipment used during individual projects.
- To control dust emissions:
    - Spray down construction sites with water or soil stabilizers
    - Cover all hauling trucks
    - Maintain adequate freeboard on haul trucks
    - Limit vehicle speed in unpaved work areas
    - Suspend work during periods of high wind or
    - Install temporary windbreaks
    - Use street sweeping to remove dust from paved roads during earth work
- Monitor on-site air quality in relations to local agency and Air District standards and mitigate impacts
- Earthwork in areas known to contain naturally occurring asbestos.
    - Relocate earthwork to avoid geologic material containing asbestos
    - Develop asbestos dust mitigation plan in accordance with local air quality management district requirements
    - Spray down construction sites with water or soil stabilizers
    - Pre-wet the ground to the depth of anticipated cuts;
    - Suspend grading operations when wind speeds are high

- Apply water prior to any land clearing; or
- Shake or wash wheels of vehicles leaving sites
- Cover all exposed piles

While this mitigation would likely reduce the impacts to air quality to less than significant, these required actions are outside of the jurisdiction of the water boards to implement and enforce. Instead, mitigation would need to be identified and enforced by the local permitting agencies, the California Air Resources Board and/or the local air district. Therefore, these impacts may be significant and unavoidable.

Alternative 2 would consist of an amendment to the Ocean Plan that allows a greater range of intake methods and discharge technologies than Alternative 1. Despite the greater range of options, the reasonably foreseeable intake methods and discharge technologies would require similar construction techniques and resulting air impacts related to construction as in Alternative 1. Air quality impacts associated with construction could be mitigated to less than significant by implementing the construction related practices described for Alternative 1. Alternative 2 should not create significant impacts to air quality associated with the operation of the facility. Any air quality impacts would be largely a function of power generation as described in section 12.1.3. As discussed in Alternative 1, any power savings from reduction in pumping energy requirements would be offset by energy required for pretreatment.

Mitigation for construction impacts would be the same as alternative 1. While this mitigation would likely reduce the impacts to air quality to less than significant, these required actions are outside of the jurisdiction of the water boards to implement and enforce. Instead, mitigation would need to be identified and enforced by the local permitting agencies, the California Air Resources Board and/or the local air district. Therefore, these impacts may be significant and unavoidable. However, these impacts are outweighed by the overriding need to minimize intake and mortality of aquatic life, minimize water quality impacts, and ensure that discharges do not impair beneficial uses of waters of the state

Alternative 3 would consist of an amendment to the Ocean Plan that allows for an open uncontrolled intake and a simple large diameter outfall or channel. This alternative would be the least complex alternative from a construction standpoint, and all reasonably foreseeable desalination facilities would require at least the same level of construction activities and have the same air quality impacts as described in 12.1.3. Operation of the facility would have no significant impact for the reasons described in Alternatives 1 & 2. As a result, this alternative would be less than significant.

Alternative 4 would consist of an amendment to the Ocean Plan that differs from Alternative 2 only in regards to the receiving water limit of 5 percent above background salinity following completion of initial dilution. The same assumptions stated in Alternative 2 apply to this Alternative, and therefore, we would conclude that these impacts may be significant and unavoidable.

Alternative 5 represents the “no project alternative.” Under this alternative there would be no amendment of the Ocean Plan to specifically address intakes and outfalls associated with desalination facilities. As a result, this alternative would result in no additional requirements that would affect the construction and operation of a desalination facility. Air emissions would be the same as would occur in absence of this policy. As a result, there would be no impact to Air Quality from Alternative 5.

12.4.3 Biological Resources

Alternative 1 would not have direct effects on biological resources, but indirectly would require new and expanded facilities to construct and operate subsurface intakes and multiport diffusers capable of meeting the receiving water limit.

Impacts to biological resources associated with onshore and marine construction activities are similar to those described in section 12.1.4, except that onshore impacts could be greater if a facility used a distributed system of vertical wells that would require a larger facility footprint than would occur in absence of Alternative 1. Marine construction impacts could be significantly greater or less than would occur in absence of Alternative 1 depending on the type of intake structure used. For example, as noted in 8.3.2, slant wells may have no impact on marine habitat as construction may occur in areas uninhabited by marine organisms. Vertical beach well intakes will have minimal on marine habitat as most construction activities will occur in areas uninhabited by marine organisms. Whereas offshore infiltration galleries can require complete substrate replacement and ongoing maintenance in order to ensure continued longevity. In the case of expanded facilities, compliance with Alternative 1 may also require decommissioning existing facilities which could result in additional impacts to the marine environment.

Construction related impacts to biological resources are discussed in detail in Sections 12.1.4 and 8.3.2. Specifically those sections noted that construction activities could result in the following potentially significant adverse impacts to biological resources:

- Loss or modification of sensitive habitat including habitat for sensitive species identified in table 12-10 and 12-11. Potentially affected habitat is also discussed in detail in section 7.
- Conversion of riparian or wetland habitat supporting a variety of resident and migratory species
- Disturbance or interference with fish migration patterns due to underwater pile-driving noise during reconstruction facility infrastructure.
- Adverse impacts to migratory bird nesting and feeding habitat
- Disturbance of marine and onshore habitat through generation of noise and vibration.

During the operation of a desalination facility, a subsurface intake would have no impact on biological resources because these intakes collect seawater from beneath the ocean floor or from saturated sediments beneath a beach. As a result, under Alternative 1, neither impingement nor entrainment would occur as a result of seawater intake. Nor would discharge have a significant impact on biological resources because the brine would be discharged through a diffuser to maximize turbulent mixing. In addition the discharge would need to meet the receiving water limit at the edge of the mixing zone. The proposed salinity objective of two ppt above that which occurs naturally is protective of aquatic life based on studies conducted by the Marine Pollution Studies Laboratory (Phillips et al. 2012) and a summary of previous studies is presented by Roberts et al. 2010. This alternative is also consistent with the State Water Board's Expert Panel on impacts and effects of brine discharges (Roberts et al. 2012; Foster et al. 2012 and 2013) recommendation for salinity.

The Expert Panel (Foster et al. 2013) did identify the discharge from multiport diffusers as a potential cause of mortality to planktonic organisms near the discharge port. This mortality is thought to be caused by shear stress as the organisms become entrained in the turbulent jet. However, few detailed studies have been conducted to evaluate these effects under controlled conditions. (Foster et al. 2013) Further, any potential impact from the discharge point would be limited to within a few meters of the point of discharge since the discharge velocity is reduced rapidly as the plumes cross-sectional area expands.

While site specific factors make any detailed analysis of required mitigation speculative, mitigation for construction and operational impacts is generally expected to be similar to that discussed in 12.1.4, which included:

- commingling brine waste with other waste streams to dilute brine concentration to near ambient
- construction surveys,
- relocation of impacted species
- noise abatement
- consultation with NOAA Fisheries and CDFW to identify seasonal work windows, avoidance technology and required monitoring
- obtaining Clean Water Act section 404 permit from the US Army Corp to Engineers to mitigate for impacts to wetlands.
- exclusion buffers and postponement of activities till after nests have been vacated.
- avoidance or replacement of trees greater than a specific size and at a ratio agreed upon with local permitting agencies.

Finally, Alternative 1 would require new or expanded desalination facilities to fully mitigate for all marine life mortality associated with construction and operational activities. The mitigation requirements would be the same as the Desalination Amendment and are discussed in detail in Section 8.5. As supported by the review of currently planned projects (section 12.1.4), mitigation would likely reduce the impacts to biological resources to less than significant, however many of the required mitigation measures are outside of the jurisdiction of the water boards. For example, the regional board can require desalination facilities to commingle brine, establish enforceable conditions within 404 permits, and can require the mitigation for intake and mortality described above. However, requiring construction surveys, construction buffers and tree replacement are not under the jurisdiction of the water boards, and mitigation would be enforced by the appropriate state or local permitting agency. Therefore, these impacts may be significant and unavoidable.

Alternative 2 would consist of an amendment to the Ocean Plan that allows for a greater range of intake methods and discharge technologies than Alternative 1. As noted in section 12.2, under this alternative, a proposed desalination facility could choose to construct and operate a facility equivalent to Alternative 1, in which case the project would have equivalent impacts to Alternative 1. Conversely, a proposed facility could choose new methods and technologies that are not foreseeable at this time. In that case, impacts and mitigation are speculative and would need to be evaluated during subsequent project specific CEQA evaluations. The rest of the analysis for Alternative 2 will assume that the a proposed desalination facility would include the construction and operation of a surface water intake designed to limit intake velocity to no greater than 0.5 feet per second in combination with mesh screens having slot opening sizes that could range from 0.5 to 1 millimeter. Based on the existing and planned facilities evaluated in section 12.1, this slot size is likely to be significantly smaller than what would occur in absence of the alternative. This difference will result in potentially significant construction and operational impacts.

Impacts to biological resources associated with onshore and marine construction activities are similar to those described in section 12.1.4 and 8.3.1, except that the smaller screen slot size would likely require surface intakes to be larger or potentially more numerous than would occur in absence of the alternative. This could increase the magnitude of construction impacts over those identified in 12.1.4, though it would be speculative to try to quantify the increase. The final size and number of intakes could differ based on which screen size the State Water Board chooses to adopt. In the case of expanded facilities, compliance with Alternative 2 may also require decommissioning existing facilities and constructing new facilities that meet the intake and discharge requirements. However, given the added flexibility in facility design, this is less likely than Alternative 1.

The construction related impacts identified in Sections 12.1.4 and 8.3.1 included the following potentially significant adverse impacts to biological resources:

- Loss or modification of sensitive habitat including habitat for sensitive species identified in table 12-10 and 12-11. Potentially affected habitat is also discussed in detail in section 7.
- Conversion of riparian or wetland habitat supporting a variety of resident and migratory species
- Disturbance or interference with fish migration patterns due to underwater pile-driving noise during reconstruction facility infrastructure.
- Adverse impacts to nesting and feeding habitat
- Disturbance of marine and onshore habitat through generation of noise and vibration.

With regard to operational impacts, U.S. EPA (2011) determined that an intake velocity of 0.5 feet per second, such as what would be required by Alternative 2, is less likely to harm fish that are consequently able to detect and escape the physical pull of the intake at that intake velocity. In the studies they reviewed, impingement was reduced by 96 percent at velocities of 0.5 feet per second or less. This threshold has been applied in multiple federal regulations, including the Phase I 316(b) rule. Fine-mesh cylindrical wedgewire screens, such as what would be required by Alternative 2, can reduce entrainment, preventing anything larger than the specified slot size from passing through, though larger soft bodied organisms may be compressed and pulled in as well. However, pass-through would depend on the plasticity of the organism as well as intake velocity and slot size. Smaller planktonic organisms including early life stages of black abalone a federally listed Threatened and Endangered species may not be protected from entrainment by this alternative. There are more impingement and entrainment impacts compared to Alternative 1 because Alternative 1 completely eliminates impingement and entrainment by use of subsurface intakes.

As with Alternative 1, the discharge of waste brine is not expected to have a significant impact on biological resources because the brine would be discharged through a diffuser to maximize turbulent mixing. In addition the discharge would need to meet the receiving water limit at the edge of the mixing zone. The proposed salinity objective of two ppt above that which occurs naturally is protective of aquatic life based on studies conducted by the Marine Pollution Studies Laboratory (Phillips et al. 2012) and a summary of previous studies is presented by Roberts et al. 2010. This alternative is also consistent with the State Water Board's Expert Panel on impacts and effects of brine discharges (Roberts et al. 2012; Foster et al. 2012 and 2013) recommendation for salinity.

Also as with Alternative 1, the Expert Panel (Foster et al. 2013) did identify the discharge from high velocity multiport diffusers as a potential cause of mortality to planktonic organisms near the discharge port. This mortality is thought to be caused by shear stress as the organisms become entrained in the turbulent jet. However, few detailed studies have been conducted to evaluate these effects under controlled conditions. (Foster et al. 2013) Further, any potential impact from the discharge point would be limited to within a few meters of the point of discharge since the discharge velocity is reduced rapidly as the plumes cross-sectional area expands.

While site specific factors make any detailed analysis of required mitigation speculative, mitigation for construction and operational impacts is generally expected to be similar to that discussed in 12.1.4, which included:

- comingling brine waste with other waste streams to dilute brine concentration to near ambient
- construction surveys,
- relocation of impacted species
- noise abatement
- consultation with NOAA Fisheries and CDFW to identify seasonal work windows, avoidance technology and required monitoring
- obtaining Clean Water Act section 404 permit from the US Army Corp to Engineers to mitigate for impacts to wetlands.
- exclusion buffers and postponement of activities till after nests have been vacated.
- avoidance or replacement of trees greater than a specific size and at a ratio agreed upon with local permitting agencies.

Like Alternative 1, Alternative 2 would require new or expanded desalination facilities to fully mitigate for all marine life mortality associated with construction and operational activities. The mitigation requirements would be the same as the Desalination Amendment and are discussed in detail in Section 8.5. As supported by the review of currently planned projects (section 12.1.4), mitigation would likely reduce the impacts to biological resources to less than significant, however many of the required mitigation measures are outside of the jurisdiction of the water boards. For example, the regional board can require desalination facilities to comingle brine, establish enforceable conditions within 404 permits, and can require the mitigation for intake and mortality described above. However, requiring construction surveys, construction buffers and tree replacement are not under the jurisdiction of the water boards, and mitigation would be enforced by the appropriate state or local permitting agency. Therefore, these impacts may be significant and unavoidable. However, these impacts are outweighed by the overriding need to minimize intake and mortality of aquatic life, minimize water quality impacts, and ensure that discharges do not impair beneficial uses of waters of the state

Alternative 3 would consist of an amendment to the Ocean Plan that allows for an open uncontrolled intake and a simple large diameter outfall or channel. This alternative would eliminate impingement, but only by allowing unconstrained entrainment. A simple large diameter outfall would provide little dilution of the effluent upon discharge. This incomplete mixing of the effluent with the receiving water may cause salinity related stresses to biological resources and sensitive habitats if located in close proximity to the discharge. These impacts are similar in nature but much more severe than Alternatives 1 and 2 because there is no control for intakes and no control for discharges in preventing marine life mortality. As with Alternatives 1 and 2, this Alternative would include a requirement for full mitigation of intake and mortality to marine resources and onshore resources. However, other construction and operation impacts discussed in Alternatives 1 and 2 would still occur. These impacts may be significant and unavoidable.

Alternative 4 is similar to Alternative 2 and only differs in the receiving water limit where the difference between the plume and the natural salinity must not exceed 5 percent. Given the natural range of salinity, between 33 and 34 ppt, a 5 percent does not differ significantly from Alternative 2 and would provide similar impacts and require similar mitigation. As a result, impacts from this alternative may be significant and unavoidable.

Alternative 5 represents the “no project alternative.” Under this alternative there would be no amendment of the Ocean Plan to specifically address intakes and outfalls associated with desalination facilities. As discussed previously, a regional water board would have the flexibility to identify appropriate technologies to protect water quality from impacts associated with desalination intakes and outfalls discharging brine. Under this alternative, a regional water board could require an open intake and a simple large diameter outfall. Conversely, for new discharges, a regional water board could also require open surface water intake, a screened surface water intake or subsurface intake. While the former could have significant impacts on biological resources through entrainment, impingement, and water quality impacts associated with elevated salinity, the latter could result in impacts similar to that described under Alternative 1. Furthermore, this alternative doesn’t include a requirement for mitigation of marine resources, although the regional boards would still have the Porter Cologne section 13142.5(b) requirement to make their own determinations and require the use of best available site, design, technology, and mitigation measures to minimize the intake and mortality of all forms of marine life. Impacts associated with brine discharge, as well as construction related impacts similar to those identified in Alternative 1 may be significant and unavoidable.

12.4.4 Greenhouse Gas Emissions

Alternative 1 1 would consist of an amendment to the Ocean Plan that would require a desalination facility to withdraw seawater through a subsurface intake, and discharge waste brine through either a commingled effluent outfall, or through a diffuser capable of achieving a receiving water limit of 2 ppt above background salinity following completion of initial dilution. Under this alternative, adoption of the project alternative as an amendment to the Ocean Plan would not in itself directly cause or result greenhouse gas emissions. Indirectly, implementation of the alternative, by a regional water board through the permitting process would require a permittee to operate subsurface intake structures on shore and outfalls capable of achieving the necessary dilution to meet the receiving water limit. Other aspects of the desalination facility, and greenhouse gas emissions associated with the construction and operation of these facilities would be unaffected by Alternative 1. As a result, the reasonably foreseeable greenhouse gas emissions are limited to construction and operation of the intake and discharge structures.

As described in 12.1.7, greenhouse gas emissions from the operation of a desalination facility would be largely a function of power generation. Similar to the assessment of air quality in Alternative 1(section 12.4.2), electricity required to pump subsurface water from an estimated depth of 50 meters could require a 5 to 10 percent increase in electricity over open surface intakes. However, this increase in pumping energy would be offset by a 13 percent reduction in energy required for a pretreatment process. As a result use of subsurface intakes would not substantially change the power generation related to intake of seawater.

Construction related greenhouse gas emissions for Alternative 1 would predominantly come from exhaust emissions resulting from the use of construction equipment (including, but not limited to: graders, dozers, back hoes, haul trucks, stationary electricity generators, vessels and construction worker vehicles). These emissions may exceed local thresholds of significance. Mitigation for greenhouse gas emissions would include the same activities as discussed in the Air Quality impacts section (12.4.2). While this mitigation would likely reduce greenhouse gas emissions to less than significant, these required actions are outside of the jurisdiction of the water boards to implement and enforce. Instead, mitigation would need to be identified and enforced by the local permitting agencies, the California Air Resources Board and/or the local air district. Therefore, these impacts may be significant and unavoidable.

Alternative 2 would consist of an amendment to the Ocean Plan that allows a greater range of intake methods and discharge technologies than Alternative 1. Despite the greater range of options, the reasonably foreseeable intake methods and discharge technologies would require similar construction techniques and resulting in similar greenhouse gas emissions related to construction as in Alternative 1. Alternative 2 should not create significant impacts to air quality associated with the operation of the facility. Any greenhouse gas emissions would be largely a function of power generation as described in section 12.1.3. As discussed in Alternative 1, any power savings from reduction in pumping energy requirements would be offset by energy required for pretreatment.

Mitigation for greenhouse gas emissions would include the same activities as discussed in the Air Quality impacts section (12.4.2). While this mitigation would likely reduce greenhouse gas emissions to less than significant, these required actions are outside of the jurisdiction of the water boards to implement and enforce. Instead, mitigation would need to be identified and enforced by the local permitting agencies, the California Air Resources Board and/or the local air district. Therefore, these impacts may be significant and unavoidable. However, these impacts are outweighed by the overriding need to minimize intake and mortality of aquatic life, minimize water quality impacts, and ensure that discharges do not impair beneficial uses of waters of the state

Alternative 3 would consist of an amendment to the Ocean Plan that allows for an open uncontrolled intake and a simple large diameter outfall or channel. This alternative would be the least complex alternative from a construction standpoint, and all reasonably foreseeable desalination facilities would require at least the same level of construction activities and have the same greenhouse gas emissions as described in 12.1.7. Operation of the facility would have no significant impact for the reasons described in Alternatives 1 & 2. As a result, this alternative would be less than significant.

Alternative 4 differs from Alternative 2 only in regard to the statement of the receiving water limit. It would result in the same level of impacts described under Alternative 2 and resulting impacts may be significant and unavoidable.

Alternative 5 represents the “no project alternative.” Under this alternative there would be no amendment of the Ocean Plan to specifically address intakes and outfalls associated with desalination facilities. As a result, this alternative would result in no additional requirements that would affect the construction and operation of a desalination facility. Air emissions would be the same as would occur in absence of this policy. As a result, there would be no increase in greenhouse gas emissions Air Quality from Alternative 5.

12.4.5 Hydrology and Water Quality

Alternative 1 would have similar construction related impacts as those described in section 12.1.9. As such, it is unlikely that construction and operation of a coastal desalination facility would alter the drainage of streams or rivers, place housing or structures within flood plain, or redirect or impede flood waters, or expose people or structures to significant risk or loss due to flooding. It is possible that a subsurface intake could cause or exacerbate saltwater intrusion into freshwater wells, but it is unlikely that the regional water boards or other permitting agencies would approve such a project. One important factor to consider would be the quality and quantity of water to be pumped into the intake system. Another important factor to consider is the yield required to meet the anticipated need and ability to maintain adequate flows over the life of the project. If surface or subsurface potable water supplies are located nearby, they could potentially be impacted by pumping from subsurface wells. Additional studies may be necessary to assess potential impacts under a range of pumping rates. If pumping from the subsurface intakes has the potential to alter groundwater flow to freshwater aquifers and wells, then the intake may need to either be relocated or flow rates reduced so existing aquifers are not affected.

This alternative would not otherwise impact water quality as the alternative would require the discharge of brine to the receiving water through a multiport diffuser to ensure the discharge meets the receiving water limit of no more than 2 ppt above background salinity upon completion of initial dilution. This limit was selected based on the results from the Brine Panel and Granite Canyon studies, the Panel recommended that salinity should not be elevated over 5 percent or 2 ppt above natural background salinity. The Panel reported the salinity objective should be based on the most sensitive species. Since salinity toxicity studies were not done for all organisms in the California marine environment, the 2 ppt limit may be overly conservative for some species, but not conservative enough for others. However, the majority of the studies on elevated salinity showed effects were not seen below 2 to 3 ppt above natural salinity. (Roberts et al. 2012) The intake of seawater and discharge of brine through a diffuser would be prohibited within MPAs, SWQPAs, areas of high biological productivity, or in areas where there are sensitive habitats and organisms, including threatened and endangered species. Studies will be necessary to design diffusers that provide adequate dilution in the receiving water. Biological and ecological studies will be required to provide a baseline prior to construction and operation. The baseline would be used to develop mitigation for construction and operational activities. This alternative would also require biological and ecological studies and monitoring to address mitigation for impacts appropriately. Implementation of this alternative would have a less than significant impact on water quality in comparison to baseline because mitigation will be required to fully mitigate for impacts.

Alternative 2 would also have construction related impacts from foreseeable intake methods and discharge technologies similar to Alternative 1 and those described in section 12.1.9. As such, it is unlikely that construction and operation of a coastal desalination facility would alter the drainage of streams or rivers, place housing or structures within flood plain, or redirect or impede flood waters or expose people or structures to significant risk or loss due to flooding. Operational impacts would also be similar to Alternative 1, except that the potential for seawater intrusion would be absent from facilities that choose surface water intakes. Construction and operation impacts from alternative intake methods and discharge technologies that are not yet developed may have different impacts, but these impacts are not reasonably foreseeable and would require additional project level CEQA review. Similar to Alternative 1, Alternative 2 would have similar siting of the intake and outfalls to avoid impacts to sensitive species and habitats. Like Alternative 1, this alternative would also require biological and ecological studies and monitoring to address mitigation for impacts appropriately. This alternative will also require mitigation for new or expanded facilities, therefore making this alternative result in a less than significant impact to no impact on water quality for new or expanded facilities. Existing facilities may have an area that extends 100 m from the discharge in which salinity could be elevated to impact water quality; however, existing facilities have a very small discharge and would not cause a significant impact. For all new, existing, and expanded facilities, mitigation is not required for impacts occurring within the 100 m zone. Alternative 2 does not include mitigation for this impact for existing facilities; however, the impacts could be less than significant if mitigation is incorporated.

Alternative 3 would consist of an amendment to the Ocean Plan that allows for an open uncontrolled intake and a simple large diameter outfall or channel. Construction of this alternative would have impacts no worse than Alternatives 1 and 2 and could actually have fewer impacts as the facilities could be significantly less complex and correspondingly less difficult to construct. However, under this alternative, there would be no requirement to ensure effluent mixing sufficient to meet ambient salinity concentrations. Instead, desalination facilities could discharge dense, non-buoyant plumes of high salinity water (i.e., above 2 ppt over natural background salinity), which would adversely affect water quality as described in 8.6. Specifically, such a plume could result in osmotic stress or shock, the potential formation of hypoxic or anoxic zones, endocrine disruption, compromised immune function, acute or chronic toxicity, and in extreme conditions, death for marine organisms. This alternative could result in impaired water quality that would not be supportive of marine beneficial uses; therefore this impact would be considered significant. Mitigation could include increasing the amount of intake water to provide for sufficient flow augmentation to dilute the brine, but with an uncontrolled intake, this would result in excess aquatic life mortality. Therefore, this alternative would have significant, unavoidable impacts.

Alternative 4 differs from alternative 2 only in regards to the statement of the receiving water limit. In most locations, a 5 percent salinity range is roughly equivalent to 2 ppt. However, under Alternative 4, the actual receiving water limit would vary among facilities based on a facility's natural background salinity. When natural background salinity is higher, the receiving water limit for salinity would allow a greater salinity range than when natural background salinity is lower. For example if natural background salinity is 36 ppt a 5 percent receiving water limit would limit salinity to 1.8 ppt above natural background salinity, whereas if natural background salinity is 32 ppt a facility would be held to a limit 1.6 ppt above natural background salinity. This alternative would result in the same level of impacts to hydrology and water quality described under Alternative 2 and would be less than significant.

Alternative 5 is unlikely to alter the drainage of streams or rivers, place housing or structures within flood plain, or redirect or impede flood waters or expose people or structures to significant risk or loss due to flooding. However, under Alternative 5, the potential impacts to water quality may vary and in some instances may be significant and unavoidable depending upon the specific approaches employed by the regional water boards to protect water quality.

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